Abstracts

20th Colloquium
on
Latin American Earth Sciences

Kiel, Germany
11 - 13 April 2007

Contents

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Scientific Program

THEMES / SESSIONS

Code	Theme/Session
AN	The Andes and Adjacent Regions
BA	Basins and Sedimentology
CT	Caribbean Tectonics
EN	Environment, Climate and Landscapes
ER	Economic Resources: Minerals, Energy & Water
HZ	Hazard Monitoring and Mitigation
LI	Life from Fossils to Humans
SZ1	Subduction Zones: Input, Fore-arc and Seismogenic Zone
SZ2	Subduction Zones: Volcanism & Magmatism

Code	Additional Posters Themes
CO	Continential Geology, Tectonics and Structure
GG	Geodesy, Geophysics & Geodata

LAK 2007 Program, Tuesday 10.04.2007

1800 -2100	Registration and Icebreaker (Geology Museum)

LAK 2007 Program, Wednesday 11.04.2007

0800 - 0900	Registration and poster hanging

TIME	Lecture Hall HSH *Chair: H.-J. Götze*	
0900 - 0935	Welcome & Introduction	
0940 - 1010	Key note	Clavero, J.
1010 - 1040	Key note	Hoernle, K

1040 - 1110 COFFEE BREAK

LAK 2007 Program, Wednesday 11.04.2007 (continued)

TIME	Lecture Hall HSA *Chair: P. Wigger*		Lecture Hall HSF *Chair: G. Alfaro*		Lecture Hall HSK *Chair: J. Bundschuh*	
1110 - 1130	SZ101	Comte, D.	ER01	Charrier, R.	EN01	Zech, R.
1130 - 1150	SZ102	Krawczyk, C.M.	ER02	Peregovich, B.	EN02	Walde, D.H.G.
1150 - 1210	SZ103	Stipp, M.	ER03	Benitez, E.	EN03	Rondanelli, M.
1210 - 1230	SZ104	Ivandic, M.	ER04	Masuch Oesterreich, D.	EN04	Wallner, J.
1230 - 1250	SZ105	Bürk, D.			EN05	Horn, A.H.
1250 - 1310					EN06	Pereira, B.R.B.

1250 - 1400 LUNCH

TIME	Lecture Hall HSH *Chair: K. Hoernle*	
1400 - 1430	Key note	Bundschuh, J.
1430 - 1500	Key note	Cabral, A.R.

1500 - 1520 POSTER SESSION

1520 - 1540 POSTER SESSION

1540 - 1610 POSTER SESSION / COFFEE

TIME	Lecture Hall HSA *Chair: C. Krawczyk*		Lecture Hall HSF *Chair: D. Rubiolo*		Lecture Hall HSK *Chair: G. Soto*	
1610 - 1630	SZ106	Juan Diaz-Naveas, J.	ER05	Alfaro, G.	HZ01	Climent, A.
1630 - 1650	SZ107	Weinrebe, W.	ER06	Moya, P.	HZ02	Strauch, W.
1650 - 1710	SZ108	Herms, P.	ER07	Giron, J.	HZ03	Gutierrez, V.
1710 - 1730	SZ109	Dinc Akdogan, A.N.	ER08	Yutsis, V.	HZ04	Funes, G.

1930 - 2130	Evening Public Lectures (Lecture Hall HSH)
The UN International Year of Planet Earth and Latin America	Eder, W.
The Atacama Desert region of northern Chile: Its geological and geobiological setting and special relationship with microorganisms	Chong, G.
The Future Ocean	Schneider, R.

LAK 2007 Program, Thursday 12.04.2007

TIME	Lecture Hall HSH *Chair: W. Rabbel*	
0900 - 0930	Key note	Alvarado, G.E.
0930 - 1000	Key note	Tassara, A

1000 - 1010 TRANSFER

TIME	Lecture Hall HSD *Chair: C. Prezzi*		Lecture Hall HSF *Chair: M. Meschede*		Lecture Hall / HSK *Chair: W. Strauch*	
1010 - 1030	SZ110	Perdomo, R.	CT01	Schmitz, M.	HZ05	Soto, G.J.
1030 - 1050	SZ111	Protti, M.	CT02	Denyer, P.	HZ06	Hernadez, W.
1050 - 1110	SZ112	Victor, P.	CT03	Wobbe, F.	HZ07	Espinosa, T.

1110 - 1140 COFFEE BREAK

TIME	Lecture Hall HSD *Chair: V. Ramos*		Lecture Hall HSF *Chair: D. Völker*		Lecture Hall HSK *Chair: G. Alvarado*	
1140 - 1200	BA01	Adams, C.J.	CT04	Cobiella-Reguera, J.	SZ201	Arévalo, C.
1200 - 1220	BA02	Rubinstein, N.	CT05	Meschede, M.	SZ202	Breitkreuz, Ch.
1220 - 1240	BA03	Martins-Neto, M.A.	CT06	Stanek, K.P.	SZ203	Pérez, W.
1240 - 1300	BA04	Velasco-Segura, J.A.	CT07	Maresch, W.V.	SZ204	Schmincke, H.-U.

1250 - 1400 LUNCH

TIME	Lecture Hall HSH *Chair: K. Hoernle*	
1400 - 1430	Key note	González, A.H.
1430 - 1500	Key note	Kay, S. M.

1500 - 1520	**POSTER SESSION**
1520 - 1540	**POSTER SESSION**
1540 - 1600	**POSTER SESSION**
1600 - 1630	**POSTER SESSION / COFFEE**

LAK 2007 Program, Thursday 12.04.2007 (continued)

TIME	Lecture Hall HSD *Chair: G. Wörner*		Lecture Hall HSF *Chair: W. Stinnesbeck*		Lecture Hall HSK *Chair: J. Diaz-Naveas*	
1630 - 1650	AN01	Mamani, M.	LI01	Leppe, M.	SZ205	*Navarro, P.*
1650 - 1710	AN02	Cardona, A.	LI02	Brenner, W.	SZ206	Pulgarin, B.
1710 - 1730	AN03	Grosse, P.	LI03	Erdtmann, B.-D.	SZ207	Wegner, W.
1730 - 1750	AN04	Rubiolo, D.	LI04	Salazar, C.	SZ208	Gonzalez, G.

1930 - 2300	Social Event (Lithothek, IfM-GEOMAR)

LAK 2007 Program, Friday 13.04.2007

TIME	Lecture Hall HSH *Chair: R. Hackney*	
0900 - 0930	Key note	Oncken, O.
0930 - 1000	Key note	Ramos, V

1000 - 1010 TRANSFER

TIME	Lecture Hall HSD *Chair: A. Tassara*		Lecture Hall HSF *Chair: H. Miller*		Lecture Hall HSK *Chair: C. Breitkreuz*	
1010 - 1030	AN05	Prezzi, C.	LI05	Aceñolaza, G.	SZ209	Schaaf, P.
1030 - 1050	AN06	Brasse, H.	LI06	Schmincke, H.-U.	SZ210	Freundt, A.
1050 - 1110	AN07	Folguera, A.	LI07	Koutsoukos, E.A.M.	SZ211	Heydolph, K.
1110 - 1130	AN08	Richter, A.	LI08	Ifrim, C.	SZ212	Kutterolf, S.

1130 - 1200 COFFEE BREAK

TIME	Lecture Hall HSH *Chair: R. Hackney*	
1200 - 1230	Key note	Pritchard, M.E.

TIME	Lecture Hall HSH
1230 - 1300	POSTER PRIZE + CLOSING

Abstracts

KN

Keynote

KN01 – Wed., 11.4., 10:10 - 10:40 · HSH

Hoernle, K. (IFM-GEOMAR), present and past members of SFB 574 (CAU Kiel and IFM-GEOMAR)

Volatiles and Fluids in Subduction Zones: Climate Feedback and Trigger Mechanisms for Natural Disasters - An Overview of the Activities of SFB 574

Collaborative research center SFB 574 at the University of Kiel investigates the role of fluid and volatile cycling in the Central American subduction zone through integrated geological, geophysical, volcanological, petrological and geochemical studies. Twelve scientific projects are evenly distributed between three major themes:

1) Subduction zone structure and tectonics,

2) fore-arc volatile turnover and fluid flow, and

3) transfer of fluids/volatiles from the slab through the wedge and arc to the atmosphere.

Extensive on- and offshore campaigns have been carried out along the entire Central America subduction system extending from Guatemala to Panama contributing to all themes. Highlights include physical and chemical characterization of the input, in particular, demonstrating the presence of serpentinites in areas where faults created by the bending of the incoming oceanic plate penetrate into the upper lithospheric mantle offshore of Nicaragua to Guatemala. These serpentinites may provide the major source of water causing melting beneath some parts of the subduction zone. Hundreds of fluid venting sites at mud mounds, faults, landslide scarps and fractures have been mapped along the continental slope off Nicaragua and Costa Rica with geochemical studies of pore water indicating that the source of the fluids is the dehydration of minerals in the subducting sediments. The end of fluid release by dehydration of subducting sediment at the 150°C isotherm, where the smectite to illite transition is complete, is concurrent to the updip limit of interplate thrust earthquakes (seismogenic zone), suggesting that seismic activity may be coupled with a sharp decrease in fluid release from subducting sediments (clays). Systematic changes in the isotopic composition of volcanic front rocks from Nicaragua to Costa Rica appear to reflect changes in the subduction input (subduction of Galapagos Hotspot track beneath Costa Rica), whereas changes in isotopic composition from Nicaragua to Guatemala appear to reflect interaction of melts with increasingly thick continental lithosphere towards Guatemala. Magma fluxes, derived from widespread tephra and volcano edificevolumes, as well as volatile fluxes for H_2O, S, F and Cl have been determined for the different parts of the Central American volcanic arc. Modelling of these volatile inputs into the atmosphere is being carried out to determine the impact on the climate. Investigations in the erosive Central America subduction system are presently being concluded and work is beginning in the accretionary segment of the Chilean subduction system.

Web page: http://www.sfb574.uni-kiel.de

KN02 – Wed., 11.4., 14:00 - 14:30 · HSH

Bundschuh, J. (San Jose, Costa Rica, International Technical Cooperation Program, CIM (GTZ/BA), Frankfurt, Germany -Instituto Costarricense de Electricidad), García, M.E. (La Paz, Bolivia, Universidad Mayor de San Andrés), Cumbal, L.H. (Sangolqui, Ecuador, Scientific Research Center of the Escuela Politecnica del Ejercito), Lopez, D.L. (Athens, U.S.A., Department of Geological Sciences, Ohio University), Bhattacharya, P. (Stockholm, Sweden, Department of Land and Water Resources Engineering, KTH)

Identifying occurrences of groundwater arsenic in Latin America: a continentwide problem and challenge

E-Mail: jochenbundschuh@yahoo.com

In Argentina, Chile, Bolivia, Peru, and Mexico at least 4 million people depend on drinking water with high toxic arsenic concentrations. In most cases, arsenic originates from geogenic sources. In Argentina (and until 1970 also in Chile) over one percent of the population is exposed to the problem, whereas in Bolivia, Ecuador, Costa Rica, El Salvador, and Guatemala, arsenic in drinking water has been detected recently, but the extent of the problem and the numbers of people affected are yet unknown.

In Argentina, As has been reported in groundwater of in the Chaco-Pampean Plain, where between 1.2 and 2 million are exposed to As in drinking water with concentrations higher than 0.05 mg/L. The aquifers comprises Tertiary aeolian loess type deposits, with water soluble volcanic glass component as the principal source of As. In the Andean range, As is predominantly released by weathering/dissolution of volcanic rocks and sulfide ore deposits. This explains the high levels of As in drinking water of northern Chile. In this region, the principal drinking water source are the rivers (0.2 to 0.9 mg/L As), which originate at the flanks of the Andean mountains. Arsenic is mobilised following the snow melt and rain. Dissolution of the Andean volcanic rocks of the Andean chain adds As to the overland flow and infiltrating water and transport it to the rivers and springs, respectively. The same process explains the arsenic release to ground and surface waters in Peru and regions of the Andean Highland of Bolivia. In Peru, geogenic As contaminants are present in the Aricota lake (Ilo city), which is fed by the rivers Collazas and Salado. The central and the southern region of Bolivia‘s Andean highland (Potosí and Oruro departments, with more than 200,000 persons exposed) are the areas with the worst environmental problems related to geogenic arsenic sources. The release intothe environment is mainly natural leaching/weathering from volcanic rocks, and locally by mining activities. In Poopo basin (Oruro department), surface water samples from different rivers and Poopó lake have between 0.09 to 0.14 mg As/L in areas not affected by mining activities and up to 2.0 mg As/L in rivers influenced by mining activities. Arsenic concentrations in groundwater are in the range between 0.01 to 0.09 mg/L.

In Mexico, the release of As to drinking water supplies of Zimapán area of Mexico occurs due to both, the natural dissolution/weathering of the As rich rocks and due to mining activities (e.g. through tailings with up to 22,000 mg As/kg). As a consequence, the groundwater in the area of Zimapán has high concentrations of As (0.19 to 0.65 mg/L; average 0.38 mg/L). The Salamanca aquifer system located in Guanajuato state, is naturally affected by As from geogenic sources. At this site, the highest As concentration observed in groundwater of a well was 0.28 mg/L.

In other Latin American countries, the existence of a groundwater arsenic problem has not been properly assessed yet. This is for example the case of Nicaragua, where exposure of the population to arsenic in groundwater and related severe health effects, was reported for the first time in 1996. The source of As is geogenic and due to dissolution of volcanic rocks and the sediments of their weathering products. Highest concentrations (up to of 1.32 mg/L) of As were found in groundwater of El Zapote and Llano La Tejera towns.

In Ecuador, the occurrence of natural arsenic was found recently (2005) in the Papallacta Lagoon, in the central part of the Andean Region. This lagoon is fed by the Tambo River and geothermal residual waters showing arsenic concentrations that vary from 0.104 to 0.360 mg As/L. In addition, arsenic above the Ecuadorian standard (0.010 mg/L) was also found in springs that are used as drinking water sources in towns of Tumbaco, Guayllabamba, Cumbaya, Yaruqui, El Quinche, Pifo and Puembo in the Pichincha Province. Although arsenic contamination has not been totally identified and quantified in Ecuador, it is believed that around 200.000 people in rural areas may be exposed to arsenic ingestion by water and food consumption.

In the case of El Salvador, high concentrations of arsenic have been found in three lakes: Ilopango, Coatepeque, and Olomega. Only Ilopango and Coatepeque have been investigated. Ilopango Lake (184.9 km2) hosts more than 300,000 inhabitants in its drainage basin, many of them use its water even when high concentrations As of 0.15 to 0.77 mg/L make this water unsuitable for human consumption. Two sources of As in the Ilopango waters can be identified: (1) the internal sediments of the lake that contain arsenic rich volcanic products of the last eruptions of this caldera, and (2) the material transported to the lake by the Chaguite river, whose arsenic load originates from leaching and erosion from the volcanic deposits of the Illopango lake basin. We assume that the ash of the last calderic eruption of Ilopango (about 2000 years ago) covers all El Salvador and could be the source of As contamination for other surface and subsurface water bodies and affect other environments. At Coatepeque and Olomega lakes, hotsprings located at the lake shore and probably hot water seeping into the lakes is one of the sources of As concentration.

It can be concluded that contamination of ground and surface water by As of geogenic origin is one important environmental problem in Latin America. The As sources are predominatly sediments derived from volcanic rocks, sulfide ore bodies, and volcanic rocks. The solution of this problem is a severe challenge for the Latin American countries during the 21st century.

Web page: http://www.isgsd.org

KN03 – Wed., 11.4., 14:30 - 15:00 · HSH

Cabral, A.R. (Rhodes University, Grahamstown, South Africa)

Palladiferous gold mineralisation in Minas Gerais, Brazil

Palladiferous gold mineralisation engendered a large-scale gold rush which culminated in a majestic centre of baroque architecture in Minas Gerais, Brazil: the city of Ouro Preto, a UNESCO world heritage site. The city was named after gold nuggets, typically black in colour, the so-called *ouro preto*, or black gold. A DFG-financed research project focused on the characterisation of *ouro preto* nuggets and the poorly understood *ouro preto*-bearing mineralisation.

Ouro preto-bearing mineralisation occurs as sulphide-free, hematitic cross-cutting veins hosted by Palaeoproterozoic banded iron formation, i.e. itabirite. Gongo Soco, a hematite deposit, and Itabira, an iron-ore district, in the Quadrilátero Ferrífero of Minas Gerais, are remarkable examples of this mineralisation style (Hussak, 1904).

Gongo Soco has specular hematite-rich auriferous veins (*jacutinga*) and disseminations in itabirite and soft hematite ore. *Jacutinga* veins show enrichment in Au, Pd, Fe, Mn, Ba, Hg and Cr compared to fresh, unmineralised itabirite. Palladiferous gold is compositionally variable with respect to Pd, Ag and Hg and contains a number of inclusions of platinum-group minerals (PGM): isomertieite, mertieite-II, chrisstanleyite and selenides of empirical stoichiometry of $Pd_5(Hg,Sb,Ag)_2Se_6$ and $(Pd,Sb,Ag,Hg)_5Se_4$. Native palladium, associated with the Pd-O phase that characterises *ouro preto*, is formed by a two-stage process of alteration, from PGM through Pd-O to native palladium. Specular hematite from *jacutinga* veins has inclusions of moderately saline fluids that homogenise at about 160°C (Cabral and Lehmann, 2003; Cabral and Kwitko-Ribeiro, 2004; Lüders et al., 2005; Cabral, 2006).

Ouro preto nuggets are black in colour due in part to a Pd-O coating on palladium minerals on the surface of palladiferous gold (cf. Johnson and Lampadius, 1837). Hydrogen in Pd-O, confirmed by elastic recoil detection analysis with a heavy ion microbeam (micro-ERDA), was lost from Pd-O-bearing areas during the microanalyses, but not from goethite. This observation indicates that such a Pd-O-H phase is unstable relative to goethite. A Pd-O-H phase is transient between a PdO-like species, via a deoxygenation-dehydration process, to native palladium, which would be the stable form of palladium under supergene conditions (Cabral et al., 2004).

Itabira also has *jacutinga* veins that truncate itabirite. *Jacutinga* veins are enriched in Au, Pd, Pt, Cr, Mn and Hg in relation to the host itabirite. Palladiferous gold and PGM are commonly found as fracture infill and, more rarely, as inclusions in specular hematite. The PGM identified in the samples investigated are represented by palladseite, sudovikovite, isomertieite, atheneite and hongshiite (Kwitko et al., 2002; Cabral 2006). Hematite-hosted fluid inclusions consist of two high-temperature (>300°C) assemblages of aqueous-carbonic and aqueous inclusions. Water-rock interaction at approximately 340$\pm$ 40°C is indicated by Na/K and Na/Li geothermometers (Lüders et al., 2005). However, assemblages of mineral inclusions in palladiferous gold are suggestive of lower temperatures, i.e. <300°C (Cabral, 2006).

Cross-cutting relationships suggest that *jacutinga* emplacement at Gongo Soco and in the Itabira district is late- to post-Brasiliano orogeny ($\sim$ 0.6 Ga) in age (Galbiatti et al., 1997; Varajão et al., 2000; Cabral, 2006). Lead-Pb and U-Pb isotope data are compatible with a Brasiliano age. Fluid inclusions in quartz and hematite have narrow ranges of Na/K ratios and considerable sulphate contents. Their halogen ratios are consistent with a fluid evolved from dissolving and reprecipitating halite that was subsequently diluted.

Gongo Soco and Itabira are thought to represent the primary mineralisation from which the gold rush-sparking alluvial *ouro preto* was derived, giving rise to the Brazilian Gold Cycle (∼1695-1785). About 30 years ago, a spectacular gold rush was triggered by palladiferous gold in Amazonia, at Serra Pelada, Carajás mineral province, Pará state (Meireles and Silva, 1988; Cabral et al., 2002a, 2002b). All three deposits, Gongo Soco, Itabira and Serra Pelada, have mineralogical and geochemical characteristics of highly oxidising conditions typical of hydrothermal selenide vein-type mineralisation.

References

Cabral, A.R., 2006, Palladiferous gold mineralisation (ouro preto) in Brazil: Gongo Soco, Itabira and Serra Pelada: Stuttgart, E. Schweizerbart'sche, Geologisches Jahrbuch, Sonderhefte Reihe D, Heft SD 8, 115 p. Cabral, A.R., and Lehmann, B., 2003, A two-stage process of native palladium formation at low temperatures: evidence from a palladian gold nugget (Gongo Soco iron ore mine, Minas Gerais, Brazil): Mineralogical Magazine, v. 67, p. 453-463. Cabral, A.R., and Kwitko-Ribeiro, R., 2004, On the rosettes of 'native palladium' from Minas Gerais, Brazil: evidence from Gongo Soco: Canadian Mineralogist, v. 42, p. 683-687. Cabral, A.R., Lehmann, B., Kwitko, R., and Cravo Costa, C.H., 2002a, The Serra Pelada Au-Pd-Pt deposit, Carajás mineral province, northern Brazil: reconnaissance mineralogy and chemistry of very high grade palladian gold mineralization: Economic Geology, v. 97, p. 1127-1138. Cabral, A.R., Lehmann, B., Kwitko, R., and Cravo Costa, C.H., 2002b, Palladium and platinum minerals from the Serra Pelada Au-Pd-Pt deposit, Carajás mineral province, northern Brazil: Canadian Mineralogist, v. 40, p. 1451-1463. Cabral, A.R., Lehmann, B., Grambole, D., and Herrmann, F., 2004, Hydrogen in a natural Pd-O compound from Gongo Soco, Minas Gerais, Brazil: Canadian Mineralogist, v. 42, p. 689-694. Galbiatti, H.F., Pereira, M.C., and Fonseca, M.A., 1997, Estruturação dos corpos auríferos (jacutingas) na mina do Cauê - Itabira - MG, in Simpósio de Geologia de Minas Gerais, 9th, Ouro Preto: Boletim 14, p. 60-62. Hussak, E., 1904, Über das Vorkommen von Palladium und Platin in Brasilien: Sitzungsberichte der mathematisch-naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften, v. 113, p. 379-466. Johnson, P.N., and Lampadius, W.A., 1837, Ueberbrasilianisches Palladgold und dessen Ausbringen und Scheidung: Journal für praktische Chemie, v. 11, p. 309-315. Kwitko, R., Cabral, A.R., Lehmann, B., Laflamme, J.H.G., Cabri, L.J., Criddle, A.J., and Galbiatti, H.F., 2002, Hongshiite (PtCu) from itabirite-hosted Au-Pd-Pt mineralization (jacutinga), Itabira district, Minas Gerais, Brazil: Canadian Mineralogist, v. 40, p. 711-723. Lüders, V., Romer, R.L., Cabral, A.R., Schmidt, C., Banks, D.A., and Schneider, J., 2005, Genesis of itabirite-hosted Au-Pd-Pt-bearing hematite-(quartz) veins, Quadrilátero Ferrífero, Minas Gerais, Brazil: constraints from fluid inclusion infrared microthermometry, bulk crush-leach analysis and U-Pb systematics: Mineralium Deposita, v. 40, p. 289-306. Meireles, E. de M., and Silva, A.R.B., 1988, Depósito de ouro de Serra Pelada, Marabá, Pará, in Schobbenhaus, C., and Coelho, C.E.S., eds., Principais depósitos minerais do Brasil, Volume 3: Brasília, Departamento Nacional da Produção Mineral, Companhia Vale do Rio Doce, p. 547-557. Varajão, C.A.C., Colin, F., Vieillard, P., Melfi, A.J., and Nahon, D., 2000, Early weathering of palladium gold under lateritic conditions, Maquiné mine, Minas Gerais, Brazil: Applied Geochemistry, v. 15, p. 245- 263.

KN04 – Thu., 12.4., 09:00 - 09:30 · HSH

Alvarado, G.E. (San José-Costa Rica)

Paleo and Neo Volcanic Fronts in Central America

Paleogene to Neogene Volcanic Front/arcs in Central America are poorly known and described, however, using geological maps, field criteria, and isotopic dating (K/Ar and Ar/Ar) from the literature, is possible the reconstruction of the volcanic arcs during the Late Paleocene to Late Pleistocene. Old magmatism (60-50 Ma) is present at least from Honduras to Panama, with an apparent gap in outcrops (plutons and subaerial lavas) in Costa Rica. Only andesitic conglomerates and volcanic sandstones are found in this gap, which probably represents a marine seaway. Interesting is also the dislocation in volcanic front in the present political boundary between Honduras and Nicaragua. The other apparent gap in the volcanism is located in Guatemala, but plutons of the same age following the almost E-W volcanic arc trend from Honduras. In Panama, the Paleocene/Eocene volcanism migrated about 120 km northwards away from the trench to the present position of the volcanic front due to subduction erosion, or a change in the subduction angle. The early Middle Miocene arc in Central America (25-13 Ma) extends along all of Central America. In Guatemala it was very close to its present position. In Nicaragua the volcanic front migrated trenchward with time (about 100 km) from Late Miocene (25 Ma) to its present position, and similar situation appear to happened in Honduras. Subduction of young lithosphere (25-14 Ma), could have caused migration of volcanism landward in central and north Costa Rica. In Nicaragua it shifted towards the southwest, close to its present position. In Costa Rica there has been a 30° counterclockwise rotation of the arc from its Middle Miocene position close to the modern volcanic front. This occurred between 15 to 8 Ma (geographically continuous with the Coyol arc ages) and is attributed to deformation in the overriding plate (shortening in the south coeval with extension in the NW), accompanied by trench retreat in the north. Tectonic and magmatic activity during the Middle Miocene to Pliocene was characterized by uplift, intrusions along the inner arc, extensive volcanism, and folding with reverse and thrust faulting. Episodes of abundant arc magmatism are present at 16-12 Ma. Ignimbrites (andesites to rhyolites), related to the pre-neovolcanism (30-6 Ma) are present throughout the Central America. Most of the plutons (10-7 Ma old), were emplaced during an apparent gap in volcanism in Costa Rica. Since 8 Ma the arc was parallel to the modern volcanic front, but progressively retreated to the northeast in Costa Rica and northeast in Panama. Subduction of the Cocos ridge affected the southern part of Costa Rica by basement-rooted thrusting, back arc and intra-arc compression, volcanic arc extinction, and uplift. The rise of the Talamanca range was caused by the subduction of the Cocos ridge beneath the volcanic front, and the collision of the arc with the South American plate led to the development of Panama microplate. The age of the Cocos ridge collision with the Middle America Trench is, however, matter of debate. A few authors claim the age of collision as early as Middle Miocene, based on geological evidence, although the most accepted age at present is around 5-6.5 Ma. An age of the subduction of a submarine range or aseismic ridge (whether called Cocos or not) as old as Middle Miocene age, however, could explain several process at the same time: the subduction erosion since 16 Ma contemporary to the basement-rooted thrusting of the Fila Costeña, the uplift of Quepos-El Caño-Osa mélanges, and the absence of a volumetrically extended calc-alkaline volcanism since 14 Ma in the south part of Costa Rica. In general, the major arc or volcanic front in Central America has migrated seaward from Paleocene to the present (with the exception of Panama). During the Early Oligocene this migration was probably due to the development of a new subduction zone. During the Neogene, the migration was the product of slow

or retrograde motion of the upper plate and the subduction of relatively old lithosphere (> 25 Ma). This permitted steeper subduction and seaward migration of the trench resulted in back arc and intra-arc extension. In Costa Rica, the Late Miocene-Early Pliocene (6-3.5 Ma) volcanic front was, however, nearer to the coast and it migrated landward during the Late Pliocene-Early Pleistocene (2-1 Ma) and Late Pleistocene-Holocene (0.6-0 Ma). The most recent volcanoes (0.3-0 Ma) from the present Volcanic Front in Central America is segmented, but the reasons for that is still matter of discussion. Field mapping and accurate radiometric ages are still needed in order to establish a clear sequence of events.

KN05 – Thu., 12.4., 09:30 - 10:00 · HSH

Tassara, A. (Departamento de Geofísica, Universidd de Chile)

Compositional structure, temperature and rheology of the Andean margin: From data through models toward geodynamic implications

E-Mail: `andres@dgf.uchile.cl`

The most striking features of the western active margin of South America is the systematic along-strike variations on topography, morphology, slab geometry, deep lithospheric structure, tectonic styles and shortening, distribution and composition of active volcanism, crustal structure, and geologic history. This lead to the concept of Andean Segmentation, under which the margin can be divided in four continental-scale segments: Northern (10N-5S), Central (5S-33.5S), Southern (33.5S-46.5S) and Austral (46.5S-56S) Andes (e.g. Gansser, 1973; Jordan et al., 1983; Mpodozis and Ramos, 1989; Kley et al., 1999; Stern, 2004). Different phenomena (subducting plate structure, mantle thermal regimen, inherited crustal structure and composition, seismogenic zone structure) have been proposed as main factors controlling this segmentation (e.g. Jordan et al., 1983; Isacks, 1988; Allmendinger et al., 1997; Kley et al., 1999; Gutscher et al., 2000; Yanez et al., 2001; Lamb and Davis, 2003; Sobolev and Babeyko, 2005). This debate could benefit from a three-dimensional (3D) representation of the compositional and thermal structure of the slab-continent system at regional to continental scales, and from an independent estimate of the integrated strength of the lithosphere resulting from this structure. This presentation reviews some models proposed by the author and co-workers that, starting from the integration, analysis, modeling and inversion of geophysical data, are producing a characterization of the 3D density structure below the continental margin, the temperature distribution inside the continental lithosphere and the elastic thickness variations for the continent and surrounding oceans.

The 3D density model of the Central and Southern Andes (Tassara et al., 2006) is the result of forward modeling the Bouguer anomaly, and considers a minimum number of bodies for mantle and crust of the oceanic plate, subducted slab and continental margin to represent the density structure until 410 km depth. Each body has one value of density that was selected in accordance to its position into the model and after studying the dependency of this physical parameter on chemical composition, metamorphic pressure-temperature conditions, water content and degree of partial melting (Tassara, 2006). The Intra-Crustal Discontinuity (ICD) separating light upper crust from dense lower crust in the model is a proxy to the regional-scale lateral density variations that occur inside the crust owing to changing proportion of felsic to mafic material, spatial variations of lower crustal temperature, hydration and partial melting degrees. The geometries of other density discontinuities were preferentially fixed making use of independent information (e.g. seismic and heat flow data). The final results of the model are the digital 3D geometries of the subducted slab, lithosphere-astenosphere boundary (LAB), continental Moho and ICD. Work in progress attempts to derive a 3D temperature model for the continental lithosphere taking the geometries of the 3D density model as boundary conditions to resolve the one-dimensional conductive thermal equation. This model does not consider advective heat transport related to the movement of cold oceanic lithosphere below the continent or hot magmas toward the surface, and should be consider a reference thermal model accounting for the conduction of heat from the slab upper surface and the LAB. Both models, along with experimental rheologic parameters of typical crustal and mantle materials, can be used to construct a 3D thermo-mechanical model, which is a powerful tool to analyze the relationship between crust-mantle structure, tectono-magmatic processes and the deformation of the continental margin. Finally, Tassara et al. (2007) used a wavelet formulation of the classical spectral isostatic analysis to invert satellite-derived gravity (from CHAMP and GRACE missions) and topography/bathymetry for the elastic thickness structure of South America and surrounding plates. This parameter is a measure of the integrated strength of tectonic plates and can be used as an independent constraint for the thermomechanical structure of the Andean continental margin.

In this presentation we will try a unified interpretation of these different models in an attempt to gain insights into the geodynamic processes interacting to shape the Andean segmentation.

References

-Allmendinger, R. W., T. E. Jordan, S. M. Kay, and B. L. Isacks (1997), The evolution of the Altiplano-Puna Plateau of the central Andes, Annu. Rev. Earth Planet. Sci., 25, 139-174. -Gansser, A. (1973), Factsand theories on the Andes, J. Geol. Soc. London, 129, 93 - 131. -Gutscher, M.-A., W. Spakman, H. Bijwaard, and R. Engdahl (2000), Geodynamics of flat subduction: Seismicity and tomographic constraints from the Andean margin, Tectonics, 19, 814 - 833. -Isacks, B. (1988), Uplift of the central Andean plateau and bending of the Bolivian orocline, J. Geophys. Res., 93, 3211 - 3231. -Jordan, T., B. L. Isacks, R. W. Allmendinger, J. Brewer, V. A. Ramos, and C. J. Ando (1983), Andean tectonics related to geometry of subducted Nazca Plate, Geol. Soc. Am. Bull., 94, 341- 361. -Kley, J., C. R. Monaldi, and J. A. Salfity (1999), Along-strike segmentation of the Andean foreland: Causes and consequences, Tectonophysics, 301, 75 - 94. -Lamb, S., and P. Davis. (2003), Cenozoic climate change as a possible cause for the rise of the Andes, Nature, 425, 792-797. -Mpodozis, C., and V. A. Ramos (1989), The Andes of Chile and Argentina, in Geology of the Andes and Its Relation to Hydrocarbon and Mineral Resources, Earth Sci. Ser., vol. 11, edited by G. Ericksen, M. Canas Pinochet, and J. Reinemund, pp. 59-89, Circum-Pac. Res. Counc., Houston, Tex. -Sobolev, S., and A. Babeyko (2005), What drives orogeny in the Andes?, Geology, 33, 8, 617-620, doi: 10.1130/G21557.1 -Stern, C. (2004), Active Andean volcanism: Its geologic and tectonic setting, Rev. Geol. Chile, 31, 161 - 206. -Tassara, A. (2006), Factors controlling the crustal density structure underneath active continental margins with implications for their evolution, Geochem. Geophys. Geosyst., 7, Q01001, doi:10.1029/2005GC001040. -Tassara, A., H.-J. Gotze, S. Schmidt, and R. Hackney (2006), Three-dimensional density model of the Nazca plate and the Andean continental margin, J. Geophys. Res., 111, B09404, doi:10.1029/2005JB003976. -Tassara, A., Swain, C., Hackney, R., Kirby, J. (2007), Elastic thickness structure of South America as estimated with the fan wavelet method and satellite-derived gravity data, Earth and Planetary Science Letters, 253, 17-26, doi:10.1016/j.epsl.2006.10.008. -Yanez, G., C. R. Ranero, R. von Huene, and J. Diaz (2001), Magnetic anomaly interpretation across the southern central Andes (32S-34S): The role of the Juan Fernandez Ridge in the late Tertiary evolution of the margin, J. Geophys. Res., 106, 6325-6345.

KN06 – Thu., 12.4., 14:00 - 14:30 · HSH

González, A.H. (Museo del Desierto, Coahuila), Stinnesbeck, W. (Univ. Karlsruhe)

Prehistoric Caves in Quintana Roo, Mexico: Study of the Early Inhabitants through Underwater Archeology

This paper presents the first results of an ongoing paleoanthropological and paleontological investigation of submerged caves in the north of the Yucatan Peninsula. So far, three human skeletons were registered and recovered near Tulum, Quintana Roo, in water depths of 20 to 30 m below surface. These skeletons are between 70and >90% complete and represent the oldest human remains known to exist in southern Mexico and Central America, with ages of between 7,000 and 11,000 k.y. B.P. Adiverse and abundant assemblage of late Pleistocene mammals is also preserved in the caves, at similar depths, and bones are partially associated with human activity (e.g., fire places). Most of these animals (e.g., camels, horses, gomphotheres) are here reported for the first time for the east of the Yucatan peninsula. We suggest that the caves were used by human groups and animals near the end of the Pleistocene, when the caves were dry and the peninsula covered by grasslands.

KN07 – Thu., 12.4., 14:30 - 15:00 · HSH

Kay, S. M. (Cornell University Ithaca)

Consequences and causes of Andean shallow subduction zones: Evidence from the magmatic record between 26°S and 37°S

E-Mail: smk16@cornell.edu

Shallow subduction of the Nazca plate below the South American plate has been a common occurrence along the Andean margin since the Oligocene. The best known shallow subduction zones are the modern nearly horizontal segments under the modern Chilean and Peruvian flatslab regions. Older transient shallow zones have been proposed in the Oligocene under the southern Altiplano by James and Sacks (1999) and in the early to middle Miocene under the northern Puna by Kay et al. (1999). The most recent suggestion for transient shallow subduction has been Miocene under the Neuquén basin north of c.a. 38°S in the Miocene (papers in Kay and Ramos, 2006). Evidence for these transient shallow subduction periods comes from the timing, chemical and isotopic characteristics, and structural setting of Miocene to Holocene magmatic rocks. A simple southern temporal progression in the younging of shallow subduction along the Andean margin is interrupted by the inferred late Miocene shallowing over a broad region from 27°S to 36°S. Such shallowing shows that the southward progression of subduction of the Juan Fernandez ridge on the Nazca plate cannot be the only driving force.

The Neogene shallowing of the subducting Nazca plate between 26°S and 37°S can be examined relative to several segments. The most discussed case is for the modern Chilean flat-slab segment (28°S to 33°S) where the shallowing of the Nazca plate is inferred to have initiated at c.a. 19 Ma and to have been most pronounced after subduction of the E-W trending segment of the Juan Fernandez ridge at c.a. 10 Ma. The shallowing history has been read from the eastward expansion of arc-style magmatic rocks and contractional deformation that occurred up to a distance of c.a. 700 km east of the trench. Further south, the segment from 35°S to 37°S under the Neuquén basin experienced a similar 19 to 5 Ma eastward expansion of arc-style magmatism and contractional deformation, consistent with a contemporaneous, but less pronounced shallowing of the Nazca plate. The peak of shallowing in both regions is marked by the nearly contemporaneous eruptions of the far backarc arc-like Pocho and Chachahuén volcanic rocks. These hornblende-bearing mafic andesitic to dacitic magmas with arc-like chemistry erupted in ranges being uplifted on reverse faults at distances over 500 km east of the trench. The strongest support for an association of the Chachahuén and Pocho volcanic rocks with shallow subduction comes from an increasingly strong chemical subduction signature in magmas erupted from c.a. 8 to 5 Ma.. The case is strongest at Chachahuén, where the volcanic rocks overlie early Miocene intraplate mafic flows with no subduction component. Importantly, the magmatic and deformational pattern under the Neuquén Basin cannot be linked to the subduction of the Juan Fernandez ridge which was far to the north. After c.a. 4.7 Ma, the eruption of arc-style backarc volcanic rocks essentially ceased between 28°S and 37°S with the exception of minor centers in the San Luis volcanic field. After similar Miocene histories, a strong divergence between the southern and northern regions occurred in the Pliocene to Pleistocene as magmatism ceased over the Chilean flatslab and backarc alkaline intraplate volcanism reached voluminous proportions south of 35°S. In the intervening region from 33°S to 35°S, the arc front migrated eastward with a surge at c.a. 19 to 16 Ma as the slab initially shallowed and contraction began, and again at c.a. 8 to 4Ma during the peak of shallowing beneath the adjoining backarc regions. Unlike to the north and south, little backarc volcanism took place from 33°S to 35°S.

Taken together, the intensity of shallowing appears to reflect three primary factors. (1) General accelerated periods of westward drift of South America over the Nazca plate leading to a synchronicity of magmatic and deformational events along the margin and periods of broad scale shallowing. (2) Subduction of local features on the downgoing Nazca plate including the Juan Fernandez ridge and completely subducted features that locally accentuate the intensity of slab shallowing. (3) The general intermediate age of the subducting Nazca plate that made local factors critical in achieving or not achieving the eclogite transformation. Removal of the shallow slab leads to accelerated melting in the mantle wedge and facilitates delamination of any dense overlying continental crust. This is the case beneath the Puna north of 28°S. Crustal and mantle lithospheric delamination is not a significant factor in regions of thinner crust as under the Neuquén basin.

Selected References

Bermúdez, A., 1991, Sierra del Nevada, el limite oriental del arco volcánico neógeno entre los 35°30’-36°00’S, Argentina, VI Congreso Geológico Chileno, p. 318-322.

Kay, S.M. and Ramos, V.A. (eds.), 2006, Evolution of an Andean Margin: A tectonic and magmatic view from the Andes to the Neuquén Basin (35°-39°S lat.), Geological Society of America Special Paper 407: see particularly Chapters 2, 9 and 10.

Kay, S.M. and Mpodozis, C., 2002, Magmatism as a probe to the Neogene shallowing of the Nazca plate beneath the modern Chilean flatslab: Journal South America Earth Science., v. 15, p. 39-58.

KN08 – Fri., 13.4., 09:00 - 09:30 · HSH

Oncken, O. (GFZ Potsdam), TIPTEQ Research Groups (Universidad de Concepcion (Concepcion and Los Angeles), SEGMI (Santiago), GFZ Potsdam, FU Berlin, BGR Hannover, IfM-GEOMAR Kiel, Universities Potsdam, Hamburg, Kiel, Bremen, Freiburg)

What controls mega-thrust earthquakes at convergent margins and the related surface deformation - the project TIPTEQ in Southern Chile

Convergent continental margins are the Earth's principal locus of important earthquake hazards with nearly all interplate megathrust earthquakes (M>8) in the seismogenic coupling zone between the converging plates. Despite the key importance of this zone, the associated processes that shape it are poorly understood. The vision of project TIPTEQ is a quantitative understanding of megathrust earthquake seismicity in subduction zones, and its relation to processes at depth from the properties of the incoming plate to surface deformation in order to improve hazard assessment strategies.

Seismogenic coupling zones occupy a limited depth range of convergent plate interfaces between 5 to 10 km depth at the updip end and 30 to 60 km at the downdip end. Slip near the updip end controls tsunami generation, while slip near the downdip end controls maximum ground shaking in the coastal zone area. The downdip end of seismogenic zones is of particular importance: virtually all subduction megathrust earthquakes nucleate here and ruptures propagate trenchward and sideways. The reason for this observation and the processes that trigger rupture are not yet fully understood. It is hypothesized that the lower limit of the locked zone is controlled either by intersection of the downgoing slab with the hydrated forearc mantle or the brittle-ductile boundary. Owing to its shallow position, the updip end of a coupling zone can be imaged seismically at a reasonably high resolution, accessed via drilling and, indirectly, via sampling of rock and volatiles from exposed faults that splay from the plate interface. For continental convergent margins, the position of the downdip end tends to be deeper than for oceanic margins and to be below the coastline or even below the onshore forearc. Due to this position and the geometry of the downgoing plate, as well as to incompatible onshore- and offshore imaging technologies, virtually no high-resolution images exist for these deeper parts of the seismogenic zone other than earthquake hypocenters tracing the Wadati-Benioff zone. The integrated geophysical experiment ANCORP'96 in Chile at 21°S and the Vancouver Island experiment, providing the only higher resolution images of the deeper parts of an active downgoing plate, only imaged incomplete segments of the plate interface.

While significantly more information is becoming available for the related surface deformation from monitoring techniques that assess seismic hazard based on dense GPS networks and Synthetic Aperture Radar, the precise link between surface deformation and slip on buried thrusts like the subduction plate interface is mainly basedon inferences made from numerical modelling of a simplistic model system, which cannot yet account for the complexities found in natural forearcs. The solution of this aspect is required to (1) better constrain the distribution of seismic deformation at the plate interface up to the surface, and (2) to assess the relation between tsunami hazard and ground shaking for the coastal areas.

In order to address these issues, we use the southern Chilean convergent margin as a natural laboratory. Here, the largest instrumentally recorded earthquake occurred in 1960 (Mw = 9.5). It ruptured the margin starting at 38°S towards the south for approximately 1000 km with a coseismic slip of up to 40 m, up to 2 m vertical displacement and a tsunami up to 15 m high that affected the entire Pacific. Recent GPS data reveal this part of the upper plate to still be in the post-seismic relaxation stage. Immediately north of the rupture area, next to the second largest Chilean city and harbour (Concepcion), a seismic gap is observed with a predicted rupture of magnitude 7-8 within the next 1-2 decades. Only in May 2004, a magnitude 6.6 earthquake occurred exactly at the transition between both segments.

Between 2004 and 2007, we have conducted a series of field and lab studies that (1) image a complete seismogenic plate interface from the updip to below the downdip end in order to (2) yield key petrophysical and mechanical properties. We are currently (3) testing the variation of properties along different segments of the plate interface, which are at different stages of the seismic rupture cycle, and (4) observe and model the surface response to seismic rupture. We have started with an integrated onshore-offshore experiment SPOC (Subduction Processes Off Chile) that was completed in early 2002, providing the first complete high-resolution coverage of this particular plate interface. It allowed us to relocate the 1960 hypocentre and to identify the intersection of the Nazca plate with the upper plate Moho as the downdip end of the locked zone - in contrast to recent predictions, which suggested a thermally defined limit at larger depths. Neogene surface deformation has been complex exhibiting tectonically uplifting areas along the coast driven by interseismically active reverse faulting. In addition, we observe coseismically subsiding domains along other parts of the coast. Moreover, the coseismic and interseismic vertical displacement identified is not coincident with long-term vertical motion that probably is superseded by slow basal underplating occurring at the downdip parts of the seismogenic zone causing discontinuous uplift.

KN09 – Fri., 13.4., 09:30 - 10:00 · HSH

Ramos, V., Folguera, A. (Laboratorio de Tectonica Andina, Universidad de Buenos Aires)

Evidence of flat and steep subduction on the Andes: Geological processes and tectonic inferences

Evidence of flat and steep subduction on the Andes: Geological processes and tectonic inferences

The present knowledge of the Andean system shows many different segments with some extraordinary processes that only recently have been the focus of renewed interpretation. The main features observed are: (1) General resetting of the remanent magnetization, known in the literature as the Zongo San Gabán Effect in Perú or the San Rafael Effect in central Argentine, among others; (2) Resetting of the low temperature geochronology, mainly Ar-Ar dating in different minerals and whole-rock analyses; (3) Contrasting evidence for coeval extension and compression based on fault analyses of main and secondary faults in a specific time span; (4) Large volumes of acidic rocks, mainly of rhyolitic type and/or mafic poorly evolved basalts with OIB signature directly derived from the mantle, together with (5) shifting, expansion and/or retraction of the volcanic front at surface related to generalized extension or compression. All these features indicate an important pervasive metasomatism across the lower and upper crust, at temperatures capable to remagnetize the rocks, and therefore above the Curie temperature. This effect was also detected in the Appalachian system, where it was recognized on paleomagnetic grounds. This was interpreted by Oliver (1992) with a model of remagnetization by migration of fluids expelled from the orogenic area that reached rocks not involved directly in the deformation. A similar pattern was proposed by Rapalini and Astini (2005) to explain the San Rafael Effect in central Argentina linked to a deformation associated with the San Rafael orogenic phase in the Lower to Upper Permian with a migration in time and space from the orogenic area towards the foreland. Both cases have been interpreted as produced by either collision in the North American orogen or through an important orogenic compressional phase in the southern Andes. However, the analysis of some Cenozoic examples, like the Zongo San Gabán effect in southern Perú shows new insigths . This tectonothermal event affected an area 450 km wide across the orogen (Farrar et al., 1988) and reached at about 38 Ma temperatures above 350°C in order to reset the Ar-Ar ages, and even higher to obliterate the primary magnetic remanence of older rocks. The similarities of these effects with the San Rafael Event are striking, and even more when the geologic framework of both areas is analyzed. As already established by James and Sacks (1999) in southern Perú, this event predates important rhyolitic magmatism associated with a shifting to the trench and contraction of the volcanic front, in a similar way that has been proposed by Kay and Mpodozis (2001) in southern Bolivia and northern Argentina. The three cases have a similar relationship to the steepening of the subduction zone, associated with lower crustal delamination (Kay and Kay, 1993). Based on these facts, we propose that the San Rafael Effect in central Argentina is associated with steepening of the oceanic slab being subducted, probably related to a crustal delamination process as proposed by Martinez et al. (2006). Strong deformation as the one associated with the San Rafael orogenic phase, as well as migration of fluids expelled from the orogenic area, immediately followed the slab steepening, and as a consequence of the thermal weakening that affected the crust deformation took place after delamination of the lower crust. A general comparison along different segments suspected of having increased the angle of subduction after a period of expansion and flat-subduction shows several common and different features. The main difference among them is the resulting magmatism after steepening. In some cases rhyolitic rocks are dominant, while in others as in southern Mendoza, poorly evolved mafic lavas are prevalescent (Ramos and Kay, 2006). The previous tectonic history is the main control for the magmatic response: the areas with abnormal thick crust gives preferentiality to the melting of the lower crust and to the rhyolitic magmatism. On the other hand, thin crust or even attenuated crust favor the rise of asthenospheric magmas with very low Sr87/Sr86 ratios as shown by Ramos and Barbieri (1989). These features are found along many segments of the Andes in Cenozoic times, indicating that steepening of the subduction is not an exceptional characteristic but somewhat a recurrent process inthe Andean evolution. When the analyses involve older rocks there is partial evidence of similar processes that can be obliterated by the younger deformation, but still seems to be a frequent process. Based on these facts, we propose that shallowing of the subduction zones and the consequent steepening have dominated the Cenozoic evolution of the Andes, and could be also an important process in orogens as old as the Late Paleozoic.

REFERENCES

Farrar, E., Clark, A.H., Kontak, D.J. and Archibald, D.A.1988. Zongo-San Gabán zone: Eocene boundary of the Central Andean orogen, northwest Bolivia and southern Peru. Geology 16: 55-58. James, D.E. and Sacks, S.1999. Cenozoic formation of the Central Andes: A geophysical perspective. In B. Skinner et al. (eds.) Geology and Mineral Deposits of Central Andes. Society of Economic Geology, Special Publication 7: 1-25. Kay, R.W. and Kay, S.M. 1993. Delamination and delamination magmatism. Tectonophysics 219: 177-189. Kay, S.M. and Mpodozis, C. 2001. Central Andean ore deposits linked to evolving shallow subduction systems and thickening crust. GSAToday 11(3): 4-9. Martínez, A.N.., Rodríguez Blanco, L. and Ramos, V.A. 2006. Permo-Troassic magmatism of the Choiyoi Group in the Cordillera Frontal of Mendoza, Argentina: geological variations associated with changes in Paleo-Benioff zone. Backbone of the Americas, Abstracts with Programs, p. 77. Mendoza. Oliver, J. 1992. The spots and stains of plate tectonics. Earth Science Reviews 32: 77-106. Ramos, V.A. and Barbieri, M. 1989. El volcanismo cenozoico de Huantraico: edad y relaciones isotópicas iniciales, provincia del Neuquén. Asociación Geológica Argentina, Revista 43: 210-223. Ramos, V.A. and Kay, S.M. 2006. Overview of the Tectonic Evolution of the Southern Central Andes of Mendoza and Neuquén (35°-39°S Latitude). En Kay S.M. and Ramos, V.A. (eds.) Evolution of an Andean margin: A tectonic and magmatic view from the Andes to the Neuquén Basin (35°-39°S latitude). Geological Society of America, Special Paper 407: 1-18. Rapalini, A.E. and Astini, R.A. 2005. La remagnetización sanrafaélica de la Precordillera en el Pérmico: Nuevas evidencias. Revista de la Asociación Geológica Argenttina 60: 290-300.

KN10 – Fri., 13.4., 12:00 - 12:30 · HSH

Pritchard, M. E., Loveless, J. P., Finnegan, N. (Cornell University)

Deformation in the central and southern Andes observed with InSAR

We use Interferometric Synthetic Aperture Radar (InSAR) observations from 5 satellites (ERS1, ERS2, Envisat, RADARSAT, and JERS1) along with published GPS displacements to constrain the deformational processes in the central and southern Andes between 1992-2006. In this contribution, we review the types of deformation that are occuring (volcanoes, earthquakes, post-seismic deformation, and groundwater processes) and present new observations and models of these processes.

In the central Andes, wehave used InSAR to measure sub centimeter scale deformation during all seasons from volcanoes, the earthquake cycle, and human-induced processes with horizontal spacing of about 20 meters over approximately 1 million square kilometers. We have collected InSAR data at over 1,000 volcanic structures, but only about 400 of them have been active in the last 1-2 million years, and 50 or so are considered potentially active. We find at least 6 areas of likely volcanic deformation, although only one of these regions (Uturuncu, Bolivia) is actively deforming during the entire timespan of the InSAR data (14 years).

We use InSAR, GPS and seismic data to better understand processes occuring during the different parts of the earthquake cycle (coseismic, post-seismic, and inter-seismic) in the Peru-Chile subduction zone. We invert seismic and geodetic data both jointly and separately to constrain the rupture processes (coseismic deformation) of six subduction zone earthquakes ($6.7 < Mw < 8.4$) in southern Peru and northern Chile. In northern Chile, because of the spatially and temporally dense geodetic data, we can clearly separate coseismic and post-seismic deformation. We document a complex mosaic of phenomena including large earthquakes, post-seismic afterslip with a spatial distribution that appears to be tied to variations in coastal morphology, and a completely aseismic pulse that may trigger a Mw 7.1 earthquake in 1998. Finally, we discuss our ability to measure inter-seismic deformation given the various sources of noise in the InSAR data, including: changes in the water vapor content of the troposphere, perturbations in the ionosphere, and uncertainty in the precise orbital positions of the satellites. We will also discuss our observations of deformation from groundwater movements (both natural and human-induced), shallow crustal earthquakes, and possible triggered motion on shallow crustal faults during subduction zone earthquakes.

In the southern Andes, because of the more humid climate, deformation measurements at the volcanoes are only successful during the austral summer. Due to a lack of data acquisistions, observations are limited to only a subset of the potentially active volcanoes and a fraction of the time period for which there is satellite data. In spite of the difficulties, we observe deformation at at least two two volcanoes (Cerro Hudson and Cordon Caulle), as well as motion of glaciers at the Northern and Southern Patagonian Icefields.

EV

Evening

EV01 – Wed., 11.4., 19:30 - 21:30 · HSH

Eder, F. W. (IYPE, University Munich)

The UN International Year of Planet Earth and Latin America

E-Mail: w.eder-geo@hotmail.de

The ”International Year of Planet Earth” (IYPE) is a joint initiative of the International Union of Geological Sciences (IUGS) and UNESCO. The Year, proclaimed for 2008 by the UN General Assembly in late December 2005 will be the central year in a Planet Earth triennium that has begun in January 2007 and will end in December 2009.

The central aims and ambitions of this triennium are to demonstrate the great potential of the Earth sciences in building a safer, healthier and wealthier society, and to encourage more widespread and effective application of this potential by targeting politicians and other decision-makers, educational systems, and the general public.

UN proclamation implies that all 191 UN nations have adopted these aims and ambitions and are all willing to contribute to their implementation. Never before have all nations on Earth expressed their dedication to learn from and apply geoscientific knowledge in both day-to-day and longer term policy and practice.

During the preparatory phases of the International Year, a Management Team brought the initiative to the United Nations, attracted 12 Founding Partners and 26 Associate Partners, and raised the funds necessary to pave the way for implementation. On March 16th 2006, the initiative was registered as a not-for-profit 501 (c) (3) Corporation under the laws of the State of Delaware, USA.. Meanwhile, a Board and a Secretariat has been established in cooperation with IUGS and UNESCO; for detailed information, please check the website: www.yearofplanetearth.org.

The Science and Outreach programmes have been in place for some time. Science Implementation Teams, the primary tasks of which are to evaluate Expressions of Interest and Project Proposals, are now in process of formation. It is planned to dedicate about half of the income for the International Year to outreach activities and the other half to science projects for the ten selected Science themes:

1. Climate Change - the ’stone tape’
2. Deep Earth - from crust to core
3. Earth & Health - building a safer environment
4. Earth & Life - origins of diversity
5. Groundwater - towards sustainable use:
6. Hazards - minimizing risk, maximizing awareness
7. Megacities - going deeper, building safer
8. Ocean - abyss of time
9. Resources - prosperity and sustainability
10. Soils - the living skin of the Earth

Fund raising is still the first priority of the Development Committee of the Board. The mining sector and the oil and gas industry are seen as the likely main sponsors and donors, not least because they stand to profit substantially from the wide-ranging outcomes of the International Year. In an improving political climate with respect to sustainable use of the Earth and its materials, outcomes include the securing of future specialist expertise by attracting increasing numbers of students opting for training in the Earth sciences (as was the case following the German National Year of the Geosciences in 2002). The aim is to raise 20 million dollars to achieve the IYPE’s goals, and to ensure that this greatest geo-show on Earth will be remembered alongside the formative International Geophysical Year 1957/1958 half a century ago.

A particularly important action that is fundamental to the successful implementation of the Year is the establishment of National Committees of the Year of Planet Earth. At the time of writing, 29 such National Committees are up and running (like in Austria, Brazil, Germany, India, Ireland, Japan, Mongolia, Namibia, New Zealand, Spain, Sweden, UK). In twenty other countries such Committees are being actively developed. Such National Committees are independent bodies while, at the same time, having links with the International Corporation. The success of the International Year very much depends on quality and range of activity at the national level, not least because of the need to attract, in a sustained way, the attention and engagement of both public and political life at all levels.

Within a spectrum of 10 scientific themes, selected for the IYPE, Hazards - minimizing risk, maximizing awareness, including ”landslides”, play an important role. The following key questions should trigger good proposals for projects under the umbrella of the IYPE:

- How have humans altered the geosphere, the biosphere and the landscape, thereby helping to trigger certain hazards and increasing societal vulnerability to them?

- What technologies and methodologies are required to assess the vulnerability of people and places to hazards - and how might these be used at a variety of spatial scales?

- How does our current ability to

  monitor, predict and mitigate vary from one geohazard to another? What methodologies and new technologies can improve such capabilities, and so help civil protection locally and globally?

- What are the barriers for each geohazard which prevent governments (and other entities) from using risk and vulnerability information to create policies and plans to reduce both?

We call upon all members of the geoscience community around the world, including those of the Latin American region to recognize the opportunities offered by this global initiative, and to provide their support at all scales, from global to local, to make this a once in a lifetime event. Given the Years worldwide political support, rising commodity values, and a profession that increasingly recognizes the need for strong mutual support in the realization of the societal potential and value of Earth science, the situation has never been more favourable.

Web page: http://www.yearofplanetearth.org/

EV02 – Wed., 11.4., 19:30 - 21:30 · HSH

Chong Diaz, G. (Antofagasta, Univ. Católica del Norte)

The Atacama Desert region of northern Chile. Its geological and geobiological setting and special relationship with microorganisms

Northern Chile region (18°00'/27°00' South Lat.) has been described as the Desierto de Atacama *sensu lato* and reputed as "the driest desert of the world". It is divided in north-south morphotectonic units climbing dramatically from the Pacific Ocean to the west up to volcanic peaks over 6000 m in its eastern border. A number of local base levels corresponding to closed basins constrain water to reach the ocean. Climatic conditions change from extreme arid to hyperarid conditions (Coastal Range/Central Depression) to increasing wet areas in the Precordillera and with a snowline over 5000 m altitude.

To these general conditions we have to associate a number of features that makes this region a singular one. Volcanic peaks define a rain shadow effect and volcanic activity is the cause of a high geothermal gradient able to increase leaching of rocks. Dripping fogs notwithstanding are defined as a coastal phenomena, can reach more than 150 km inland. Marine phenomena as El Niño and La Niña define severe climatic conditions. A huge amount of salts are present in soils, rocks and waters (Saline Domain) as well as a worldwide anomalous amount of ore minerals deposits including Cu, Mo, Re, Zn, NO_3, I, Li ("Planetary Anomaly").

All these conditions, including mining activity, define different and unique environments for microorganisms widespread in the region. We have found them in thermal springs, caves, paleogeothermal fields, saline soils, evaporites, salt flats, saline lakes and mining dumps We have recognize Bacteria and Archaea domains. Some of them are related with salt flats and saline lakes where presence of five of the major lineages of Bacteria plus Holoarchaea and unidentified Euryarchaea was detected. In turn, in geothermal fields are present five bacterial phyla and Euryarchaea and Crenarchaea from the Archaean domain. "Macro" life is also widespread in the dryest areas.

Our research in Geobiology (Geomicrobiology) started some eight years ago and intends to determine relationships between these habitats and microorganisms with regional geologic, geomorphologic and climatic setting. We also intend to compare the today environments with similar geological conditions of the past.

One of the more interesting findings was made in an isolated and unique habitat in the boundary between desert *sensu stricto* and the zone of steppes to the east. It corresponds to an assemblage including unicellular cianobacterias and other eubacterias distributed and organized (?) in gypsum structures resembling an "igloo" or sub -spherical shapes sizing between 0.5 up to 1.5 cm diameter, fixed on the surface of rocks as well as in gypsum veins.

EV03 – Wed., 11.4., 19:30 - 21:30 · HSH

Schneider, R. (IfG, Kiel)

The Future Ocean

The ocean covers two thirds of our planet and hosts the largest ecosystem on earth. Human society is increasingly dependent on the ocean for numerous reasons:

1. it plays a dominant role in the global climate system through the storage and transport of heat and water;
2. it mitigates global warming through the absorption and storage of 50% of fossil fuel CO_2 emissions over the past 200 years;
3. it provides economically important living and non-living resources;
4. it serves as a site for deposition of waste products; and
5. it contributes to global trade and national security.

In addition to these resources and services, the ocean poses considerable threats to coastal populations in the form of tsunamis and storm surges amplified by climate-induced sea-level rise. In turn, the ocean is increasingly affected by human society as a result of growing coastal populations, increased shipping, coastal and deep-sea habitat destruction, marine resource exploitation, rising CO_2 levels and climate change. Interdependence between the ocean and society is growing, and the future of the ocean is both uncertain and of vital relevance to humankind.

The Future Ocean Cluster at CAU will conduct research with the goal of improving and broadening our understanding of on-going and future changes within the oceans as well as their interaction with society in terms of resources, services and risks. It will provide the scientific basis for the development, implementation and assessment of sound global and regional ocean management options.

A major driving force for human-induced ocean and climate change is the emission of CO_2 into the atmosphere. Anthropogenic CO_2 affects the ocean through increased warming and the acidification of surface seawater, which may in turn trigger major changes in ocean circulation, ecosystem structure, marine carbon cycling, and exchanges with the atmosphere. The on-going and future environmental effects of rising CO_2 emissions on the ocean can only be assessed through a multidisciplinary approach which integrates climate sciences, oceanography, biogeochemistry, marine biology and geosciences. Scientists from these natural science disciplines will cooperate within the Future Ocean Cluster to identify feedback mechanisms in the ocean-climate ecosystem which may either amplify or mitigate CO_2-induced ocean change. Advancements in the natural sciences will serve to assess threshold values in atmospheric CO_2 beyond which the ocean will either experience irreversible change or cause intolerable damage to human society. The risks, costs or benefits of CO_2-induced ocean change and the feasibility of possible countermeasures such as deliberate CO_2 sequestration at the seafloor, improved global ocean and carbon management practices, or improved technology will be evaluated in socio-economic and legal terms by Cluster expertise from the social sciences.

Natural and man-made hazards arising from the oceans threaten the increasingly populated coastal zone. The Cluster will conduct basic research to study coastal erosion induced by sea-level rise, to better understand the triggering of tsunamis by submarine earthquakes and landslides, and to develop new instruments which will assist decision makers in risk mitigation. The oceans also offer a wide range of natural resources, including fish stocks, gas hydrates, mineral deposits, andgenes in marine organisms, which may serve to develop new treatments for human diseases. By combining the legal, medical, socio-economic and natural scientific expertise assembled in Kiel, the Cluster will explore these opportunities and will develop strategies for the sustainable use and management of marine resources.

More than 100 scientists from a broad range of disciplines are members of the Cluster and will elevate ”The Future Ocea to an overarching theme for a broad segment of the University. The Cluster will create a cutting-edge, comprehensive and truly multidisciplinary center of excellence for ocean studies with an internationally outstanding and unique profile.

Web page: http://www.the-future-ocean.de/

AN

The Andes and Adjacent Regions

AN01 – Thu., 12.4., 16:30 - 16:50 · HSD

Mamani, M. (Göttingen / Puno), Tassara, A. (Santiago de Chile), Wörner, G. (Göttingen)

Crustal Domains in the Central Andes and their control on orogenic structures

Isotopic compositions for Pb and Nd in igneous rocks in the Central Andes (13°S-28°S) reflect the compositions of the underlying basement, because the mass balance of magma assimilation at c. 15-20 per cent dominates the Pb and Nd isotopic composition of the basement through which the magmas ascend, Therefore, Andean igneous rocks can ”fingerprint” distinct basement domains. We provide a map of crustal domains in the Central Andes and evaluate their control on orogenic structure and evolution.

This domain map is based on 802 Pb samples (346 published, 456 new) and Nd-Sr isotopes (150 published, 180 new) from Proterozoic to Holocene igneous,and crustal rocks as well as arc-related ore deposits. These domains (Arequipa, Clemesi, Chilenia, Cordillera Domains and and Transitional Zones) correlate with the compositional structure of the crust as revealed by a 3D density model (Tassara et al., 2006). This particular crustal structure index geometry and correlated isotope and geochemical signatures distinguish more felsic from more mafic crustal crustal blocks.

Nd isotope values further support our domain distinctions and corroborate finding based on Pb isotopes. Sr-isotope variations do not constrain the boundaries of crustal domains because the domains show less distinct Sr isotopic signatures and the mass balance relations for Sr during assimilation is less favorable for isotopic fingerprinting. The crustal domain boundaries constrain crustal heterogeneities in the segmentation, evolution and deformation pattern of the Central Andes. The Transition Zone (between 21°S and 22°S) coincides with the transition between the Altiplano and Puna segments of the Andes. Moreover, erosion products from the Andean orogeny deposited during orogeny are thicker and more continuous only in the area of the Arequipa Domain.

Paleomagnetic data of Arriagada et al. (2006) describe block rotation (clockwise up to 35°to 40°) in the forearc between 22°and 28°S during the Jurassic to Oligocene. The regions of rotation and the block boundaries follow the Chilenia Domain. In southern Peru, Roperch et al. (2006) presented paleomagnetic results of Eocene-Oligocene sediments from the forearc from 18 to 16 deg S and observed a gradient in counterclockwise rotations, between $\sim$ 0 deg in Arica (18°S) to 50 deg in Caravelí (16°S). Additionally, on the Altiplano, i.e. on the Arequipa Domain, the Tertiary Huaccochullo and Corque basins are rotated counterclockwise as a coherent region (Rousse et al., 2005). The central Andean rotation patterns as described by Rousse et al. (2005), Arriagada et al. (2006) and Roperch et al. (2006) in fact seem to be related to individual crustal blocks with increased deformation and shear near their margins. In this scenario, the Arequipa Domain, appears to be a relatively rigid block that utimately led to the formation of the Altiplano Plateau and controlled its present location.

We conclude that crustal domains identified here based on geochemical and geophysical data are related to distinct basement domains of different ages and compositions in the Central Andes: The Arequipa Domain represents a relatively mafic and more rigid block. Its rheological identity is shown by the Cenozoic deformation pattern in the Central Andes as well as the distribution and thickness of syndeformational sedimentary deposits. Deformations and rotations are mostly concentrated the more felsic Cordillera Domain. The Chilenia Domain is interpreted as a block with major mafic Mesozoic juvenile contribution to the crust. Juvenile addition is dominates also the Clemesi domain. Therefore we argue that the nature, i.e. the bulk composition and thus the different rheologies of the crust are an important factor that controlled the deformation pattern of the Central Andes and the localization and segmentation of the Andean plateau.

Arriagada, C., Roperch, P., Mpodozis, C., Fernandez, R., 2006, Paleomagnetism and tectonics of the southern Atacama Desert (25-28°S), northern Chile. Tectonics, v. 25, TC4001, doi: 10.1029/2005TC001923.

Rousse, S., Gilder, S., Fornari, M., Sempere, T., 2005, Insight into the Neogene tectonic history of the northern Bolivian Orocline from new paleomagnetic and geochronologic data: Tectonics, v. 24, TC6007, doi:10.1029/2004TC001760, 2005.

Tassara, A., Götze, H.-J., Schmidt, S., Hackney, R., 2006, Three-dimensional density model of the Nazca plate and the Andean continental margin: J. Geophys. Res., 111, B09404, doi:10.1029/2005JB003976.

AN02 – Thu., 12.4., 16:50 - 17:10 · HSD

Cardona, A. (Smithsonian Tropical Research Institute, Panama), Cordani, U. G. (University of Sao Paulo, Brazil), Sanchez, A. (INGEMMET, PERU)

Metamorphic, geochronological and geochemical constraints from the Pre-Permian basement of the eastern Peruvian Andes (10° S): A Paleozoic extensional-accretionary orogen?

Introduction

The growth of accretionary orogens is related to the dynamics of the b-subduction system and the accretion of different tectonostratigraphic terranes (Cawood, 2005). From the Late Neoproterozoic to the Early Paleozoic the tectonic evolution of the Proto-Andean margin is marked by almost continumm plate convergence that built variable and diachronous accretionary orogens and ends with Pangea formation (Cawood, 2005).

In this contribution we integrate petrological, geochemical and geochronological data from the scarcely known Pre-Permian metamorphic basement of the Eastern Peruvian Andes (10° S) in order to understand its orogenic evolution.

Petrologic and geochemical constraints

The metamorphic rocks of the Eastern Peruvian Andes between 6° and 10° S were grouped in the Pre-Ordovician Marañon Complex (Dalmaryac et al., 1988 for review). Around the Huánuco area (10° S) this metamorphic complex can be divided into three metamorphic units. An ortho-derivate (?) mylonitic domain, and two different schist belts, made of metavolcanic and metasedimentary rocks. Mineral parageneses and conventional thermobarometry (Spear, 1995) within the schist belts show two main domains with P-T estimates of 3-5 Kb and 350°-450°C, and 7-10Kb and 540°-660°C in the eastern belt, and a coherent lower grade western belt with estimates of 3-4 Kb and 350-400°C. For the mylonite unit, temperature estimates were of 590°-616° C.

Trace element discrimination analysis from the metavolcanic and metasedimentary rocks of the two schist belts are markedly similar, and suggest an evolving E-MORB to MORB continental extensional environment and an upper crust with minor felsic arc-related provenance.

Geochronological results

Rb-Sr whole rock-muscovite isochrons, Ar-Ar and K-Ar in micas, and zircon U/Pb SHRIMP in metamorphic overgrowths from the three metamorphic units, yield metamorphic ages of Middle Ordovician for the mylonitc unit, and Silurian and Late Carboniferous for the eastern and western schist belts. The eastern Silurian schist belt also shows Late Carboniferous partial features related to younger deformation.

Discussion

From the data presented in this work, the tectonic evolution of the Pre-Permian basement of the Eastern Peruvian Andes can be interpreted in terms of three succesive Paleozoic metamorphic belts, with their protoliths formed in an active and evolved continental margin. The two schist belts were formed in arc related basins (fore-arc or back-arc) as suggested by the features in the metavolcanic rocks. Geochemical data from the metasedimentary rocks of the two schist belts and the geochronological record presented by Cardona et al. (2005) suggest that both belts are spatially linked. Middle pressure barrovian metamorphic conditions may suggest a significant time span between basin formation and inversion. This type of tectonic evolution reseambles the so-called accretionary-extensional orogens of Collins (2002), where the orogenic evolution is related to the temporal shifting of the plate convergence variables.

Bibliography

Cardona, A., Cordani, U., Ruiz, J., Valencia, V., Nutman, A., Sanchez, A., 2006. U/Pb detrital zircon geochronology and Nd isotopes from Paleozoic meta-sedimentary rocks of the Marañon Complex: insights on the Proto-Andean tectonic evolution of the eastern Peruvian Andes. South American Symposium of Isotope Geology. Punta del Este, Uruguay

Cawood, P. A., 2005. Terra Australis Orogen: Rodinia breakup and development of the Pacific and Iapetus margins of Gondwana during the Neoproterozoic and Paleozoic. Earth-Science Reviews. 69, 249-279.

Collins, W. J., 2002. Hot orogens, tectonic switching, and creation of continental crust. Geology. 30, 535-538.

Dalmaryac, B., Laubacher, B., Marocco, R., 1988. Caracteres generales de la evolución geológica de los Andes Peruanos. Instituto Geológico Minero y Metalúrgico. Boletin N° 12. 313p.

Spear, F. S., 1995. Metamorphic phase equilibria and pressure- temperature-time paths. Mineralogical Society of America Monograph. Second printing. 799 p.

AN03 – Thu., 12.4., 17:10 - 17:30 · HSD

Grosse, P. (INSUGEO-UNT, Argentina), Söllner, F. (LMU München), Báez, M. A., Rossi, J. N., Toselli, A.J. (INSUGEO-UNT, Argentina), de la Rosa, J. D. (Universidad de Huelva, Spain)

Petrology of post-orogenic granites in Central-Eastern Sierra de Velasco, NW Argentina

The Sierra de Velasco conforms the largest granitic massif of the Sierras Pampeanas geological province of NW Argentina. Two main groups of granitoids can be distinguished in this sierra: older deformed granitoids and orthogneisses of Ordovician age, related to the Famatinian orogenic cycle, and younger undeformed granites of Carboniferous age, post-tectonic relative to the deformation phases of the Famatinian cycle.

In the central-eastern region of the Sierra de Velasco, two such post-tectonic granites are present, the Huaco granite (HG) and the Sanagasta granite (SG). These granites consist in adjacent, sub-elipsoidal bodies with dimensions of approximately 40 x 30 km for the HG, and 25 x 15 km for the SG. They intrude into strongly to moderately peraluminous, two-mica orthogneisses of monzogranitic composition.

Both the HG and the SG are rather homogeneous porphyritic syeno- to monzogranites. They are characterized by abundant K-feldspar megacrysts set in a medium- to coarse-grained groundmass of quartz, plagioclase, K-feldspar, micas and accessory minerals (apatite, zircon, monazite and opaque minerals). The HG contains both biotite and muscovite, while the SG contains only biotite, and occasionally titanite and allanite. Both granites commonly contain small, rounded and generally elongated mafic microgranular enclaves, rich in biotite and of tonalitic composition.

U-Pb age determinations on monazites have given two reverse discordant ages of 350 +- 11 Ma and 358 +- 10 Ma for the HG, and a concordant age of 353 +- 1 for the SG (Grosse et al., in preparation). Additionally, LA-ICP-MS U-Pb age determinations on zircons of the HG has given a main crystallization age of 354 +- 4 Ma (Söllner et al., 2007, this volume). Many of these zircons have older, non-detrital cores with Ordovician ages, suggesting significant participation of Ordovician orthogneisses in the formation of the granites (Söllner et al., 2007, this volume).

Both granites are alkali-calcic to slightly calk-alkalic, ferroan and silica- and potassium-rich. The HG is moderately peraluminous, while the SG is weakly peraluminous. In an A-B diagram, the HG defines a positive trend of decreasing peraluminosity with increasing differentiation, while the SG defines a negative trend of increasing peraluminosity with increasing differentiation.

Mayor and trace element contents indicate that the SG is a less evolved, somewhat more mafic granite compared to the HG. The SG has lower SiO2 contents and higher concentrations in Fe2O3tot, MgO, TiO2 and CaO. It also has higher contents in Sr, Ba, Y, Th and the REE, while the HG is richer in Li, Rb and U. The more evolved character of the HG is also indicated by its lower K/Rb ratios and higher Rb/Sr ratios.

The HG has higher 87Sr/86Sr initial ratios than the SG (0.730-0.752 and 0.717-0.732, respectively), while both granites have similar Epsilon Nd values (-2.1 to -4.3). The mafic enclaves have 87Sr/87Sr initial ratios similar to their host granites but higher Epsilon Nd values (0.6 to -0.6). On the other hand, the surrounding orthogneisses exhibit 87Sr/86Sr initial ratios similar to the SG but much lower Epsilon Nd values (-6.8 to -7.4). Younger Carboniferous granites of the Sierra de Velasco, such as the La Chinchilla stock (345 +- 1 Ma, U-Pb on monazite; Grosse et al., in preparation) and the San Blas granite (334 +- 5 Ma and 340 +- 3 Ma, U-Pb on zircon; Báez et al., 2004 and Dahlquist et al., 2006, respectively) have more primitive isotopic ratios than the HG and SG (87Sr/86Sr initial ratios of 0.717 and Epsilon Nd values of -0.9 to -1.4 for the La Chinchilla stock; 87Sr/86Sr initial ratios of 0.703-0.705 and Epsilon Nd values of -1.5 to

-1.8 for the San Blas granite).

The geochemistry of the HG and SG is compatible with a post-orogenic setting, in accordance with the obtained Carboniferous ages. The geochemistry and isotopic ratios of these granites suggests a mainly crustal source, although with some participation of mafic material. The Ordovician ages of the zircon cores and the intermediate Epsilon Nd values, together with the presence of mafic enclaves and comparisons with compositions of experimental melts, supports the possibility of an origin by means of partial melting of peraluminous orthogneisses combined with assimilation of mafic material, more pronounced in the SG than in the HG. The more primitive nature of the younger Carboniferous granites suggests an increasing participation of mantle material in the granitic melts with time.

The abundant magma generated during the Carboniferous in this area of the Sierras Pampeanas, as represented by the HG and SG, and the La Chinchilla stock and San Blas granite, is evidence of an important crustal heating event. This event was possibly associated with the collapse of the Famatinian orogen and extension of the crust, which favored mantle upwelling via delamination or slab-breakoff.

References:

Báez, M. A., Basei, M. A., Toselli, A. J. and Rossi, J. N., 2004.Geocronología de granitos de la sierra de Velasco (Argentina): reinterpretación de la secuencia magmática. Simposio 40 años de geocronología en Brasil, Actas: 85. San Pablo, Brasil.

Dahlquist, J. A., Pankhurst, R. J., Rapela, C. W., Casquet, C., Fanning, C. M., Alasino, P. and Báez, M. A., 2006. The San Blas Pluton: An example of Carboniferous plutonism in the Sierras Pampeanas, Argentina. Journal of South American Earth Sciences, 20: 341-350.

Grosse, P., Söllner, F., Rossi, J. N., Toselli A. J. and de la Rosa, J. D., in preparation. Carboniferous granites in Central-Eastern Sierra de Velasco, Sierras Pampeanas, Argentina: U-Pb monazite geochronology and geochemical constraints.

Söllner, F., Gerdes, A., Grosse, P. and Toselli, A. J., 2007. U-Pb age determinations by LA-ICP-MS on zircons of the Huaco granite, Sierra de Velasco (NW-Argentina): A long-term history of melt activity within an igneous body. 20 Geowissenschaftliches Lateinamerika-Kolloquium. Kiel, Germany. This volume.

AN04 – Thu., 12.4., 17:30 - 17:50 · HSD

Rubiolo, D. (Buenos Aires, CONICET - SEGEMAR)

The Hornillos laccolite in the Eastern Cordillera of Argentina: A way to explain A-type magmatism in the Central Andes

E-Mail: danielrubiolo@gmail.com

Small alkaline complexes crop out in the Eastern Andes from Southern Peru to Northwestern Argentina. They are related to Cretaceous basins, which were built during a rifting process with accompanying alkaline basaltic effusions. These complexes form the Eastern Cordillera's alkaline petrographic province, which up to now has been barely investigated. Because its petrographic variations, the Hornillos complex presents one suitable of study object for understanding petrogenetic processes for alkaline rocks in the Eastern Andes. The Hornillos complex (Santa Victoria department, Salta Province, Argentina) consists of a composed, high level, almost subvolcanic laccolite (nearly 6 km2). Seven different types of rocks have been distinguished in this complex: 1) nordmarkites, 2) syenites, 3) coarse grained syenites, 4) monzonites and monzodiorites, 5) pulaskites, 6) syenitic porphyries and 7) trachytic vent-breccias. The Cenozoic tectonic cut the laccolite into isolated blocks. Although the outcrop situations in the single units do not show clearly if the different types of rocks grade into one another or if they are separated by intrusive contacts, there is petrographical and geochemical evidence that they are comagmatic. Subvolcanic intrusive bodies and country rocks are crossed by dykes. These are distributed in a total area of approx. 30 km2 and correspond in their composition to the plutonic and subvolcanic rocks, excepting the melanocraticones. The dykes range from melanocratic (limburgites, dolerites with teschenitic affinities, latiandesites and malignites) to mesocratic (tinguaites) and leucocratic (bostonites, rhomb porphyries and syenitic aplites). In the same area are recognized a 20 m thick vulcanoclastic sequence composed by basanitic lavas and basaltic pyroclastic levels overlie red beds, which are lithostratigraphically comparable with the Balbuena Subgroup of Salta Group, Upper Cretaceous age. The red beds are also crossed by rhombic porphyry dykes. On the top of the sequence are lying red sandstones, lithostratigraphically compared with the Santa Bárbara Subgroup of the Salta Group. These new sequence are free of dykes. Therefore an Upper Cretaceous to Lower Tertiary age is assumed for the dykes and the volcanoclastic sequence. The intrusive rocks and dykes of the Hornillos complex can be divided into two sets, defined by a silica-oversaturated (nordmarkitic trend) and a silica-under saturated (foyaitic trend) character. These groups form two geochemical suites of a typical alkaline association, showing strong similarities with annular anorogenic intrusions. Anhand from textural observations and whole rock geochemistry it was possible to deduce that the two trends could be derived from a single pulaskitic-mozonitic magma type, which was originally produced by minor fractionation of a mantle-derived melts in a high crustal magmatic chamber. In this way the twodifferent trends could be explained by differences in f 02 and PH2O during an AFC-process (assimilation and fractional crystallization). Rare Earth Elements (REE) chondrite-normalized diagrams show negative Eu-anomalies for nordmarkites, syenitic porphyries and tinguaites, documenting the differentiated character of these rocks, while the positive Eu-anomaly of the coarse grained syenites underlines their cumulative character. The strong REE's fractionation supports the theory of a small degree of partial melting from a mantle enriched in incompatible elements, and high garnet contents in the residua. Results from oxygen and carbon isotopes in carbonate phases of different magmatic rocks show that some of them, especially in the Hornillos complex, have truly primary, magmatic values. This could indicate a genetic relationship to carbonatites. Additionally, hydrothermal carbonates occur in the Hornillos complex, Generally, there is a shift of isotopic composition as a result of temperature decrease. Dating by the K/Ar methode indicates ages between 108 Ma and 66 Ma. Associated to the intrusive are leucocratic and melanocratic dikes, which corresponds their composition to varieties, recognized in the laccolite. In addition alkaline lamprophyres, volcanic breccias and carbonatitic veins were identified. In the region a volcanoclastic sequence corresponding to the Pirgua Sub-group was recognized with dated basanitic lavas in 98 Ma.

AN05 – Fri., 13.4., 10:10 - 10:30 · HSD

Prezzi, C. (Buenos Aires, CONICET - Universidad de Buenos Aires), Götze, H.-J., Schmidt, S. (Kiel, Institut für Geowissenschaften - Abteilung Geophysik, Christian Albrechts Universität)

Thermal Isostasy and Altiplano-Puna Elevation

E-Mail: prezzi@gl.fcen.uba.ar

The most remarkable feature of the Central Andes is the Altiplano-Puna plateau. This plateau is characterized by 3.5 km average elevation, approximately 70 km crustal thickness and very high heat flow. Furthermore, below the Altiplano-Puna the existence of a partial melting zone at mid-crustal depth has been established by a number of independent observations (e.g. extreme high conductivity zones, broad low seismic velocity zones, etc.). This interpretation is strongly supported by the presence of a huge concentration of Neogene ignimbrites (most of them derived from crustal melting): the Altiplano-Puna Volcanic Complex. On the other hand, the forearc and the foreland basins have lower heat flow, thinner crust, and lower altitude. These features suggest that thermal isostasy could play a role in the compensation of the Altiplano-Puna. Thermal isostasy is the geodynamic process whereby regional variations in the lithospheric thermal regime cause changes in elevation. Elevation changes result from variations in rock density in response to thermal expansion. However the thermal contribution to continental elevation is difficult to asses, because variations in crustal density and thickness can mask it. This study estimates the elevation effect due to compositional variations and removes it by an isostatic adjustment, revealing the thermal and geodynamic effects on elevation. The effects of compositional and thickness variations within the crust were removed using the crustal density structure obtained for the Central Andes between 19°S and 30°S from 3D forward gravity modelling. The gravity model is very well constrained by a large amount of geophysical, geological, petrological and geochemical data. The elevation was adjusted for compositional buoyancy by calculating the density-thickness product from our 3D gravity model, relative to a reference crustal section (average crustal density: 2850 kg/m3, average mantle density: 3350 kg/m3, crustal thickness: 40 km). GTOPO30 digital elevation model was used to estimate the actual topography. The heat flow data base considered in this study includes new values recently published. The thermal isostatic relationship describing the thermal contributions to the elevation was determined using a reference geotherm corresponding to a surface heat flow of 30 mW/m2 and assigning a lithosphere having this thermal estate an elevation of 0 km. Average elevation adjustments range between 300 and 3000 m, with maximum values of approximately 6000 m. It is observed that no correlation exists between the actual elevation and the corresponding heat flow values. In contrast, the compositionally adjusted elevation shows direct correlation with heat flow, with an increase of around 3000 m elevation between low and high heat flow zones. The forearc and the foreland basins areas are characterized by lower heat flow and lower elevation adjustments, whereas the Altiplano-Puna plateau, the Western Cordillera and the Eastern Cordillera, show higher heat flow and higher elevation adjustments. Our results suggest that while the thermal component of the Altiplano elevation would be of 1 km, the thermal contribution to the Puna elevation would be of 2 km. Previous works highlighted the fact that the Puna and the Altiplano have uniform average elevation in spite of showing great variation in the amount of structural shortening. Shortening estimates are sufficient to account for crustal cross sectional area in the Altiplano north of 22°S, but are less than that needed in the Puna south of 22°S. Other authors suggested that thermal heating and crustal flow would explain the uniform altitude of the Altiplano-Puna, in coincidence with our results. Moreover, it was determined that the above mentioned partially molten zone would extend in the backarc region between about 22 and 24º S and below the Altiplano-Puna Volcanic Complex area of caldera concentration. On the other hand, our 3D gravity model shows the presence of shallower asthenosphere below the Puna than below the Altiplano, suggesting a possible relationship between the depth to the top of the asthenosphere and the higher heat flow, the existence of a mid-crustal partially molten zone and of the Altiplano-Puna Volcanic Complex in the Puna. The obtained results would suggest that the thermal state of the lithosphere could play a significant role in the elevation of the Central Andes.

Web page: http://ingeodav.fcen.uba.ar/ingeodav.htm

AN06 – Fri., 13.4., 10:30 - 10:50 · HSD

Brasse, H. (FU Berlin)

Electromagnetic images of partial melts in the Central Andes: An attempt of a synthesis

E-Mail: `h.brasse@geophysik.fu-berlin.de`

Long-period electromagnetic induction studies have been carried out over the last 15 years along several transects in the Central Andes of Chile, Bolivia and Argentina. While an older study comprised the entire mountain range from the coast of the Pacific Ocean to the foreland of the Argentinian Chaco, more recent investigations concentrated on the Chilean forearc, the volcanic zone and the Altiplano high plateau at 21°S, 20.5°S and 18°S. Period range was from 10s to 10.000s, thus principally enabling resolution of upper and lower crustal features as well as the uppermost mantle.

Three common features dominate the data: 1) The forearc is characterized by strong three-dimensional anomalies, associated with NS as well as EW (i.e., obliquely to the trench and coastline) running fault zones. 2) The volcanic arc is clearly not associated with a high conductivity zone at any depth, as one might expect considering the standard model of subduction, which implies the release of fluids from the subducting oceanic plate, melting of the asthenospheric wedge and subsequent rise of fluids/melts. 3) Instead, a highly conductive zone is modeled at upper-mantle depths (approx. 100km) in the backarc beneath the Altiplano. This implies a non-vertical rise of melts towards the volcanic arc, which is laterally about 100km to the west.

At 21°S and farther to the south the latter anomaly is obscured by a huge conductor at mid- to lower crustal depth levels, interpreted as as a migmatitic body with melt rates in the order of more then 10%. Spatially this body coincides with the northern margin of the Altiplano-Puna Volcanic Complex (APVC). At 18°S this crustal conductor is missing, thus making the crust more transparent to electromagnetic signals and enabling resolution at larger depth. The clearly resolved asthenospheric wedge is so highly conductive that it is difficult to assume a realistic melt fraction. Additional sources of enhanced conductivity have to be taken into account, in particular fluids which have to aquire dissolved ions during their way from the source region (slab) to the wedge.

AN07 – Fri., 13.4., 10:50 - 11:10 · HSD

Folguera, A. (Laboratorio de tectonica Andina, X., Departamento de Geologia, Universidad de Buenos Aires. Pabellon dos de Ciudad Universitaria. Capital Federal. Argentina), Alasonati Tašárová, Z., Hese, F., Hackney, R., Götze, H.-J., Schmidt, S. (IfG, CAU Kiel), Ramos, V. (Laboratorio de tectonica Andina, X., Departamento de Geologia, Universidad de Buenos Aires. Pabellon dos de Ciudad Universitaria. Capital Federal. Argentina)

Crustal attenuation along the Andean retroarc zone 36-39 S from gravimetric analysis

The Andean retroarc between 35º and 39ºS has been subjected to extension as a consequence of the steepening of the subducted Nazca plate beneath the South American plate, during the last 4 Myr (Ramos and Folguera, 2005) after a cycle of shallow subduction during the Late Miocene (Kay, 2002). Direct evidence of retroarc extension comes from the existence of normal faults that affected intermediate to mafic mantle-derived lava flows and crustal melts that are less than 5 Myr old (Hildreth et al., 1999; Kay et al., 2006). These volcanic products can be found from the arc front to the eastern retroarc zone along a series of troughs (Folguera et al., 2006, 2007). The extensional depocenters (troughs) resulted from the reactivation of previous extensional structures inherited from the Late Triassic initial stages of Pangea breakup, and generalized extension during Late Oligocene-Early Miocene (Ramos and Folguera, 2005). The main objective of this present study is to create a 3D image of the lower crust, presently two dimensionally imaged by receiver function analysis at 39ºS (Yuan et al., 2006), between 36º and 39ºS using gravity data,. In order to provide further insight into the lithospheric structure of this region, a 3-D density model was recently constructed between 36º and 42ºS (Tasarova, 2004). The forward density modelling was performed using the IGMAS software (Interactive Gravity and Magnetics Application System; e.g. Gotze and Lahmeyer, B., 1988; Schmidt et al. 2004) and the 3-D model integrates all available geophysical and geological data. While the forearc-arc areas between 36º and 39ºS are constrained by geophysical data, the southern part of the model (south of 39ºS) and the western retroarc are unconstrained. The crust in the model is represented by three layers with densities corresponding to global average density values (Christensen and Mooney, 1995). In general, the average crustal thickness in the retroarc area, based on this gravity model, is around 40 km behind the volcanic arc at 36º-39ºS. The crustal thickness decreases everywhere in the retroarc to 30 km towards the Atlantic coast, where positive Bouguer gravity anomalies are observed. Underneath the retroarc zone, crust thinned to about 30 km is also observed along a receiver function profile at 39ºS (Yuan et al., 2006). In the density model, such thinning was included only along several profiles in the vicinity of the receiver function profile. However, further north, the tomography model of Gilbert et al. (2006) shows similarly attenuated crust underneath the extended regions at 36ºS. Therefore, based on the tomography model, receiver function analysis and geological evidence mentioned above, we modified the density model of Tasarova (2004) by including an thinned crust from 38º to 39ºS. In this revised model, the thinned crust has a thickness similar to that determined by Yuan et al., (2006) and a width that corresponds with the area presently being extended (Folguera et al., 2006, 2007). The mass excess resulting from thinned crust was compensated by introducing sedimentary basins in the arc and retroarc zone, basins that were not considered in the initial gravity model. The geometry of the sedimentary basins, which is influenced by deformation of the sedimentary depocenters, has been constrained by analyzing residual gravity anomalies derived using different procedures: i) isostatic residuals computed by subtracting a regional field defined by a Vening-Meinesz model of regional isostasy with lithospheric rigidity of 1023 Nm, normal crustal thickness of 35 km and a density contrast between mantle and crust of 350 kg/m3; ii) residuals computed by subtracting the gravity effect of the Moho modelled by the initial gravity model of Tasarova (2004) without the attenuated crust between 36º and 39ºS; and iii) residuals computed by subtracting the long-wavelength gravity field defined by the EIGEN-GL04C satellite gravity model (Forste et al., 2006). The three residual fields are similar and suggest equivalent basin geometries compatible with known surface geology. Basin geometry was also inferred by the aid of Euler deconvolution solutions (source points) calculated using the approach of Pasteka (2000) and Pasteka and Richter (2002). The main structures controlling the most significant depocenters were detected by Euler source points. The residual anomalies resulting from the three procedures (i, ii, iii) show two broad areas in the retroarc zone with positive values that are coincident with the extent of the attenuated crust in the Yuan et al. (2006) and Gilbert et al. (2006) models. Moreover, Euler solutions with larger window-size (50-60 km) were computed in order to estimate anomaly sources resulting from regional geological features. The Euler source points define a series of surfaces, some of which correspond to the seismically well-constrained interface between pre-Jurassic basement and sedimentary fill (Zapata and Folguera, 2005). However, in most cases, the surfaces detected by Euler deconvolution are located at middle and/or lower crustal depths and suggest reduced crustal thickness, similar to the crustal image of Yuan et al. (2006). Most of the surfaces, which could reflect intra-crustal compositional transitions, define three main areas of reduced crustal thickness that are elongated in a north-south direction: a westernmost area corresponding to the Loncopué trough, an area beneath the Tromen plateau and Agrio fold-and-thrust belt corresponding to Las Loicas trough, and an eastern area underlying the Entre Lomas depocenter. In addition, the main area of lower crustal attenuation along the retroarc zone seems to change from north to south. Whereas between 37º and 39ºS this area is located in the western part of the retroarc, between 35º and 37ºS it is displaced to the east beneath the Payenia flood basaltic plain. Finally, the amplitude of reduced crustal thickness coincides exactly with areas characterized by broad positive residual gravity anomalies. By computing the gravity of the theoretical-introduced Moho in Tasarova´s model (2004) and subtracting it to the surface data, we have explained those broad positive residual anomalies. This suggests a relatively deep origin for these anomalies, an origin that is potentially associated with crustal attenuation at depth.

References Christensen, N. and Mooney, W. 1995. Seismic velocity structure and composition of the continental crust: A global view. Journal of Geophysical Research, 100 (B7), 9761-9788. Folguera, A., Zapata, T., Ramos, V.A., 2006. Late Cenozoic Extension and the evolution of the Neuquén Andes. In: Kay, S.M., Ramos, V.A. (Eds.), Late Cretaceous to Recent magmatism and tectonism of the Southern Andean margin at the latitude of the Neuquen basin (36-39ºS). Geological Society of America, Special Paper 407, 267-285. Folguera, A., Bottesi, G., Ramos, V., Zapata, T. 2007. Crustal collapse at the retroarc zone (2-0 Ma):Tromen volcanic plateau, Southern Central Andes (36º40´-37º30´S). Tectonophysics. International Symposium on Andean Geodynamics 2005 Special Issue. Forste, C., Flechtner, F., Schmidt, R., Konig, R., Meyer, U., Stubenvoll, R., Rothacher, M., Barthelmes, F., Neumayer, K.H., Biancale, R., Bruinsma, S., Lemoine, J. M. 2006. A mean global gravity field model from the combination of satellite mission and altimetry/gravimetry surface gravity data. Poster presented at EGU General Assembly 2006, Vienna, Austria, 02-07, April 2006, Geophysical Research Abstracts, 8, 03462. Gotze, H., and Lahmeyer, B. 1988. Application of three-dimenasional interactive modeling in gravity and magnetics, Geophysics, 53 (8): 1096-1108. Gilbert, H., Beck, S., Zandt, G. 2006. Lithospheric and upper mantle structure of central Chile and Argentina. Geophysical Journal International, 165 (1), 383. doi: 10.1111/j.1365-246X.2006.02867.x. Hildreth, W., Fierstein, J., Godoy, E., Drake, R., Singer, B., 1999. The Puelche volcanic field:

extensive Pleistocene rhyolite lava flows in the Andes of Central Chile: Revista Geológica de Chile 26 (2), 275-309. Kay, S. M., 2002. Tertiary to Recent transient shallow subduction zones in the Central and Southern Andes, in Proceedings, Congreso Geológico Argentino 15th: Calafate, v. 3, 282-283. Kay, S.M., Burns, M., Copeland, P., Mancilla, O., 2006. Upper Cretaceous to Holocene Magmatism and evidence for transient Miocene shallowing of the Andean subduction zone under the northern Neuquén basin. In: S.M. Kay and V.A. Ramos (eds.) Evolution of an Andean margin: A tectonic and magmatic view from the Andes to the Neuquén Basin (35º-39ºS latitude). Geological Society of America, Special Paper 407, 19-60. Lüth, S., Wigger, P., 2003. A crustal model along 39ºS from a seismic refraction profile-ISSA 2000. Revista Geológica de Chile 30 (1), 83-101. Pasteka, R. 2000. 2D semi-automated interpretation methods in gravimetry and magnetometry. Acta Geologica Universitatis Comenianae, 55, 5-55. Pasteka, R. and Richter, P. 2002. A simple approach to regularized gradients calculation in gravimetry and magnetometry. EAGE 64th, Florence, Italy. Ramos, V.A. and Folguera, A., 2005. Structural and magmatic responses to steepening of a flat subduction: Southern Mendoza, Argentina. VI International Symposium of Andean Geodynamics. Actas: 592-595. Barcelona. Schmidt S, Götze H-J, Siehl A and Tasarova Z., 2004. 3D Gravity and Magnetic Modelling and Integration of Constraints Using Open GIS: The IGMAS Software Package, Extended Abstracts, 17th Conference and Exhibition Aust. Soc. Expl. Geophys., 15-19th August, Sydney, 4pp, CDROM. Tasarova, S., 2004. Gravity data analysis and interdisciplinary 3D modeling of a convergent plate margin (Chile, 36º-42ºS). Berlin University, 170 pp. Yuan, X., Asch, G., Bataile, K., Bohm, M., Echtler, H., Kind, R., Onchen, O., Wölbern, I., 2006. Deep seismic images of the Southern Andes. In: Kay, S.M., Ramos, V.A. (Eds.), Late Cretaceous to Recent magmatism and tectonism of the Southern Andean margin at the latitude of the Neuquen basin (36-39ºS). Geological Society of America, Special Paper 407. Zapata, T. and Folguera, A. 2005. Tectonic evolution of the Andean fold and thrust belt of the Southern Neuquén basin, Argentina. En: L. Spalletti, G. Veiga and E. Schwarz, J. Howell (eds.) The Neuquén Basin: A case study in sequence stratigraphy and basin dynamics. Geological Society of London, Special Publication 252, 37-56.

AN08 – Fri., 13.4., 11:10 - 11:30 · HSD

Richter, A. (Dresden, Institut für Planetare Geodäsie, TU Dresden), Hormaechea, J. L. (Rio Grande, Estación Astronómica Río Grande), Dietrich, R. (Dresden, Institut für Planetare Geodäsie, TU Dresden), Perdomo, R. (La Plata, Universidad Nacional de La Plata), Fritsche, M. (Dresden, Institut für Planetare Geodäsie, TU Dresden), Connon, G. (Rio Grande, Estación Astronómica Río Grande)

Lake level variations of Lago Fagnano, Tierra del Fuego, and their

E-Mail: fritsche@ipg.geo.tu-dresden.de

Based on pressure tide gauge records from three locations within the lake between January 2003 and May 2006, time series of water level changes have been derived. Based on the general knowledge of different phenomena affecting the water level in lakes, the obtained water-level time series are analysed regarding the orders of magnitude, the periods, the spatial pattern, and the driving mechanisms of variation components representing such phenomena.

We identified shift and tilt of lake level, surface seiches and the tides as the most important of these phenomena. We will present and discuss the results in detail. Special focus will be put on tides with specific implications also on ocean tides around Tierra del Fuego and the crustal structure in the area of investigation.

ANP01 – The Andes and Adjacent Regions ·

Augustsson, C., Bahlburg, H. (Geologisch-Palaeontologisches Institut, Muenster), Berndt-Gerdes, J. (Institut fuer Mineralogie, Muenster)

Preliminary U-Pb data from detrital zircons of the Middle Ordovician Lower Turbidite System, NW Argentina

Detrital zircons from the Middle Ordovician Lower Turbidite System of the Puna Turbidite Complex in northwestern Argentina have been anaysed for their U-Pb ages. The 50-60 zircons from each of two metasandstone samples from a 2 km thick section along the Río Grande at approximately 23°S and 66°30´W originate from the lower and uppermost part of the section. The Lower Turbidite System was deposited in a retro-arc foreland basin position with a magmatic arc to the (present-day) west, and the Gondwana mainland to the east. Most palaeocurrent directions in the central part of the basin are indicative of northward directed detrital transport in the basin during Middle Ordovician time, whereas turbidite channel morphology points to original transport from the west. The zircon analyses indicate a dominance of grains 100-150 micrometres in length that are euhedral or slightly abraded. Cathodoluminescence images reveal that most analysed zircons in the two samples are oscillatorily zoned, which is indicative of a magmatic origin. Zircons with only one visible growth phase are common. The outer zoning was preferrably dated in grains with several growth phases. Concordant preliminary U-Pb ages (uncorrected for common Pb) are mostly younger than 600 Ma. The morphology, zoning and U-Pb data, although preliminary, make it probably that most zircons are of local origin, which also can be expected for detrital zircons deposited along an active continental margin. Furthermore, the many zircons with only one visible age zoning point only to a minor importance for sedimentary recycling. Preliminary $^{238}U/^{206}Pb$ ages (uncorrected for common Pb) from rims and cores from the same indivicual zircons are mostly younger than 600 Ma, indicative of two growth stages in late Proterozoic to early Palaeozoic time.

ANP02 – The Andes and Adjacent Regions ·

Duhart, P. *(Puerto Varas, SERNAGEOMIN.), Adriasola, A.C. (Llandudno, Fugro-Robertson Limited.)*

Provenance, metamorphism and exhumation of the Bahía Mansa Metamorphic Complex on the Main Chiloé Island, south-central Chile

The Coastal Ranges in the western part of the Chiloé Archipelago represent an emerged forearc high at the subduction front of south-central Chile. Prior to the Cenozoic framework of the subducting Farallón and Nazca plates beneath the South American plate, the history of the metamorphic rocks in the Coastal Ranges involve episodes of subduction and/or accretion of oceanic and ensialic material along the proto-Pacific margin of Gondwana. Progressive mapping campaigns supported by geochronological studies have led to the correlation of these rocks to the Bahía Mansa Metamorphic Complex (BMMC), which is well exposed along the Coastal Ranges between 39° and 41°30' S (Duhart et al., 2001). Previous conventional U-Pb geochronology of detrital zircons from samples collected on the Northern Segment of the Main Chiloe Island yielded concordant ages of 388, 462, 465 and 1.120 Ma (Duhart et al., 2001). These ages constrain the maximum possible sedimentation age for this portion to Middle Devonian times (Duhart et al., 2001). Also, these data suggest primary zircon sources of Devonian, Ordovician and Mesoproterozoic ages. New concordant U-Pb detrital zircons ages of 310, 360, 390 and 412 Ma from a sample collected on the Central Segment constrain the maximum possible sedimentation age to Upper Carboniferous for this portion and also suggest primary zircon sources of Carboniferous and Devonian times. The detrital zircon concordant ages dataset shows primary zircon sources of Carboniferous, Devonian, Ordovician and Mesoproterozoic ages. The detrital zircons probably derived from magmatic sources in adjacent or distal areas or, alternatively, they may represent recycled zircons. If we assume a magmatic source for the sediments prior metamorphism, the Carboniferous zircons (310 Ma) could have been derived from the erosion of the batholiths of Futrono-Riñihue (ca. 300 Ma; Campos et al., 1998) and/or Nahuelbuta (ca. 320 Ma; Hervé et al., 1976) to the north. Alternatively, they could have been derived from distal Carboniferous granodioritic to leucogranitic sources within the North-Patagonian Massif (ca. 280-300 Ma, U-Pb in zircons; Varela et al., 2005). Zircons of uppermost Devonian-Carboniferous age (360 Ma) could have derived from Devonian granites located presently in the subsurface of the Central Depression (e.g. 359.3±4.4 Ma, Ar/Ar in amphibole; Duhart et al., 1998). A possible proximal source for Devonian zircons (388, 390 and 412 Ma) is the Chaitén Metatonalite from the western part of the North Patagonian Cordillera (400±5 Ma, U-Pb in zircons; Sernageomin-Brgm, 1995), and possible distal sources are Devonian tonalites and leucogranitic intrusions from the eastern part of the North-Patagonian Cordillera (ca. 386-419 Ma, U-Pb in zircons; Varela et al., 2005) and/or the El Laurel Tonalite from the Deseado Massif (395±4 Ma, U-Pb SHRIMP in zircons, Pankhurst et al., 2003). A possible source for Ordovician zircons (462 and 465 Ma) could be the Dos Hermanos Ordovician Granite from the Deseado Massif (≥465 Ma, U-Pb SHRIMP in zircons, Pankhurst et al., 2003). Mesoproterozoic detrital zircons can be found as well in the Eastern Metamorphic Complex of the Aisén region, which probably have been derived from cratonic areas within the interior of Gondwana (Hervé et al., 2003). K-Ar and Ar/Ar dates in white mica from pelitic schists of the Northern Segment yielded 220±5 and 232,5±2,7 Ma, respectively (Duhart et al., 2001). The latter were interpreted to indicate the onset of cooling following greenschist facies metamorphism associated to the main phase of deformation (D2). Three K-Ar ages in white mica -some with traces of biotite- from metapelitic rocks of the Central Segment, collected at the vicinities of Castro, indicated 236±6, 245±8 and 230±5 Ma ages, respectively (Duhart and Muñoz, 2001). These K-Ar and Ar/Ar cooling ages are in good agreement to those previously reported from the BMMC, supporting that both segments were affected by greenschists facies metamorphism during the Middle to early Late Triassic. Asides from two samples for fission-track (FT) dating analyzed from outcrops nearby Castro (Thomson and Hervé, 2002), the low temperature history of the metamorphic basement on Chiloé Archipelago remains poorly known. Interpretations for its regional context are extrapolated from studies located further south in the Chonos Archipelago (Hervé et al., 2003), or further north in the locality of Bahía Mansa (Duhart et al., 2001). Zircon FT data from three samples in the Valdivia area yield ages between 176 and 212 Ma with a weighted average of 186±24 Ma interpreted as final cooling to below 200 °C (Glodny et al., 2005). Seven zircon and nine apatite FT ages of metamorphic and subvolcanic rocks taken from different segments of MainChiloé Island were reported (Duhart and Adriasola, submitted). The zircon samples yield central FT ages between Late Jurassic (155.6±10.1 Ma) and Late Cretaceous (90.0±3.9). Apatite FT central ages range between Early Cretaceous (117.9±5.8 Ma) and Eocene (49.9±15.7 Ma). The direct correlation between radiometric ages of greenschist metamorphism and zircon FT ages indicates very slow cooling rates between 240 Ma and 140 Ma. The wide time-span allows the possibility of previous exhumation of the BMMC followed by burial before the onset of cooling beneath the ZPAZ in Late Jurassic to Early Cretaceous times. North of 40° S, outcrops of Upper Triassic continental sequences (Tralcán and Panguipulli Formations) evidence an important contribution of sediments derived from the erosion of the BMMC. This implies that part of the complex further north of the study area was already emerged at the surface during this period. This last one is confirmed by zircon FT data from Valdivia area (Glodny et al., 2005). Within the Chiloé Archipelago no outcrops of Triassic rocks have been described. Field mapping by SERNAGEOMIN-BERGM (1995) have identified outcrops of metasedimentary rocks of possible Triassic age within the Principal Cordillera. Zircon and apatite FT cooling ages in metamorphic rocks together with the presence of marine sedimentary successions of presumable later Late Cretaceous age found at the forearc slope of the Main Chiloé Island suggest exhumation of the metamorphic unit during the early Late Cretaceous. Apatite FT ages are as young as Eocene, and these probably represent thermal resetting by shallow magmatism, possibly coeval with the Gamboa Dacite and Metalqui Pluton (Arenas and Duhart, 2003).

ANP03 – The Andes and Adjacent Regions ·

Garcia Morabito, E., Ramos, V. (Laboratorio de Tectonica Andina, FCEN, Universidad de Buenos Aires)

Superimposed structural styles: new evidences for a segment between 38° - 39°30´S, Southern Central Andes - Northern Patagonian Andes

E-Mail: ezegm@gl.fcen.uba.ar

Previous studies have shown evidences of an episodic behavior of the fold and thrust belt in Neuquen (Garcia Morabito and Folguera, 2005, Ramos y Folguera 2005), corresponding to compressive phases (Late Cretaceous, Middle Eocene and Miocene) (Cobbold and Rossello 2003) followed by stages of crustal collapse. This episodic behavior is correlated with changes in the geometry of the Benioff zone at least since upper Cretaceous times (Ramos y Folguera 2005). The analysis of structural and morphological features along the main morphostructural units between the 38°30´ and 39°30´S allow us to recognize superimposed structural styles which are consistent with a model of alternating tectonic regimes.

The western retroarc area between these latitudes is formed by a structural high flanked by two N-NW elongated ridges. The Loncopue trough is a long depression that occupies the inner sector of the retroarc area at the foothills of the Principal Cordillera. Its oriental border is defined by a series of extensional features that affects the inner sector of the Agrio fold and thrust belt (Ramos, 1977, Garcia Morabito, 2005). This trough consists of a half graben system developed during the Oligocene times which concentrates important volumes of Pliocene volcanic products that are covered by more recent monogenic basalt fields. A series of neotectonic extensionally features recognized along this unit suggest a reactivation of this trough during Pliocene - - Pleistocene times. The Bio Bio - Alumine trough is located eastwards from the Loncopue depression and intercepts the volcanic arc at the 38°S. A structural high called the Copahue - Pino Hachado Block (CPHB) is bounded by these two regional depressions. This structural high, which constitutes the drainage divide south of the 38°S, was uplifted during upper Miocene times by a west verging thrust located at its western flank (Suarez y Emparan, 1997). North of the 38°S it intercepts the volcanic front; to the south it can be correlated with the Catan Lil High (39° - 39°30´S). This block shows a higher structural complexity in comparison to the CPHB. It produces a topographic break along an W - E transect as well as a change in the amplitude of the orogen at these latitudes, reaching higher altitude values than the Principal Cordillera, and separated by tens of kilometers from the present volcanic arc. This feature represents deep levels of exposure of the Neuquen fold and thrust belt. The structures of this sector consist of a series of north - south and NW - SE oriented thrust sheets, several folds, and associated minor faults. The main deformation mechanism is of thick-skinned style (basement-involved). A minor number of thin skinned thrust sheets controls the deformation at the southern end of this segment. There is a dominant west verging geometry of the structure, with a series of east dipping faults that exhumed Paleozoic to Mesozoic rocks, controlling the development of two principal ranges which constitutes high amplitude anticlines related to these structures. Mainly of the trends of the faults respect the distribution of the Late Triassic - Early Jurassic extensional basins observed along the Southern Central Andes and Northern Patagonian Andes. The western topography break of this feature, at the western slope of the Sierra de Catan Lil, is mostly covered by Pliocene volcanic sequences which lie over volcaniclastic and clastic deposits of a narrow Miocene basin (Chimehuin basin). In spite of that, an east dipping fault that overrides Mesozoic volcanic sequences of the Choiyoi Group over volcaniclastic Miocene sequences of the Chimehuin Formation (Miocene) can be recognized for discrete segments. This fault propagates into the Miocene sequences next to the topography break and gives rise to reverse faults and asymmetric folds. Farther to the South, along the course of the Catan Lil River, an asymmetric fault propagation fold affected upper Miocene deposits. These strata show progressive discordances (Leanza et al., 2005) which indicate an active deformation along this structure during its deposition. A volcanic sequence of Pliocene age is sealing this feature. The eastern slope of the Catan Lil High is bounded by an extense volcanic field that defines the southern extreme of the Loncopue trough and seems to be controlled by an extensional regime. New evidences of a late Miocene deformation at these latitudes show that the final uplift of the Catan Lil High was simultaneously produced with the uplift of the CPHB located immediately to the northwest. This stage of compressive deformation was followed by an extensionally Pliocene-Pleistocene activity along the Loncopue trough that also affected sectors of this structural high.

REFERENCES Cobbold, P.R. and Rossello, E.A., 2003. Aptian to recent compressional deformation, foothills of the Neuquen Basin, Argentina. Marine and Petroleum Geology, 20, p. 429-443. Cucchi, R., Leanza, H., Hugo, C., Repol, D., Escosteguy, L., Gonzalez, R. y Danieli, J. 2005. Hoja geologica Junin de los Andes, Hoja 3972-IV, 1:250.000, Instituto de Geologia y Recursos Minerales, Boletin 275. 128 p., Buenos Aires. Garcia Morabito, E. y Folguera, A., 2005. El alto de Copahue - Pino Hachado y la fosa de Loncopue: un comportamiento tectonico episodico, Andes neuquinos (37° - 39°S). Revista de la Asociacion Geologica Argentina, 60 (4), p. 742-761. Ramos, V.A., and Folguera, A., 2005, Tectonic evolution of the Andes of Neuquen: Constraints derived from the magmatic arc and foreland deformation. In: G. Veiga, L. Spalletti, J. Howell and E. Schwarz (eds.) The Neuquen Basin: A case study in sequence stratigraphy and basin dynamics: Geological Society of London, Special Publication 252: 15-35. Ramos, V.A., 1977, Estructura. In: Rolleri, E.O. (Ed.), Geologia y Recursos Naturales de la Provincia del Neuquen. VII° Congreso Geologico Argentino, Relatorio 1, p. 9-24. Suarez, M. y Emparan, C., 1997. Hoja Curacautin. Regiones de la Araucania y del Bio Bio. Carta Geologica de Chile, 1:250.000, Servicio Nacional de Geologia y Mineria de Chile. 71, p. 1-105.

ANP04 – The Andes and Adjacent Regions ·

Garcia, V.H., Cristallini, E.O. (Buenos Aires, Laboratorio de Modelado Geológico (LaMoGe), Departamento de Ciencias Geológicas, FCEyN - UBA. CONICET.)

Numerical modeling of erosion, sedimentation and tectonic processes in the Andean piedmont

E-Mail: `victorg@gl.fcen.uba.ar`

The coupling between tectonics and surface processes has been demonstrated theoretically and through numerical and analogue modeling. In this work we present the firsts advances in the development of a numerical modeling platform which integrates the main variables that control erosion-sedimentation processes (terrain slope, precipitation, erodability) and the growth of neotectonic folds as a tool to study its relationship and coupling.

The basic arrangement of the present model is a bi-dimensional grid of points (x, y). Each point contains values of elevation (z), erodability and precipitation. For a better correlation with the nature an aleatory ´´noise´´ is introduced to the spatial components (x, y, z). The system allows to design an initial regional slope in some direction and to apply tectonic perturbations simulating neotectonic folds growing in piedmont environments (figure 1A). The algorithm used to fold the surface is fault parallel flow andfor each step the grid is ´´deformed´´ at the shortening rate. The erodability was adjusted using actual denudation rates measurements for Andean (and mainly erosive) fluvial basins. Flexural subsidence is calculated putting in the center of the growing fold the maximum charge and calculating the effect for each grid point using a cosine equation. This equation take into account that as the fold grows the charge is increases and the peripheral bulge migrates towards the fold.

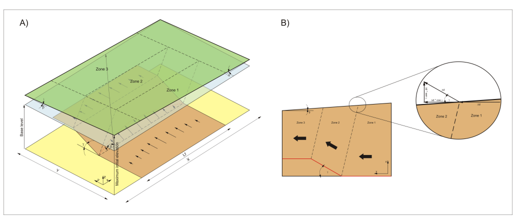


Figure 1: A) Fault surface that controls the deformation (in orange). The arrows drawn over the fault indicate the variation in displacement between the central section and its lateral culminations. This displacement gradient produces in surface a double plunging anticline. The anticline geometry is controlled by the ramp angle, the fault length and the ramp length. The initial topography is calculated using the regional slope, the maximum initial elevation and the slope direction. The deformation zones are recalculated for each program step. B) Fault parallel flow folding method. The system recognizes three deformation zones in surface that are limited by the intersection between the kinks and the topography. In the zones 1 and 3 only take place horizontal displacement. In zone 2 the displacement is divided in vertical and horizontal components as is illustrated in the detail.

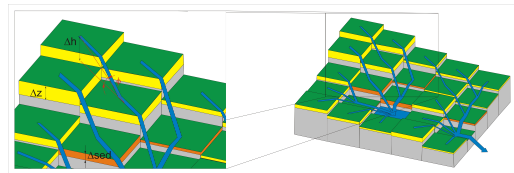


Figure 2: This sketch shows how the model selects the path for each pixel. The amount of erosion is indicated in yellow and the sediment tickness in orange.

Each step in the main subroutine comprises a sequence of modules. In the first module the zones with tectonic perturbations are determined, the shortening rate is applied and the spatial values (x, y, z) are recalculated (figures 1A and 1B). In the next module each grid point is evaluated to determine its path of maximum slope (figure 2). Following this path the system calculates the eroding capacity for each path point (Qe) and the quantity of charge (Qi). If Qe exceeds Qi thenthe river erodes its substratum, and if Qi exceeds Qe then the ex-

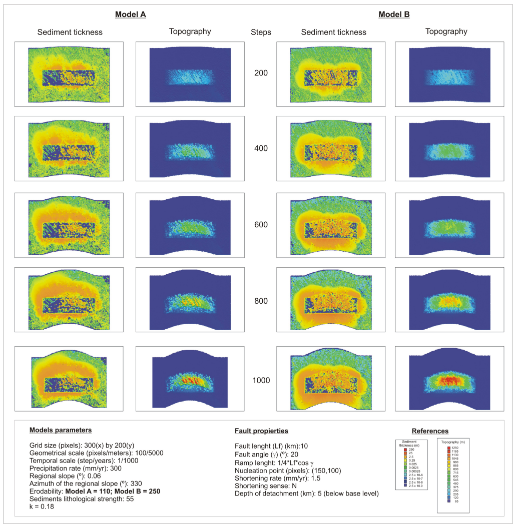


Figure 3: Evolution of the two models.

cess of charge (Qi - Qe) is deposited. These procedures continue until the last point of the path is reached and is repeated for each path calculated.

Two models have been carried out to evaluate the degrading processes on a growing anticline and to determine the associated depositional features (figure 3). The unique difference between the models is the erodability of the substratum being the double in the model B. In the model A is evident that the incision has been more efficient given its minor rock strength. The sediment thickness around the growing folds becomes greater in its vicinity and decreases with the distance. This thickness distribution is similar to the pattern founded in alluvial fans. These results are in agreement with previous works and become this modeling platform in an interesting tool to study de interaction between deformation, erosion and sedimentation.

Web page: http://aviris.gl.fcen.uba.ar/lamoge/

ANP05 – The Andes and Adjacent Regions ·

Haller, M.J. (Universidad Nacional de la Patagonia San Juan Bosco and CONICET, Puerto Madryn), Ostera, H.A., Cagnoni, M. (Instituto de Geocronología y Geología Isotópica, Buenos Aires)

Miocene Magmatism Magma Sources in the Southern Andes

E-Mail: haller@cenpat.edu.ar

INTRODUCTION During the last years, different approaches have been intended in order to determine the role of different components in the Tertiary magmatism of the Southern Andes. We present new geochemical and isotope data, results on modeling and the evolution of magmatic units with different ages from Early to Late Miocene, to elucidate the major acting processes in the area.

GEOLOGICAL SETTING The magmatic activity in the Andean segment limited by 34º and 36 S parallels includes magmatic belts associated with the major structures of this segment of the Andes, encompassing the different stages of Andean evolution. Recent papers have been focused on the possibility of an episode of flat slab subduction in Late Miocene times, which interrupted the magmatism in the area and modified the chemical and isotopic patterns. From north to south, a decreasing in crustal thickness contributes to the case complexity.

GEOCHEMISTRY The major element geochemistry shows a typical subalkalic, calc-alkalic magmatic-arc fingerprint. From Early Miocene to Late Miocene, the differentiation trends have similar characteristics, with magmatic evolution controlled by crystal-liquid equilibrium trends. The trace elements spider diagrams show enrichments in LREE and LILE, with Nb and Ti troughs. Eu depletions are present only in the most evolved rocks of rhyolitic composition. LREE enrichment factors of 30 to 60x characterize the Early Miocene units, and 50 to 70x for Medium to Late Miocene (Ostera et al., 2003, 2005).

ISOTOPE MODELING AND TEMPORAL TRENDS New geochemical data on lower crust gabbroic xenoliths and upper crust basement rocks led to model the crustal involvement in magma genesis. Fig. 1 shows the results of a simple two-component crustal contamination model; although AFC models were run, the results were not consistent with the data. As can be seen, the pattern for a two component-mixing model in both cases is very different. Upper crustal components have high Sr ratios and low Sr concentrations, and lower crustal components have low Sr ratios (relative to upper crust) and higher Sr contents, varying from Early to Late Miocene times, due the continuous influx from the mantle to the MASH zone. As a consequence, the simple two components mixing model exhibits opposite and well characterized trends. Compared with the observed general trends of the Miocene magmatism in the Southern Andes, two well defined groups can be distinguished: the Late Miocene rhyolitic units and the Early Miocene andesitic dykes and sills, which shows the most extreme variation in Sr ratios-Sr concentration graphics. On the other hand, most of the samples (independent of age and spatial locations) show slight geochemical variations and reflect a restrictive degree of lower crustal contamination (Fig. 2) or an upper crustal - Choiyoi type, (the latter can be considered a product of a Permian-Triassic lower crust fusion). The geochemical evidences indicate an abrupt increase in Ba/La ratios (Fig. 3) associated with the upper crustal contamination. La/Sm ratios behavior is also similar. The trends show average values and the volcanic front data are used for comparison. Additional evidences are shown in the Th/La evolution, with typical upper crust values in Late Miocene (Fig. 4). If we analyze the Nd isotope evolution, there is a clear evidence of upper crustal involvement in Late Miocene units (Fig. 4). In order to explain all the data, we should consider the tectonic processes as the origin of the observed variations. In our opinion, they represent a response of the magmatism to the proposed flattening of the slab during the Late Miocene, as it was suggested in earlier contributions (Ostera et al., 2000) and also by Kay et al. (2002, 2005 and references therein). The flattening is accompanied with a compressional regime and deformation. The magmas, emplaced in a compressional regime, have difficulties in their ascent through the crust, and in consequence they evolve in depth (these magmas are the most evolved suite in the Miocene). This derives in high intrusive/extrusive index and forced emplacement, as can be seen in the whole area Recent papers by Ramos and Folguera(2005) reinforce the idea with new data. Although geochemical evidences of crustal erosion have been registered in the volcanic front, the data are not still conclusive due the antithetical trends in La/Yb and La/Ta ratios. We suggest that the expected geochemical trends are conditioned by the spatial position of this magmatism.

CONCLUSIONS New data on crustal components suggest an increasing of Upper Crustal components in the Tertiary Magmatism of the Southern Andes from Early to Late Miocene times. The isotope modeling suggests that the lower crustal component varies from Early to Middle Miocene, due the continuous influx from the mantle to the MASH zone. The explanation for the major upper crust involvement towards the Late Miocene could be the slab flattening, which provokes a compressional regime and evolution of magmas in depth. The role of crustal erosion is still not well defined in the area, although some geochemical evidences are compatible with it.

REFERENCES OSTERA,H. A., HALLER, M. J., LINARES, E. and JOENSEN V. 2000. Geochemical evidences and implicancies on contrasting magma sources at Paramillos Altos Intrusive belt, Southern Mendoza, Argentina. IX Congreso Geológico Chileno, Actas, I: 669-673. Puerto Varas. KAY, S. M. 2005. Tertiary to Recent evolution of Andean arc and backarc magmas between 36°S and 38°S and evidence for Miocene shallowing of the Nazca plate under the Neuquén basin. 6th International Symposium on Andean Geodynamics - ISAG 2005, Extended Abstracts: 420-423. Barcelona. KAY, S. M. and MPODOZIS, C. 2002. Magmatism as a probe to the Neogene shallowing of the Nazca plate beneath the modern Chilean flatslab: Journal of South American Earth Sciences, 15: 39-58. OSTERA, H. A., CAGNONI, M., RAMOS, A., HALLER, M. J, .LINARES, E., and JOENSEN, V. 2003. Source contributions to arc magmatism at the Calle del Yeso dyke complex (Paramillos Altos), Southern Mendoza, Argentina.. IV South American Symposium on Isotope Geology, Short papers, 1: 241-243, Salvador. OSTERA, H. , HALLER, M. J. , LÓPEZ DE LUCHI, M., CAGNONI, M., RAMOS, A. and LINARES, E. 2005. Geochemistry of the intrusive Miocene arc magmas from the Malargüe area, southern Mendoza, Argentina: An overview and implications on crustal contamination. 6th International Symposium on Andean Geodynamics - ISAG 2005, Extended Abstracts: 559-562. Barcelona. OSTERA, H.A.; LINARES, E.; HALLER, M. J. 1999. Paramillos Altos Intrusive Belt, Southern Mendoza, Argentina. Ages, Chemical and Isotopic Constraints. Actas II South American Symposium on Isotope Geology. Anales SEGEMAR XXXIV: 256-260. Buenos Aires. RAMOS, V. and FOLGUERA, A. 2005. El origen de Payenia (Mendoza sur y norte de Neuquén): evolución estructural y tectonomagmática de los Andes a estas latitudes. VI Congreso Geológico Argentino. Actas en CD-ROM.

ANP06 – The Andes and Adjacent Regions ·

Martina, F. (Laboratorio de Analisis de Cuencas, Universidad Nacional de Cordoba. Cordoba), Viramonte, J. M. (Instituto Geonorte, Universidad Nacional de Salta. Salta), Astini, R. (Laboratorio de Analisis de Cuencas, Universidad Nacional de Cordoba. Cordoba), Pimentel, M., Dantas, E. (Instituto de Geociencias, Universidad de Brasilia. Brasilia)

Evidence of Early Carboniferous Pre-Choiyoi volcanism in western Gondwana: First isotopic, geochemical and U-Pb SHRIMP data

E-Mail: fmartina@efn.uncor.edu

The Late Paleozoic magmatism of western Argentina and Central Chile records crustal and mantle processes at the Gondwana margin during the final assembly and initial break-up of the Pangea supercontinent (Mpodozis and Kay, 1993). It comprises Pennsylvanian arc granites and the Permo-Triassic Choiyoi Group including co-genetic granites and rhyolites recording extensive crustal melting associated to extension (Kay et al., 1989). Both magmatic stages are separated by an angular unconformity along the Cordillera Frontal (Llambías y Sato, 1995). In the NW border of the Famatina belt and in the Puna Austral (NW Argentina) ca. 150 m thick undeformed rhyolites unconformably cover metamorphic basement and Ordovician volcano-sedimentary successions included in the Las Planchadas Formation. These rhyolites are overlain by a thick (>1000 m) late Paleozoic siliciclastic succession, represented by Pennsylvanian alluvial conglomerates and lacustrine beds. The volcanic rocks are essentially composed of Qtz, Plg and K-feldspar with zircon as accessory mineral and exhibit subalkaline geochemical characteristics with 74 to 76 wt. silica content. ASI index values are ca. 1.05. Initial 87Sr/86Sr ratios range from 0.71210 and 0,.7141 suggest a crustal source for the origin of parental magmas. Zircon U/Pb SHRIMP data on samples from northern Famatina (27º 19´ S) and southern Puna (28º 07´ S) yielded ages of 350 Ma (Mississippian), interpreted as crystallization ages. The volcanic rocks analyzed here have traditionally been included in the Ordovician Las Planchadas Formation. The new data allow their separation from a previously undetected Mississippian volcanic episode within this region of western Gondwana. According to our data this represents an independent episode which cannot be correlated with the known pre Choiyoi volcanic stage and seems to have further triggered the accommodation space for development of the Late Paleozoic basin. The present day area of exposure of this volcanic belt exceeds 100 km in the north-south direction and suggests a crustal origin which can be related to asthenospheric upwelling. In the light of the known paleogeographic reconstructions for western Gondwana and isotopic, geochemical and U-Pb SHRIMP data obtained by us, this volcanism may be related to either: (i) postcollisional slab breakoff, (ii) delamination in an Andean-type setting or (iii) tectonic switching in an accretionary orogen. The U-Pb ages might suggest that it could be related to the controversial Chilenia terrane accretion and subsequent removal of the subducted slab. However, these volcanic rocks occur further north of the suggested Late Devonian accretion belt. Other possible interpretation could be delamination, but this model cannot create further accommodation space to develop the large sedimentary basins recoded in the region. Alternatively, the origin of this silicic volcanism may be attributed to asthenosphere upwelling in a convergent margin after tectonic switching occurring in a suprasubduction zone (cf. Collins, 2002). According to this model, the extensional phase may be accompanied by deposition of sedimentary successions and by volcanic rocks produced by shallow crustal melting. Regionally, this hypothesis may induce their correlation, with the poorly known post-Achalian A-type granites (Dahlquist et al., 2006) that seem to record extension and heating of the crust further to the east within the Sierras Pampeanas.

References: Collins W.J, 2002. Nature

of extensional accretionary orogens. Tectonics, 21 (4), TC1024, 10.1029/2000TC001272. Dahlquist, J.A.; Pankhurst, R.J.; Rapela, C.W.; Casquet, C.; Fanning, C.M.; Alasino, P.; Baez, M., 2006 The San Blas Pluton: An example of Carboniferous plutonism in the Sierras Pampeanas, Argentina Journal: Journal of South American Earth Sciences, 20: 341; 350 Mpodozis, C. and Kay, S.M., 1992. Late Paleozoic to Triassic evolution of the Gondwana margin: Evidence from Chilean Frontal Cordillera Batholiths. GSA Bulletin, 104. Kay, S.M., Ramos V.A., Mpodozis, C. and Sruoga, P., 1989. Late Paleozoic to Jurasic silicic magmatism at the Gondwana margin: analogy to the Middle Proterozoic in North America?. Geology, 17. LLambias E.J. and Sato, A.M., 1995. El batolito de Colanguil: transición entre orogénesis y anorogénesis. Revista de la Asociación Geológica Argentina, 50: 111;131.

ANP07 – The Andes and Adjacent Regions ·

Remesal, M.B. (CONICET Universidad de Buenos Aires), Parica, C.A. (CONICET Universidad de San Martín), Salani, F.M., Cerredo, M.E. (CONICET-Universidad de Buenos Aires)

Compositional variations in Post Plateau Basalts of Somun Cura, Patagonia.

E-Mail: remesal@gl.fcen.uba.ar

The basaltic plateau of Somun Cura is interpreted as a flood basalt on a wide extension at the Northern Argentine Patagonia, its development seems to be related to tectonic environment complex not fully explained. Since the former papers until today a good consensus was agreed about the existence of more than one episode in the formation of this magmatic sequence, 1) the basalt plateau with uniform composition and 2) the younger postplateau stage (Remesal et al. 2001, Salani et al. 2006). Into the post plateau stage it is possible to differentiate lithological variations. The most conspicuous difference let to separate the big trachyte-basalt complexes (represented at the ranges of Alta Sierra de Somun Cura, Apas, Chauchaineu, etc.) from the monogenetic minor centres (Trayen Niyeu, Corona Chico, Dos Hermanos and others). The monogentic centres are characterized by a wide distribution in the plateau environment, for their exclusive basaltic composition and different type of eruption as a result of compositional variations (essentially because the content of volatile and silica). The studies carried out let to identify at least four types of basalts, a) strongly alkaline basalts, with nephelinites and noseanic basalts. b) alkaline to transitional basalts, porphyritic according to megacrystals of ortopyroxene, clinopyroxene, olivine and plagioclase in disequilibrium. c) olivine alkaline basalts and d) subalkaline basalts with crystals of orthopyroxene in reaction to clinopyroxene. Particularly the alkaline olivine basalts are the most common type associated to the biggest structures bimodal type complexes. The undersaturated basalts to the alkaline to transitional basalts are mostly related to small spatter cones and low volume lava flows. The subalkaline type are related to monogenetic vent with more complexity in the structure. A temporal superposition and coexistence of different basaltic effusions should be strongly possible for the postplateau episode also for the bimodal complexes and the monogenetic centres. At these times there no enough evidences to establish the final sequence. Furthermore, a temporal short rank for the basalt emissions is bounded with ages between 20 to 12 Ma in the Miocene. The petrographic evidences in the postplateau basalts, with spread of minerals in disequilibrium support the hypothesis of mixing processes between liquids of different origin. The geochemistry parameters sustain this idea and appoint the existence of different of sources at different depths and or liquids with different degrees of melting, also supported because the variations of isotopic ratios for Sr and Pb. The isotopic ratios of Sr and Pb are also effective for characterization of each one of the four groups (strongly alkaline basalts, the alkaline to transitional basalts, the alkaline olivine basalts and the subalkaline basalts). References. Remesal, M.B., F.M.Salani, M. Franchi and A.A Ardolino. 2001. Hoja Geologica N 4169-IV Maquinchao. Provincia de Rio Negro. Instituto de Geologia y Recursos Minerales. Servicio Geologico Minero Argentino. Boletin 372: 79p. Salani, F. M., M. B. Remesal, M. E Cerredo, M. Franchi and A. A. Ardolino. 2006. Contribution to the age of the Somun Cura Post-Plateau Events. Extra Andean Argentinean Patagonia. V Simposio Sudamericano de Geologia Isotopica (SSAGI). Acta:415-419.

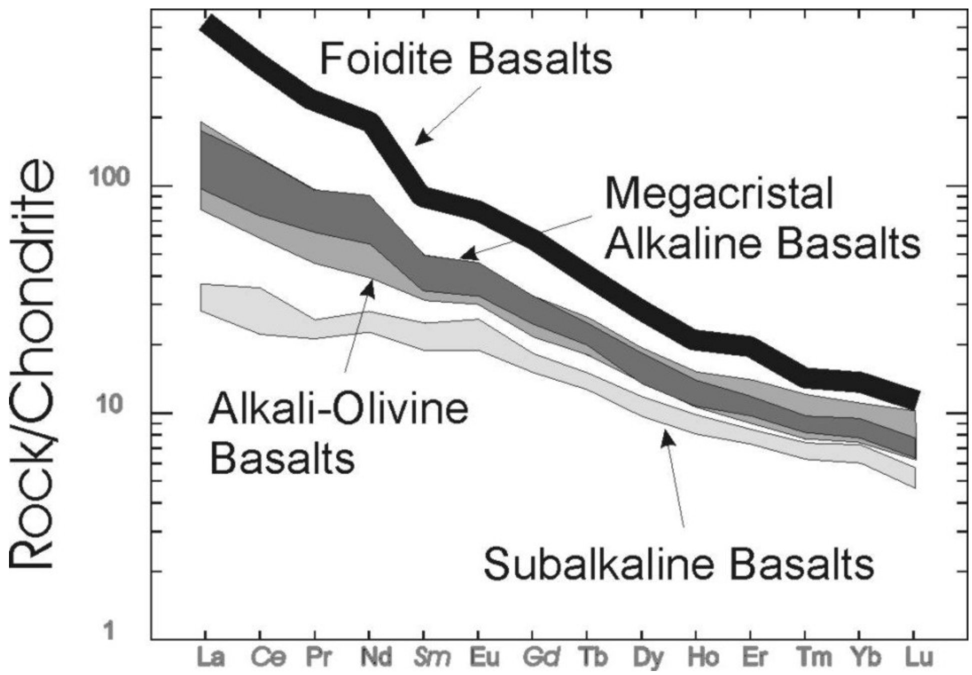


Figure 1: Figure 1. REE pattern of postplateau basalts of Somun Cura

ANP08 – The Andes and Adjacent Regions ·

Rossello, E.A. (CONICET - Univ. Buenos Aires, Buenos Aires, Argentina.), Cobbold, P.R. (Geosciences Rennes, Rennes Cedex, France,), Marques, F.O. (Dep. Geologia e CGUL, Univ. Lisboa, Lisboa, Portugal)

Late Oligocene to Miocene compressional growth strata in two Andean intermontane basins of Neuquén province, Argentina (37°- 40° S)

E-Mail: rossello@gl.fcen.uba.ar

In the Neuquen province of Argentina, the Neuquén basin formed as a composite rift basin during the early Mesozoic. It became inverted in various stages, from the middle Cretaceous onwards, as a result of Andean compression (Ramos, 1998; Cobbold and Rossello, 2003). Between the westernmost exposures of Mesozoic strata and the volcanic arc of the main Andean Cordillera, several intermontane basins contain Oligocene to Miocene continental strata. Despite claims that these basins developed as rifts (Jordan et al., 2001; Burns et al., 2006), we have evidence that at least two of them, the northern Loncopue basin and the Catan-Lil basin, developed in a compressional setting, next to westward-verging back-thrusts (Cobbold et al., 2006).

In the two intermontane basins that we have described, growthstrata are diagnostic of horizontal sublatitudinal shortening, rather than extension (Cobbold et al., 2006).

In the northern Loncopué basin, compressional growth strata of the Lileo Fm are well dated (late Oligocene to early Miocene). Although there is no guarantee that at this locality the shortening involved basement, neighbouring outcrops point to episodes of basement-involved shortening in the Palaeozoic, late Cretaceous to Eocene, late Oligocene to early Miocene, and post-Pliocene.

In the Catan-Lil basin, compressional growth strata of the Chimehuín Fm are loosely dated to the early Miocene. The deformation involved Mesozoic rocks and probably the basement as well. In neither of the two areas (nor anywhere else in the Neuquén basin) have we found any evidence for a phase of thick-skinned extension in the late Oligocene to early Miocene, as claimed by Jordan et al. (2001) and Burns et al. (2006). The only well substantiated rifts are those that formed in the early Mesozoic. We cannot rule out the possibility that there might have been a phase of Tertiary rifting, nor do we exclude strike-slip motions (for which we have little evidence). However, we urge the greatest prudence in postulating the existence of rift basins in the Andes, especially if the arguments are purely stratigraphic or the evidence is incomplete.

ANP09 – The Andes and Adjacent Regions ·

Rossello, E.A. *(Conicet - Universidad de Buenos Aires. Buenos Aires, Argentina), Bordarampe, C.P. (Universidad de Buenos Aires. Buenos Aires, Argentina), Peri, V.G. (Conicet - Universidad de Buenos Aires. Buenos Aires, Argentina)*

The Otumpa faulting: an intracontinental megastructure controlling the neogene morphology of the Gran Chaco plain (Argentina)

E-Mail: rossello@gl.fcen.uba.ar

The Otumpa faulting is an active megastructure located into the Gran Chaco on the northernmost portion of the Argentine pampas. The Gran Chaco is a huge plain with monotonous topography with altitudes ranging from 200 to 40 m a.s.l. representing the farthest foreland features of the Andean Cordillera. Being controlled by the Parana river base-level, only a few permanent rivers such as Bermejo, Salado and Pilcomayo flowing eastwards are found in this flat region.

From satellite images and DEMs associated into a GIS platform it is possible to recognize the Otumpa faulting trending NNE-SSW on the eastern flank of the homonymous hills into the Santiago del Estero province (Rossello and Bordarampe, 2005). This structure controls the drainage pattern as well as the neogene Mar Chiquita endorreic depression and the high-lifted Ceres Block

From subsurface view point, oil seismic data show the Otumpa faulting continuous to the north up to the western boundary of the Las Breñas Basin considered a Paleozoic half-graben depocenter. Besides, its SW extreme is associated with the eastern boundary of the Sierras Pampeanas (Sierra Chica of Cordoba and Ambargasta hills).

Regarding the seismicity of this portion of the South America plate the position of the Otumpa faulting coincides with the easternmost boundary of the 500 to 800 km in depth hypocenters related to the subducted Nazca plate.

From the whole available data up to present, the Otumpa faulting should be considered a megatranspressional structure with dextral strike-slip compound produced by the neogene reactivation upon extensional discontinuities related to the origin of Paleozoic depocenters such as Las Breñas Basin. The Otumpa hills represent the western uplifted flank that produced changes in drainage pattern, particularly on the Salado River. The Otumpa faulting extends for more than 600 km in the considered area.

Finally, the Otumpa faulting is considered as a first-order structure verging towards-east representing the most external Andean deformation front affecting a thickest intracontinental portion of the South America plate.

Reference

Rossello, E.A. and C.P. Bordarampe, 2005. Las Lomadas de Otumpa: nuevas evidencias cartograficas de deformación neotectónica en el Gran Chaco (Santiago del Estero, Argentina). XV° Congreso Geológico Argentino (La Plata, Argentina).

ANP10 – The Andes and Adjacent Regions ·

Söllner, F. (LMU München), Gerdes, A. (JWG-University Frankfurt), Grosse, P., Toselli, A.J. (UNacional de Tucumán, Argentina)

U-Pb age determinations by LA-ICP-MS on zircons of the Huaco granite, Sierra de Velasco (NW-Argentina): A long-term history of melt activity within an igneous body

The Sierra de Velasco, formed mainly by a crystalline basement of metamorphic and igneous rocks of Upper Precambrian to Lower Carboniferous age is part of the Sierras Pampeanas geological province of northwestern Argentina. Granites, post-tectonic relative to the deformation phases of the Famatinian cycle (about 515 - 365 Ma), have been alternatively considered the products of a crustal reheating process or part of a separate cycle. The Huaco granite forms a large granitic massif in the central region of the Sierra de Velasco. This granite consists in a sub-elipsoidal body with dimensions of approximately 40 x 30 km, spatially surrounded by meta-granitoids of Famatinian age (lower Ordovician). The Huaco granite is a rather homogeneous porphyritic syeno- to monzogranite. It is characterized by abundant K-feldspar megacrysts of up to 12 cm long, set in a medium- to coarse-grained groundmass of quartz, plagioclase, K-feldspar, micas and accessory minerals. The Huaco granite is moderately per-aluminous, alkali-calcic to slightly calc-alkalic, ferroan and potassium-rich (for more details, see Grosse et al. in prep.). Monazite ages are highly reverse discordant with ^{207}Pb/^{206}Pb ages of 350 $\pm$ 11 Ma and 358 $\pm$ 10 Ma (Grosse et al. in prep.). LA-ICP-MS U-Pb age determinations were carried out on zircons of the Huaco granite, previously depicted by cathodoluminescence investigations (CL). CL photos display both simple and complex zircon types, the latter characterized by older cores and several growth phases distinguished by variations in luminescence and texture. The euhedral outer shape of the zircons is predominantly formed by a rim without any luminescence, which corresponds to metamictization, triggered by the incorporation of high foreign element concentrations (up to 1800 ppm U and 180 ppm Pb).

The main zircon crystallization phase is dated at 354.0 $\pm$ 3.9 Ma (2σ, n=13) (see Fig. below). If the analytical spot is focused on the visible seed crystal zone, developed prevalently in complex zircons, a significantly higher age of 380.0 $\pm$ 6.3 Ma (2σ, n=8) is yielded. Often, these zircons exhibit an older core domain and the previously mentioned rim, while the main crystallization phase at about 354 Ma is mostly lacking. U-Pb ages on older zircon cores are often discordant or reverse discordant but more or less homogeneous. The regression line calculated with 14 analytical spots from older cores, forced to the origin, result in a Concordia intercept age of 477 $\pm$ 53 Ma. The attempt to fix the age of the very last stage of zircon growth provides only a rough estimation of the time span. This zircon phase is represented only by three concordant data points at 292 $\pm$ 25 Ma. Analysis of the rim, which is totally black in the CL images, provides only discordant and reverse discordant ages. All 5 data points fit a regression line with a Concordia intercept age of 314 $\pm$ 42 Ma (forced to the origin). It seems obvious that the final zircon growth and the overgrown rim developed more or less coevally.

Three stages of zircon growth, documented by age clusters at about 380 Ma, 354 Ma and

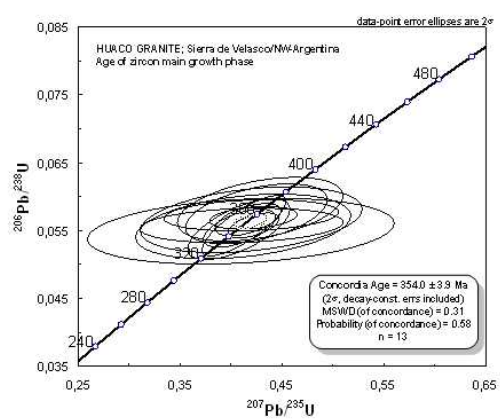


Figure 1:

about 300 Ma, unequivocally demonstrate the complex igneous history of the Huaco granite. These zircon growth stages, formed like onion skins, can be interpreted as different stages of magma generation during a long-term heating process of the crust. In several cases, zircon crystallization started around older cores which are partly resorbed by magmatic corrosion processes. The existence of these zircon cores with ages focused at about 477 Ma indicate that the Famatinian meta-granitoids of Early Ordovician age, which form the host rock, are significantly involved in melt formation. The final rim-like zircon overgrowth may originate from hydrothermal processes.

The long lasting zircon crystallization process is in good agreement with a long-term heating process of the crust which is also proven by re-crystallization processes in minerals from the surrounding Early Ordovician meta-granitoids (Höckenreiner et al. 2003). Regional cooling and uplift is documented by Rb-Sr biotite ages of 300 $\pm$ 4 Ma in the host meta-granitoids (Miller & Söllner, 2005).

References

Grosse et al. (in prep.): Carboniferous granites in centra-eastern Sierra de Velasco, Sierras Pampeanas, Argentina: U-Pb monazite geochronology and geochemical constrains.

Höckenreiner et al. 2003: Dating the TIPA shear zone: an Early Devonian terrane boundary between the Famatinian and Pampean systems (NW Argentina).- J South Am Earth Sci, 16, 45-66.

Miller & Söllner, 2005: The Famatina complex (NW Argentina): back-docking of an island arc terrane accretion? Early Palaeozoic geodynamics at the western Gondwana margin.- In: Vaughan et al. (2005): Terrane Processes at the Margins of Gondwana.- Geol Soc London Spec Publ, 246, 241-256.

ANP11 – The Andes and Adjacent Regions ·

Steenken, A. (Instituto de Geocronología y Geología Isotópica, Buenos Aires), Siegesmund, S. (Geoscience Center Göttingen), López de Luchi, M.G. (Instituto de Geocronología y Geología Isotópica, Buenos Aires), Frei, R. (Geological Institute, University of Copenhagen), Wemmer, K., Drobe, M. (Geoscience Center Göttingen)

Neoproterozoic to Early Palaeozoic events in the Sierra de San Luis: Implications for the Famatinian geodynamics in the Eastern Sierras Pampeanas (Argentina)

The application of the SHRIMP U/Pb dating technique on zircon and monazites of different rock types of the Sierra de San Luis provide an important insight in the i) provenance and timing of deposition of the sedimentary precursors as well as ii) in the metamorphic and igneous history of the different basement domains. Additional constraints on the Famatinian metamorphic episode are provided from PbSL experiments on two garnetand one staurolith separates. Results indicate that the sedimentary precursors of the Conlara Metamorphic Complex have maximum age of ∼590 Ma, whereas the Pringles metasediments appear to be sourced on the Pampean Orogen in the Early Cambrian. Folded xenoliths within the ∼496 Ma old El Peñón pluton suggests that the host Conlara Metamorphic Complex underwent a Pampean compression. Under the new light of a $^{208}Pb/^{232}Th$ monazite age at 478 Ma from a migmatite of the Nogolí Metamorphic Complex appears the structural evolution of this basement complex entirely post-Pampean. Onset of the Famatinian high-grade metamorphism bracket between ∼500 Ma and ∼450 Ma follows a period of crustal extension on the western outboard of Gondwana and might not be related directly to a Middle Ordovician accretion of the Cuyania Terrane.

ANP12

Terrizzano, C. (Laboratorio de Neotectonica (LaNeo)), Fazzito, S. (Instituto de Geofisica Daniel Valencio (Ingeodav)), Cortes, J.M. (Laboratorio de Neotectonica (LaNeo)), Rapalini, A. (Instituto de Geofisica Daniel Valencio (Ingeodav))

Quaternary transpressive zones in the Precordillera Sur, Argentina: an structural and geophysical approach.

E-Mail: cterrizzano@gl.fcen.uba.ar

The Precordillera Sur is a singular morphotectonic unit at the southern segment of the Argentine Precordillera, in the Andean foreland of San Juan and Mendoza provinces (31°30´ - 33°SL; Cortes et al. 2005). Its morphotectonic features, in contrast with other zones of Precordillera, are partially controlled by Late Cenozoic reactivation and tectonic invertion of older structures. These previous structures are of Permian to Triassic age, and have been associated both to the compressional Sanrafaelic orogeny as well as to the subsequent extensional phase during the development of the Cuyana basin.

The northern region of the Precordillera Sur is represented by a 125 km long, NW trending belt characterized by a left stepping arrangement of mountainous blocks and intermontane basins with associated thrusts and strike-slip faults, that is known as the Barreal - Las Peñas shear zone. This firstorder belt was considered as a left-lateral transpressive zone with an important concentration of Quaternary structures (Cortes et al., 2005). The location of this belt overlaps with the northern branch of the Triassic Cuyana basin. These Mesozoic structures, then, may have played a considerable role in the youngest deformation development.

The same morphotectonic and structural pattern was determined at different scales throughout the Barreal - Las Peñas belt. Two neighbour examples in the Barreal - Uspallata trough, in the Sierra de Ansilta foothills, are presented in this contribution.

The first example, the Pampa de los Burros belt, comprises a series of 58 km long, left stepping contractional structures and structural highs: the southern end of the Barreal block, the Pampa de los Burros anticline and the Lomitas Negras high. These features define a second-order, NW trending, left-lateral transpressive belt of Quaternary age bounding the western margin of Precordillera Sur.

The second one, Los Avestruces belt, comprises a set of 12 km long structural highs developed on Quaternary alluvial fans. Its en - echelon morphotectonic arrangement define a thirdorder NW trending sinistral transpressive zone.

Both examples show clear evidences of Quaternary deformation. At least three bent and tilted piedmont agradation levels and displaced alluvial fan deposits were determined. This is found at the southern edge of the Barreal block (Yamin 2007) as well as at the Pampa de los Burros anticline (growth strata in Quaternary sequences; Cortes and Cegarra 2004) and the Lomitas Negras highs (Terrizzano 2006).

Los Avestruces belt show fault scarps cutting Pleistocene levels. Outcrops of Quaternary deposits are still preserved as high remnants on top of the structural blocks. The highs are segmented by NE trending oblique faults.

As a complement to the neotectonic study of Los Avestruces highs, a transversal tomography of electrical resistivity profile was carried out. The inversion model of the subsurface resistivities obtained trough this study is consistent with the presence of Quaternary alluvial fans beds that were bent opposing their original slope, which agrees with ground geological data. A clear subvertical resistivity discontinuity in the subsurface correspond with a NNW scarp. Distribution of high resistivity zones, representative of Paleozoic metasediments, in the geophysical model, led us to the interpretation of the resistivity discontinuity as a Triassic normal fault (associated to the development of the Cuyana basin) which has been reactivated as a reverse fault during the Quaternary (Terrizzano et al. 2006).

The comparative study at different scales of the northern region of Precordillera Sur reveals the role of transpressive belts in its morphotectonic configuration and the fractal nature of those structures.

Further combined geomorphic and geophysical data in the area may confirm the important control of the pre - Cenozoic structures on the neotectonic deformation style at this latitude of the Andean foreland of Argentina.

REFERENCES: Cortes, J. M. and Cegarra, M., 2004. Plegamiento Cuaternario transpresivo en el piedemonte suroccidental de la Precordillera sanjuanina Argentina, Serie D, Publicacion Especial N. 7: 68-75. Cortes, J. M., Yamin, M. G. and Pasini, M. M., 2005. La Precordillera Sur, Provincias de Mendoza y San Juan. 16°Congreso Geologico Argentino, Actas, Tomo I: 395-402. Yamin, M. G., 2007. Tesis doctoral, Universidad de Buenos Aires, under preparation. Terrizzano, C. M., 2006. Deformacion cuaternaria en las Lomitas Negras, cinturon Barreal Las Peñas, provincia de San Juan. Resumenes de la XIII Reunion de Tectonica: 57, San Luis, Argentina. Terrizzano C. M., Fazzito S. Y., Cortes J. M. and Rapalini A. E., 2006 Deformacion tardio cenozoica en la zona de la cienaga de los Avestruces, provincia de San Juan. Resumenes de la XIII Reunion de Tectonica: 58, San Luis, Argentina.

ANP13

Viramonte, J. M. (Instituto Geonorte, Universidad Nacional de Salta. Salta.), Viramonte, J. G., Becchio, R. (Instituto Geonorte, Universidad Nacional de Salta. Salta), Pimentel, M. (Instituto de Geociencias, Universidad de Brasilia. Brasilia), Arnosio, M. (Instituto Geonorte, Universidad Nacional de Salta. Salta)

Ramadas Volcanic Centre (NW-Argentina): Linking between the Miocene volcanism and the lower Paleozoic basement

E-Mail: jviramonte@hotmail.com

The Ramadas Volcanic Centre (RVC), is situated on the Northwestern Argentine Andean Puna, approximately 13 km north of San Antonio de los Cobres associated with prominent NW striking fault zones (Calama Olacapato Toro Fault). It occurs at an altitude of ca. 3800 m a.s.l., and forms part of the extensive Altiplano Puna Volcanic Complex (APVC, de Silva, 1989a). This volcanic centre, is defined as a highly explosive rhyolitic complex and is the source vent for the extremely widespread and voluminous Corte Blanco Tuff plinian deposits (Viramonte et al. 1984, 1994; Tait, 2004). In the ring tuff of this volcanic centre crops out different crustal derived xenoliths (Viramonte et al. 1984; Gauthier et al., 1994). The rhyolitic magmatism occur during Miocene (ca. 6.6 Ma) and is constituted mainly by pumiceous lapilli fall deposits, obsidians and rhyolitic garnet-bearing tuff (Corte Blanco tuff Viramonte et al. 1984). The xenoliths represent the non exposed basement of northern Puna in this area. Garnet and tourmaline-bearing leucogranites as well as migmatites and cordierite schists are the most abundant xenoliths, but amphibolites are also present in minor amounts. Similar type of rocks outcrops towards the south (Southern Puna) and constitute the lower Paleozoic basement of the Puna region (Becchio et al. 1999, Lucassen et al. 2000; Viramonte et al. accepted). The RVC is a key area in the southern end of the Northern Puna for the understanding of the basement evolution as well as the structure and nature of the crust in this region. Also, in order to provide a possible origin and evolution of Cenozoic magmatism as a result of partial melting of Lower Paleozoic basement rocks, preliminary petrological, geochemical and Nd isotopic studies were performed in xenoliths and tuff deposits. The volcanic rocks (tuff deposits) are unusual peralouminous rhyolites containing minor than 1% of spessartine rich garnet as the dominant phenocryst phase (Viramonte et al., 1984; Viramonte et al., 1994; Gauthier et al., 1994; Marti et al. 1999). In some cases, occur plagioclase and quartz microlites and topaz as accessory. On the other hand, the leucogranite xenoliths are composed of quartz, microcline, plagioclase, garnet and/or tourmaline and biotite, apatite, zircon and opaques as accessory phases. A characteristic feature of leucogranitic and migmatitic xenolith samples is the presence of partial melting zones. These zones show radial and spherulitic textures formed by quartz, k-feldspar, muscovite aggregates, small garnet crystals and glass. Major and trace element analyses were carried out in eight samples of volcanic rocks and leucogranitic xenoliths which show similar compositions. The volcanic rocks have SiO2 and Al2O3 contents ranging from 71.3 to 74.8 %. and 13.2 to 13.9 % respectively, whereas xenoliths cover a range in SiO2 from 72.5 to 74.8 % andin Al2O3 from 14.6 to 15.6 %. Both type of rocks show subalkaline compositions. The xenoliths have total REE contents of ca.18 ppm. They are slightly enriched in LREE relative to HREE with LaN/LuN = 2.50. The volcanic rocks have higher total REE contents than the xenoliths and steeper distribution patterns with LaN/LuN from 4.29 to 4.58. Negative Eu anomalies characterize all samples, where the ratio Eu/Eu* decreasing from 0.59 for xenoliths to 0.08 for volcanic rocks. Xenoliths yield ENd (0) values between -8.8 to -9.9, whereas the volcanic rocks have ENd(0) values between -8.03 to -8.15. The preliminary data presented here and more in development suggest a possible origin of RVC Miocene rhyolitic magmatism from partial melting of Lower Paleozoic basement rocks, similar to those exposed in the Southern Puna. REFERENCES: Becchio, R. Lucassen, F., Franz, G., Viramonte, J. G. y Wemmer, K., 1999. El basamento del Paleozoico inferior del Noroeste de Argentina (23° ; 27° S) metamorfismo y geocronología. In: González Bonorino, G., Omarini, R. y Viramonte, J.G. (Eds.) Relatorio XIV Congreso Geológico Argentino. 1: 58;72. Salta. Gauthier, J.P., Deruelle, B., Viramonte, J.G., Aparicio, A., 1994. Grenats des rhyolites de la caldera de La Pava ; Ramadas (NW Argentine) et de leurs xenolites granitiques. C.R. Acad. Sci. Paris. 318 (serie II), 1629;1635. Lucassen, F. Becchio, R., Wilke, H., Franz, G., Thirwall, M., Viramonte, J.G. y Wemmer, K. 2000. Proterozoic Paleozoic development of the basement of the central andes (18 ; 26º) a mobile belt of the South America craton. Journal of South America Earth Science, 13, 697;715. Marti, J., Soriano, C., Dingwell, D.B., 1999. Tube pumices as strain markers of the ductile;brittle transition during magma fragmentation. Nature 402, 650;653. Tait, M.A. 2004. Dynamics Eruption Dynamics and Evolution of a Highly Explosive Rhyolitic Volcanic Complex in the High Andes: The Late Miocene Ramadas Volcanic Centre, Andean Puna, Salta Argentina. Unpublished Ph.D. Thesis, Monash University, Clayton Australia. Viramonte J.G., Omarini, R.H., Arana Saavedra, V., Aparicio, A., Garcia Cucho, L., Parica, P., 1984. Edad, genesis y mecanismos de erupcion de las riolitas granatiferas de San Antonio de los Cobres, Provincia de Salta. IX Congr. Geol. Arg. Actas 3 : 216;233., Viramonte, J.G., Reynolds, J.H., Del Papa, C. y Disalvo, A., 1994. The Corte Blanco garnetiferous tuff: A distinctive late Miocene marker bed in northwestern Argentina applied to magnetic polarity stratigraphy in the Rio Yacones, Salta Province. Earth Planet. Sci. Lett. 121, 519;531. Viramonte, J.M., Becchio, R., Viramonte, J.G. Pimentel, M.M. y Martino, R.,. Ordovician igneous and metamorphic units in Southeastern Puna: New U-Pb and Sm-Nd data and implications for the evolution of Northwestern Argentina. Journal of South American Earth Sciences, accepted.

ANP14

Viramonte, Jose M. (Salta. Instituto Geonorte, Universidad Nacional de Salta), Pimentel, M. (Brasilia. Instituto de Geociencias, Universidad de Brasilia), Becchio, R., Viramonte, J. G. (Salta. Instituto Geonorte, Universidad Nacional de Salta)

Geochemical and isotopic (Nd and Sr) characteristics of the Ordovician magmatism on the Southeastern Puna, NW-Argentina.

E-Mail: jviramonte@hotmail.com

The geodynamic evolution of the Proto-Andean margin of Gondwana during Lower Paleozoic is still a subject of controversy. On one hand, it was characterized as a repeated onset of subduction processes associated with the docking of several terranes (Ramos et al., 1986; Ramos 1988; Rapela et al., 1998; Coira et al., 1999). On the other hand, Damm et al., 1990; Becchio et al., 1999; Lucassen et al., 2000; Zimmermann and Bahlburg 2003 and Franz et al., 2006 among other authors, suggest a geodynamic evolution dominated by intracrustal recycling processes with minor contribution of juvenile magmatism. The Puna region of the NW-Argentina, records sedimentation, deformation, metamorphism and magmatism events since ca. 510 to 440 Ma (Bahlburg and Furlong 1996; Moya 1999; Hongn and Mon 1999; Becchio et al., 1999; Lucassen et al., 2000; Hongn et al., 2005) where it is difficult to discriminate different tectono-thermal cycles. Structural, petrological (Hongn et al., 2005; Kirschbaum et al., 2006) and sedimentological (Zimmermann and Bahlburg 2003) studies suggest that during the Lower Ordovician period the central-eastern Puna region evolved in an extensional intracontinental setting. In this way, provenance studies indicate that sedimentary detritus is generally composed of reworked crustal material. This idea supports previous works on the basis of field observations, petrological, geochemical and isotopic data from metamorphic basement (ca. 510-500 Ma) to Andean rocks (Miocene) (Becchio et al., 1999; Lucassen et al., 2000; Lucassen and Franz 2005; Franz et al., 2006). The evolution of magmatism started during the Early Tremadocian and it comprises mainly intermediate and acidic plutonic rocks as well as volcano-sedimentary sequences. In general, this magmatism forms two N-S trend belts. Following previous studies, (Viramonte et al., 2005; Viramonte et al., accepted) we present new geochemical and isotopic data of Ordovician magmatic rocks of the eastern border of southern Puna. In the eastern area of salar Centenario, a voluminous and widespread plutonic unit crops out. It is composed of three silica-rich facies with U/Pb zircon and monazite ages of 475 to 463 Ma (Viramonte et al., accepted). It is also exposed a 100 m thick volcanosedimentary unit of bimodal metavolcanic rocks, metabasites and felsic metarhyolites and metadacites, intercalated with phyllites and metagreywackes. A metarhyolite exposed at the base of the sequence yields an age of 485 Ma (Viramonte et al., accepted). The bimodal nature of the magmatism in the volcano-sedimentary unit is evident as the metavolcanic rocks have basalt and rhyolite compositions. Bimodality is also shown by trace elements and Sr and Nd isotope data. Amphibolites yield positive ENd(T) values between +0.3 and +2.5 and initial 87Sr/86Sr ratios of 0.7067. These values and enrichment in LILE with Nb anomaly suggest they were derived from a mantle source in a subduction setting. Also, the flat REE pattern (LaN/SmN = 1.23 to 1.43 and LaN/YbN = 1.39 to 1.48) on a chondrite-normalized diagram resemble transitional midocean ridge basalts (TMORB). On the other hand, plutonic and felsic metavolcanics rocks are mainly subalkaline and display peraluminous character (ASI index between 1.1 and 1.5). They are enriched in LREE relative to HREE (LaN/SmN = 2.17 to 3.26 GdN/YbN = 0.94 to 1.47) with negative Eu anomalies and show negative Nb and Ta anomalies on mantle normalized multielement diagram. These rocks yield negative ENd(T) values between -3.1 to -7.5, initial Sr ratios between 0.7089 to 0.7372 and Mesoproterozoic model ages (TDM values in the interval between 1.5 and 1.7 Ga). These felsic magmas represent the product of melting of older continental crust. Isotopic and trace elements data indicate that the orthogneisses and / or metapelites / metagreywackes of the basement are its potential protolith. Our data combined with the literature about sedimentation, deformation and metamorphism suggest that a retroarc basin represents the most likely tectonic setting for the origin of the eastern magmatic rocks in southeastern Puna. According to this, the felsic magmatism could be related to extensive crustal melting associated to astenosphere upwelling after tectonic switching occurring in the suprasubduction zone in the frame of a long lived Hot Orogen (Collins, 2002; Hongn et al., 2005). REFERENCES: Bahlburg and Furlong 1996. Lithospheric modeling of the Ordovician foreland basin in the Puna of northwestern Argentina: on the influence of arc loading on foreland basin formation. Tectonophysics, 259, 245-258. Becchio, R. Lucassen, F., Franz, G., Viramonte, J. G. y Wemmer, K., 1999. El basamento del Paleozoico inferior del Noroeste de Argentina (23°-27°S) metamorfismo y geocronología. En: González Bonorino, G., Omarini, R. y Viramonte, J.G. (Eds.) Relatorio XIV Congreso Geológico Argentino. 1: 58;72. Salta. Coira, B., Perez, B., Flores, P., Kay, S., Woll, B. y Hanning, M., 1999. Magmatic sources and tectonic setting of Gondwana margin Ordovician magmas, northern Puna of Argentina and Chile. In Ramos, V.A. and Keppie, J.D. (Eds.) Laurentia-Gondwana Connections before Pangea: Boulder. Colorado. Geological Society of America. Special paper 336. Collins, 2002. Hot orogens, tectonic switching, and creation of continental crust. Geology, v.30,6, 535-538. Damm, K., Pichowiak, S., Harmon, R.S., Todt, W., Kelley, S., Omarini, R., Niemeyer, H., 1990. Pre-Mesozoic evolution of the Central Andes: the basement revisited. Geological Society of America Special Paper 241, 101-126. Lucassen and Franz, 2005. The early Palaeozoic Orogen in the Central Andes: a noncollisional orogen comparable to the Cenozoic high plateau? - In: Vaughan, A. P. M.; Leat, P. T.; Pankhurst, R. J. (Eds.), Terrane Processes at the Margins of Gondwana, 257;273.Franz, G.; Lucassen, F.; Kramer, W.; Trumbull, R. B.; Romer, R. L.; Wilke, H.-G.; Viramonte, J. G.; Becchio, R.; Siebel, W. 2006. Crustal evolution at the Central Andean continental margin: a geochemical record of crustal growth, recycling and destruction - In: Oncken, O.; Chong, G.; Franz, G.; Giese, P.; Götze, H.-J.; Ramos, V. A.; Strecker, M. R.; Wigger, P. (Eds.), The Andes Active Subduction Orogeny, Springer, 45;64. Hongn and Mon, 1999. La deformación ordovícica en el borde oriental de la Puna. In: Relatorio del XIV Congreso Geológico Argentino. Vol. 1, 212-216 (González-Bonorino, G.; Omarini, R.; Viramonte, J.; ed.) Salta, Argentina. Hongn, F., Mon, R., Acuña, P., Kirschbaum, A. Y Menegatti, N. 2005. Deformación dúctil intraordovícica en la Sierra de Cobres, (Puna Oriental-Noroeste Argentino). XVI Congreso Geológico Argentino, Actas CD-ROM. La Plata, Argentina. Kirschbaum, A., Hongn, F. Y Menegatti, N. 2006. The Cobres Plutonic Complex, eastern Puna (NW Argentina): Petrological and structural constraints for Lower Paleozoic magmatism. Journal of South American Earth Sciences, 21, 252;266. Lucassen, F. Becchio, R., Wilke, H., Franz, G., Thirwall, M., Viramonte, J.G. y Wemmer, K. 2000. Proterozoic Paleozoic development of the basement of the central andes (18-26º)- a mobile belt of the South America craton. Journal of South America Earth Science, 13, 697;715. Mendez V., Navarini, A., Plaza, D. y Viera, O., 1973. Faja Eruptiva de la Puna Oriental: Actas 5° Congreso Geológico Argentino, 4: 89;100. Córdoba. Moya, C., 1999. El Ordovícico en los Andes del noroeste Argentino. In Relatorio del Congreso Geológico Argentino, No. 14, Vol. 1, 134-152 (González-Bonorino, G.; Omarini, R.; Viramonte, J.; ed.) Salta, Argentina. Palma, M., Parica, P. y Ramos, V., 1986. El granito Archibarca: Su edad y significado tectónico, Provincia de Catamarca. Revista de la Asociación Geológica Argentina. XLI (3;4): 414;419. Ramos V.A., Jordan T.E.,.Allmendinger, R.W., Mpodozis, M. Kay, S.M. Cortes, J.M., y Palma, M.A., 1986. Paleozoic terranes of the central Argentine Chilean Andes. Tectonics, 5: 855;880. Ramos,V., 1988. Late Proterozoic-Early Paleozoic of South America- a collisional history. Episodes II, p. 168;174. Rapela, C.W., Pankhurst, R.J. Casquet, C. Baldo, Saavedra, E. J. y Galindo, E., 1998. The Pampean orogeny of the southern proto-Andes evidence for Cambrian continental collision in the Sierras de Cordoba. In: Pankhurst, R.J. and C.W. Rapela (Eds): The Proto-Andean Margin of South America, vol 142, p. 182-217. Special Publication of the Geological Society. London. Viramonte, J.M., Becchio, R., Viramonte, J.G. Pimentel, M.M. y Martino, R.,. Ordovician igneous and metamorphic units in Southeastern Puna: New U-Pb and Sm-Nd data and implications for the evolution of Northwestern Argentina. Journal of South American Earth Sciences, accepted. Zimmermann and Bahlburg, 2003. Provenance analysis and tectonic setting of the Ordovician clastic deposits in the southern Puna Basin, NW Argentina. Sedimentology, 50, 1079;1104.

BA

Basins and Sedimentology

BA01 – Thu., 12.4., 11:40 - 12:00 · HSD

Adams, C.J. (GNS Science), Miller, H. (Munich, Department of Earth and Environmental Science (Geology)), Toselli, A.J. (Faculty of Science, University of Tucumán)

Detrital zircon ages of the Puncoviscana Formation of NW Argentina, and their bearing on stratigraphic age and provenance

E-Mail: argon@gns.cri.nz

The Puncoviscana Formation comprises extensive successions of greywackes and mudstones, at very low metamorphic grade, in northwest Argentina. These extend southwards, as higher grade metasediments, to the Sierra de Córdoba.The stratigraphic age has been controversial, but rare trace fossil occurrences suggest that a Late Neoproterozoic to Cambrian range is likely.

To set a maximum stratigraphic age limit, U-Pb detrital zircon ages are reported here for six greywackes from turbidite successions representative of the Puncoviscana Formation in Salta and Tucumán provinces. The $^{206}Pb/^{238}U$ age datasets (N=50 to 100) all show dominant, several.younger age components, 500-650 Ma (Cambrian to late Neoproterozoic), but also usually carry a substantial proportion, 30-80%, of older Precambrian zircons, with mostly minor groups at 900-1050 (early Neoproterozoic to late Mesoproterozoic), and 1800-1900 Ma (late Paleoproterozoic). In detail, a first group of greywackes, from Quebrada del Toro, Cerro San Javier (Fig. A, below), and Sierra Nogalito, all have youngest age components at c. 600 Ma, and with more polymodal minor components concentrating particularly at 900-1050 Ma. A second group, comprising greywackes from Rancagua (Fig. B, below), Carmen, and to a lesser extent, Rio Choromoro, are characterised by youngest age components falling within the Cambrian, 500-545 Ma, and carrying lower proportions of Precambrian zircons, which are also less polymodal. These differences may thus indicate different stratigraphic ages (Cambrian and late Neoproterozoic) for the two groups, since both must be older than regional, Late Cambrian-Early Ordovician, metamorphisn and granite plutonism.

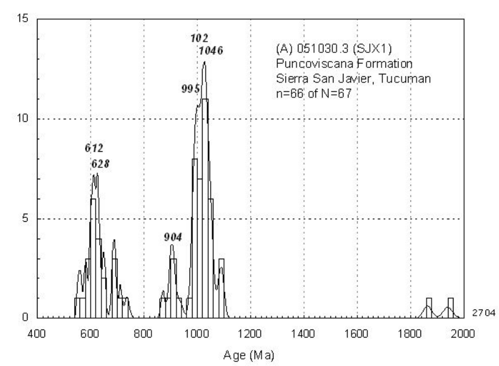


Figure 1: Figure A

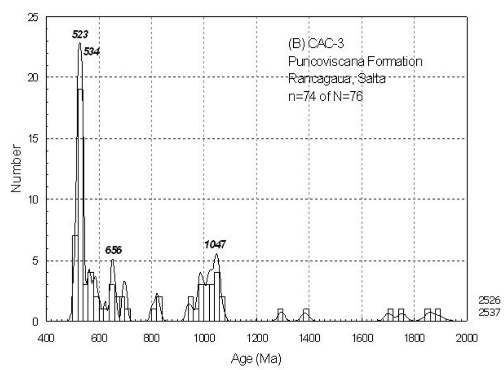


Figure 2: Figure B

Sediment sources for the Puncoviscana depocentre are possibly found to the east in Brazil. Zircons at 550-650 Ma can be matched within the Brazilian (Panamerican) orogen, particularly the Neoproterozoic plutonic and metamorphic compexes of central and south Brazil, at 950-850 Ma, 800-750 Ma, 700-650 Ma, 630-590 Ma and 570-550 Ma. However, similar ages, 700 - 570 Ma and 540 - 470 Ma, are found in Argentina, in the Siera de la Ventana. Slightly older, late Mesoproterozoic to earliest Neoproterozoic detrital zircon ages, 900 to 1060 Ma, could originate in the adjacent Sunsás orogen of westernmost Brazil, The few Paleoproterozoic zircons, 1800-2000 Ma old zircons could be derived from Ventuari-Tabajós province. Geochemical data for Puncoviscana Formation sediments indicates a passive margin setting for its deposition.

In the Late Proterozoic, the Brasiliano orogen formed at the suture between African and South American cratons, during closure of the Proto-Atlantic. Originating from developing highlands, a great river system, comparable to the present Amazon, may thus have transported a similar sediment load westwards to the Proto-Pacific, forming the Puncoviscana Formation.

BA02 – Thu., 12.4., 12:00 - 12:20 · HSD

Rubinstein, N. (Buenos Aires, Universidad de Buenos Aires), Bevins, R. (Cardiff, Nacional Museum of Wales), Robinson, D. (Bristol, University of Bristol), Sruoga, P. (Buenos Aires, Servicio Geológico Minero Argentino)

Very low grade metamorphism in the Precuyano Unit, Neuquén Basin, Argentina

The Neuquén Basin covers more than 160,000 km^2 between 30°and 40°S in the western Andean Cordillera. It developed as an ensialic intra–arc and back–arc basin from early Jurassic times and contains a thick Mesozoic–Cenozoic sedimentary succession. The onset of an extensional regime related to the initial stages of the break–up of Gondwana can be identified as early as latest Triassic times. The widespread rift system comprised several elongate troughs with a sedimentary and volcanic infill of more than 2000 m. These subparallel hemi–grabens with alternating polarity were affected by tectonic inversion during the Andean Orogenic Cycle. Several periods of tectonic reactivation took place during Triassic–Jurassic extension, controlling the characteristics and distribution of the syn–rift facies. The initial infill of these depocenters consisted of bimodal volcanic, volcaniclastic and continental epiclastic rocks, grouped in the so–called Precuyano Unit, dated as developing between 219 and 182 Ma. This unit is characterized by lateral lithological variations, including tuffs, ignimbrites, rhyolites and epiclastic rocks, and has produced oil and gas since 1960.

The study of chip samples from the Granito Negro x–1 oil producer borehole, fig.1, reveals a stratigraphic sequence that is remarkably different from the rest of the equivalent sections of the Nequén Basin, which is probably linked to the first stages of the rifting, Rubinstein et al., 2005. This is composed mainly of alkaline basaltic lavas, along with minor interbedded rhyolitic lavas, ignimbritic deposits and organic matter–bearing lacustrine shales. The lavas are vesicular, with porphyritic textures and intergranular to hyalopilitic growndmasses. Two different types of basalts are present, one dominated by plagioclase feldspar with minor clinopyroxene and scarce olivine, the other dominated by plagioclase feldspar and opaque minerals with minor clinopyroxene. They show variable alteration in the studied section, depending on their vesicularity and their primary glass content. The alteration paragenesis is dominated by chlorite along with iron oxides, carbonates, titanite, epidote, iddingsite–bowlingite, along with minor prehnite and pumpellyite, as well as very scarce albite, zeolites and quartz occurring as a replacement of interstitial areas, primary minerals, and infilling of vesicules. This paragenesis corresponds to very low–grade metamorphism in the prehnite

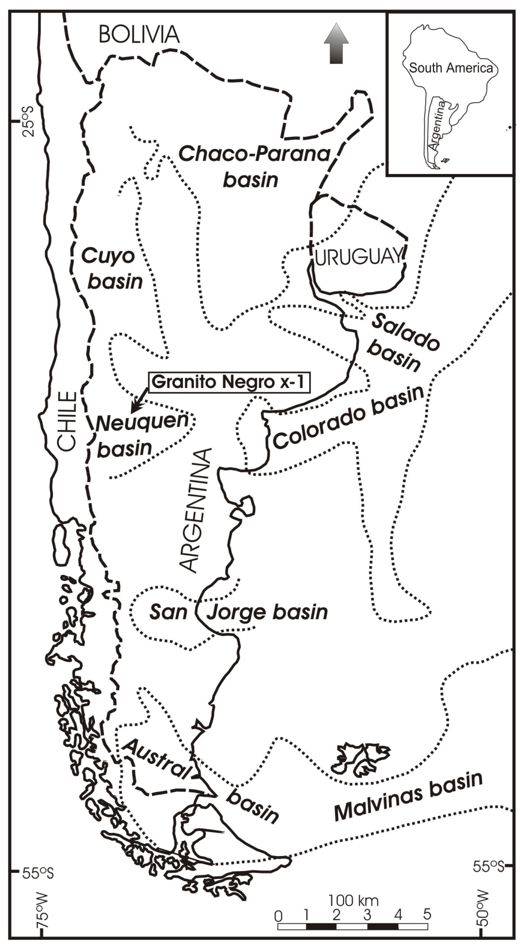


Figure 1: Location of Neuquén Basin and Granito Negro x–1 drill

– pumpellyite facies.

Some 48 samples from the basaltic lavas were examined in this study for their secondary mineralogy by petrographic methods, from a total depth range of 980 m. Three samples were investigated further by electron microprobe techniques, from depths of 2626 m, 2788 m, and 3450 m. All show a consistent assemblage, including especially the metamorphic grade indicator minerals prehnite, pumpellyite and epidote; critically, actinolite is absent. This, combined with the evidence from the epidote chemographic projection, which shows broadly parallel tie–lines for chlorite–pumpellyite in the three samples with KD Mg–Fe ratios in the range 0.26–0.84, suggests that metamorphic conditions for the section were at sub–greenschist levels. From the studies of Frey et al. 1991, this would suggest temperatures in the range 175–275°C. Critically, these temperatures are well above those for the oil–gas window.

In relation to the overall model, the sub–greenschist facies metamorphism agrees with an extensional tectonic environment, generating higher heatflow as a result of crustal thinning and raised thermal gradients, as proposed for the Welsh Basin by Bevins and Robinson1993. In this way we suggest that the metamorphism was contemporaneous with basin development and prior to oil migration.

References

Bevins, R.E. and Robinson, D., 1993. Parageneses of Ordovician sub–greenschist to greenschist facies metabasites from Wales, UK. Eur. J. Mineral., 5, 925–935.

Frey, M., de Capitani, D., Liou, J.G., 1991. A new petrogenetic grid for low–grade metabasites. Journal of Metamorphic Geology, 9, 497–509.

Rubinstein, N., Sruoga y P., Pángaro, F., 2005. Volcanismo basáltico alcalino del Ciclo Precuyano (Triásico Superior–Jurásico Inferior), rifting inicial de Cuenca Neuquina, Argentina. 16°Congreso Geológico Argentino, 3, 97–102, La Plata.

BA03 – Thu., 12.4., 12:20 - 12:40 · HSD

Martins-Neto, M.A. (UFOP-Brazil)

Proterozoic first-order sedimentary successions of the São Francisco basin in eastern Brazil

E-Mail: `marcelo@nupetro.com.br`

The record of the late Paleoproterozoic to late Neoproterozoic history of eastern Brazil (São Francisco craton as well as Brasilia and Araçuai fold belts, Fig. 1) is preserved by the sedimentary successions of the Espinhaço, Canastra-Paranoa, Macaubas and Bambui basins (Fig. 2), the last three being considered together as the São Francisco basin (Martins-Neto et al. 2001, Martins-Neto and Alkmim 2001, Martins-Neto 2005, 2007). Each of these major sedimentary successions represents a first-order sequence (or megasequence), which is the record of an unconformity-bounded, single basin-fill cycle (Martins-Neto et al. 2001, Catuneanu et al. 2005). Collectively, these basins track major plate reorganizations that affected the São Francisco craton through a time interval greater than 1 Gy.

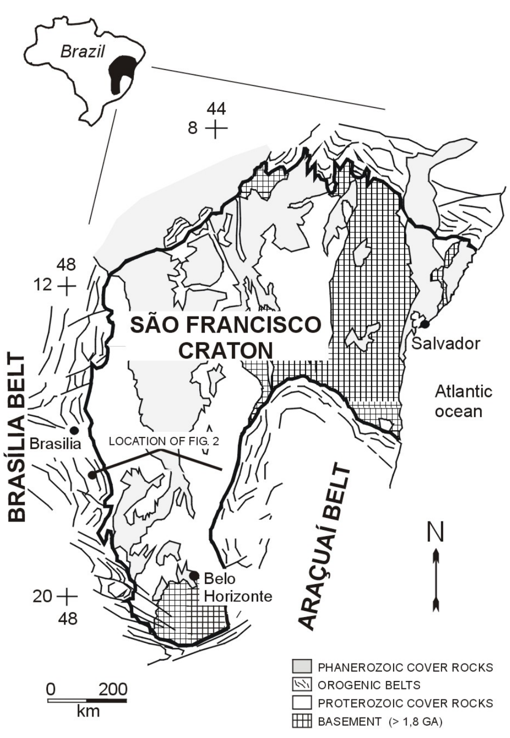


Figure 1: Simplified geologic map of eastern Brazil. Note location of seismic profile of figure 2

Seismic, well and outcrop integrated studies attest that the record of the late Paleoproterozoic to early Cambrian succession in the São Francisco basin started with the development of a rift-sag basin (Espinhaço basin), which was followed by the Rodinia-Gondwana cycle, comprising a full passive-margin basin setting and a successor convergent cycle (arc-related and foreland basins).

The Espinhaço 1st-order sequence (c. 1.73-1.50 Ga, Martins-Neto, 2000) records a stage of aborted lithospheric stretching of the São Francisco-Congo continental mass that had amalgamated during the Transamazonian-Eburnian orogeny (c. 2.2-2.0 Ga).

The Canastra-Paranoa and Macaubas 1st-order sequences (c.1200-650 Ma) comprise rift to drift successions deposited during the breakup of the supercontinent Rodinia and the opening of the Brazilide-Adamastor ocean. The Bambui foreland 1st-order sequence (c. 750-600 Ma) formed as a consequence of thrust loading related to shortening in the Brasília fold belt on the western flank of the São Francisco craton, during the closing of the Brazilide ocean and the amalgamation of the Gondwana supercontinent.

REFERENCES

Catuneanu, O.; Martins-Neto, M.A. and Eriksson, P.G. (2005): Precambrian sequence stratigraphy. Sediment. Geol. 176: 67-95.

Martins-Neto, M.A. (2000): Tectonics and sedimentation in a Paleo/Mesoproterozoic rift-sag basin (Espinhaço Basin, southeastern Brazil). Precambrian Res., 103, 147-173.

Martins-Neto, M.A. (2005): A Bacia do São Francisco: Arcabouços estratigrafico e estrutural com base na interpretação de dados de superficie e subsuperficie. In: SBG, Simp. Craton São Francisco, 3, Salvador, Anais, 283-286.

Martins-Neto, M.A. (2007) Proterozoic

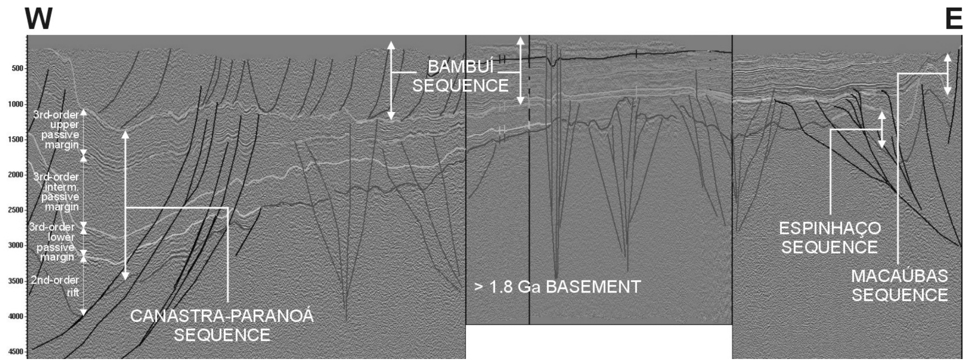


Figure 2: Interpreted reflection seismic profile across the São Francisco craton (see figure 1 for location) showing the recognized first-order sequences, as well as lower-order sequences of the Canastra-Paranoa passive-margin 1st-order sequence (modified after Martins-Neto 2005). See also the tectonic overprint of the western Brasilia and eastern Araçuai thrust-and-fold belts, both verging to the craton interior. Vertical scale in two-way-travel time

first-order sedimentary successions of the São Francisco basin in eastern Brazil. Zeitschrift der Deutschen Gesellschaft fuer Geowissenschaften, in press.

Martins-Neto, M.A.; Pedrosa-Soares, A.C. and Lima, S.A.A. (2001): Tectono-sedimentary evolution of sedimentary basins from Late Paleoproterozoic to Late Neoproterozoic in the São Francisco craton and Araçuai fold belt, eastern Brazil. In: P.G. Eriksson,O. Catuneanu, L. Aspler, J. Chiarenzelli and M.A. Martins-Neto (eds.): The influence of magmatism, tectonics, sea level change and palaeoclimate on Precambrian basin evolution: change over time, Sediment. Geol. Spec. Issue, 141: 343-370.

Martins-Neto, M.A. and Alkmim, F. F. (2001): Estratigrafia e Evolução Tectonica das Bacias Neoproterozoicas do Paleocontinente São Francisco e suas Margens: Registro da Quebra de Rodinia e Colagem de Gondwana. In: Pinto, C.P. and Martins-Neto, M. A. (eds.): Bacia do São Francisco: Geologia e Recursos Naturais: 31-54, Belo Horizonte (SBG/MG).

BA04 – Thu., 12.4., 12:40 - 13:00 · HSD

Velasco-Segura, J.A. (Facultad de Ciencias de la Tierra, UANL, Linares, México), Stinnesbeck, W. (Universität Karlsruhe (TH), Karlsruhe, Germany), López-Oliva, J.G. (Facultad de Ciencias de la Tierra, UANL, Linares, México), Frey, E. (Staatliches Museum für Naturkunde, Karlsruhe Germany), González-González, A.H. (Museo del Desierto, Saltillo, México)

Upper Jurassic sediments in the Sierra El Jabalí, Coahuila, NE México.

The Sierra El Jabalí is located about 60km south of Saltillo, in the northeastern Mexican state of Coahuila, in the Sierra Madre Oriental. We measured a 146m thick section containing the uppermost part of the Olvido Fm., the La Casita/La Caja Fms., and the base of the Taraises Fm. These sediments represent a time interval from the Early Late Kimmeridgian to Early Berriasian. Our analysis includes the microfacies, stratigraphy and sedimentology of the section, as well as some palaeoecological approaches.

The Olvido Fm. consists of thick-bedded lagoonal limestone (packstone to floatstone) with abundant fecal pellets (Favreina). The contact between the Olvido Fm. and the La Casita Fm. is wavy, abrupt and erosive, and followed by a 50 mm thick belemnite horizon. This contact marks a major hiatus with the development of paleokarst that suggests an environmental turnover, from a carbonate ramp and lagoonal environment (Olvido Fm.) to siltstones, shales and radiolarian argillites of an open marine platform with water depth of at least several ten of meters (La Casita Fm.).

Two meter thick coquina layers are present in the La Casita Fm. at 19.5m and 36m from the base of the unit. These layers consist of densely packed bivalves, among them many oysters, ammonites, rare belemnites and wood, in addition to a diverse assemblage of semi-articulated skeletons and isolated bones of marine reptilians (e.g., pliosaurs, crocodilians, ichthyosaurs). The faunal assemblage, which comprises autochthonous elements such as oysters, suggest condensation due to winnowing in a low energy shallow marine environment (<40m depth) and thus minor regressive events within the marine platform. Upsection from the coquina layers (La Casita Fm.) autochthonous phosphorite layers and concretions are present and typically interlayered between siltstones and shales with some radiolarians and planktonic foraminifers. These sediments indicate a rapid change in facies from outer platform to upper bathyal conditions, with water depths between 150m and 200m and upwelling. These sediments areinterpreted to belong to the La Caja Fm. The top of the La Caja Fm. and transition to the Taraises Fm. is characterized by a decrease in phosphate and fine-grained siliciclastic sediment, and the increase in carbonate. This alternation of calcareous shale, marl and shaly limestone with abundant calpionellids and ammonites, characterizes a further gradual increase in water depth toward basinal facies. These sediments also contain the Tithonian-Berriasian boundary.

Our study of the Upper Jurassic sediment sequencein southern Coahuila thus suggests a transgressive tendency, from lagoonal environments in the uppermost Olvido Fm. (Early Late Kimmeridgian), towards shallow marine siliciclastic platform conditions in the La Casita Fm. (Early Tithonian). Deepening towards outer platform to uppermost bathyal conditions is indicated by phosporitic sediments of the La Caja Fm. (Middle Tithonian to Early Berriasian) with a further deepening towards bathyal conditions near the La Caja-Taraises transition during the Early Berriasian.

BAP01

Fortunato, H. (STRI Panama, CAO Kiel), Schafer, P. (CAO Kiel)

Structure and rates of Holocene carbonate production in the Bay of Panama (eastern tropical Pacific)

E-Mail: fortunae@si.edu

One of the consequences of the rise of the Panama land bridge at the end of the Pliocene was the formation of two opposite marine realms: the eastern Pacific and the Caribbean. The differences in their geological origins are mirrored in the differences in both coastal geography and ecological settings. The Caribbean coast is broad and sinuous, with warm, salty and oligotrophic waters constituting an excellent environment for the development of extense coral reef and Halimeda banks which form its major carbonate system. On the other hand, the eastern Pacific coast is narrow, wide open to the ocean, resulting in a meso-eutrophic highly seasonal system where reefs are rare. Carbonate producers here can be divided in two groups: whereas some reefs and nodular/maerl coralline red algae are the major components in the Gulf of Chiriqui area, the Gulf of Panama has less reefs and encrusting red algae, as well as rhodoliths, dominate over maerl type.

Other than reefs, very little is known concerning tropical carbonate systems. Considerations about their possible value as community stabilizing and structuring led us to initiate a study of these communities, and compare them with soft bottom communities predominant in both gulfs. Preliminary results show that both maerl type and rhodolith communities are more diverse and structured than mud habitats. A thick shelled bivalve fauna (ostreids, glycymerids, cardiids) is present, showing an intergradation and affinities to reef fauna. Gastropod fauna is formed by abundant hard substrate carnivores (conids, muricids) and herbivores (columbellids and cerithids). On the other hand, soft bottom community shows the presence of typical mud dwellers (nassarids and turrids) and thin shelled endobenthic bivalves (lucinids, venerids, some pectenids). Maerl communities also show a high abundance of vermetids, free-living corals, sponges, sea urchins, incrusting and nodular bryozoans.

In what concerns community structuring, both maerl and rhodolith communities are highly structured with a multilayered, high tiering, providing shelter and food to a large and diverse group of organisms. They show a higher diversity of life forms (free-living, sessile, soft sandy, and encrusting), whereas mud habitats have more vagile and endobenthics. Nevertheless, and in spite of highly diverse, both maerl and rhodolith communities have a lower trophic index lacking mostly filter feeders. They also have less predators (e.i. no naticids). Mud dwelling predators are abundant (turrids, naticids, olivids) in soft substracts.

Growth rates of coralline algae seem be twice as high in the Gulf of Chiriqui compared with the Gulf of Panama, although they seem to be quiet variable in both regions.

BAP02

Rabehl, S., Hüneke, H., Meschede, M., Sommer, M. (Greifswald), Cobiella-Reguera, J. (Pinar del Rio)

Origin and depositional environments of Late Cretaceous to Early Palaeogene sediments in SE-Cuba (region of Mayarí)

E-Mail: sr991756@uni-greifswald.de

The orogenic belt of Cuba is the result of subduction, volcanic arc formation and accretion along the pre-Eocene northwestern leading edge of the Caribbean plate. There is evidence of a two-stage development from a southwest-dipping subduction along a Cretaceous volcanic arc to north-dipping subduction along a Palaeocene-Eocene volcanic arc. After collision of the Cretaceous volcanic arc with the North American palaeomargin, an ongoing relative northward movement of the Caribbean plate can be inferred from the eastern Cuban ophiolites. These rest on top of the Cretaceous volcanic arc and record Maastrichtian thrusting, uplift and gravitational sliding of oceanic lithosphere from a southern direction. During the Danian, a new north-dipping subduction zone was established that consumed oceanic lithosphere of the Caribbean plate until the Middle Eocene. We have studied the Maastrichtian-Danian sedimentary record closely associated with these ophiolite slide nappes in order to establish a database for tectonic interpretation. The Lower Mícara Formation represents shallow-marine deltaic deposits. Sediments are mainly reworked volcanic epiclastic materials (andesitic) supplied from the inactive Cretaceous volcanic arc in the north. The La Picota Formation comprises deposits of subaqueous debris flows and gravitational slide nappes, mainly consisting of serpentinites. Debris flows deposits are particularly common at the base of the formation and include basalts and ultramafic rocks in minor quantities. These sedimentary units derived from the south into a marine basin of moderate depth. The Upper Mícara Formation rests unconformably on the Lower Mícara and the La Picota Formations. Thick deposits of hyperconcentrated density flows in the region of Mella are interpreted as accumulations of fan deltas. Gravel of serpentinites, basalts and andesitic rocks are most common. They documenterosion of the La Picota Formation. Carbonate debris predominate in the upper part of the formation and include high amounts of shallow-water bioclastic materials supplied by concentrated density flows and turbidity flows. Reworked volcanic epiclastic materials, which record ongoing erosion of the Cretaceous vulcanic arc, also contributed to the turbidite sedimentation. During accumulation of the Gran Tierra Formation, ongoing subsidence generated a deep-marine basin withsteep slopes. Graded-stratified carbonate gravels are interpreted as deposits of concentrated density flows supplied from peritidal carbonate platforms. Organized calcarenite-marl couplets are deposits of bipartite flows. Carbonate debris from peritidal platform and slope environments occur. Thus, the provenance area has been a rimmed shelf characterised by semi-enclosed and open lagoons and reefs that locally suffered riverine supply of volcanic epiclastic debris.

BAP03

Čech, S., Rapprich, V. (Prague, CGS)

Mesozoic stratigraphy of NW El Salvador (western margin of the Chortis block)

E-Mail: cech@cgu.cz

Mesozoic sedimentary rocks in El Salvador are known as ”Estratos de Metapán” in the sense of Dürr and Stober (1956). These form structural elevations rising above Cenozoic ignimbrites. Lithologic and stratigraphic evolution of Mesozoic in El Salvador is similar to Mesozoic of Chortis block in Honduras and SE Guatemala. The basement of Cretaceous non-metamorphosed rocks consists of newly defined Espinal complex. This complex originated in submarine effusions of basaltic-andesite and andesitic lavas associated with hyaloclastic breccias, clays resedimented from hyaloclastics and submarine tuffs. Intercalations of fine-grained siliciclastic sediments are scarce. The Espinal complex is deformed and slightly metamorphosed in Prehnite-pumpellyite facies. Upper Jurassic deformation in this region was described by Viland andHenry (1996). Later, Cretaceous formations overlay this complex with unconformity therefore Espinal complex was separated from Todos Santos Formation.

Intercalating of shallow-marine and nonmarine (red beds) sediments associated with volcanic activity is characteristic for the entire Mid- and Upper Cretaceous succession. Basal Cretaceous strata (non-marine to brackish sediments of Todos Santos/Tepemechín F.) deposed locally, filling the post-Jurassic relief, and together with marine limestones of Yojoa Group transgrade unconfomably over Jurassic basement. Exact age of Todos Santos/Tepemechín F. remains unclear, due to lack of paleontological evidences. Lower Cretaceous age could be determined on the basis of superposition. The base of Todos Santos/Tepemechín F. in El Salvador consists of devitrified welded rhyoliticignimbrite. At the base and top of the ignimbrite, deposits of ground surge and ash cloud surge respectively were recognized. Radiometric dating of this volcanic event is in process. It could temporarily correspond to dacite effusion dated in Honduras to 124 Ma (Drobe, 1998). Locally, Todos Santos/Tepemechin F. is represented solely by volcanic rocks overlain by wackestones of Yojoa Group.

Abundance of cherts in wackestones of Yojoa Group is comparable with similar rocks of Atima Formation in Honduras. These wackestones are rich in biostromes of caprinid rudists and beds with bivalves *Chondrodonta* sp.

Continental deposits are characteristic for the youngest Mesozoic strata - Valle de Angeles Group. Intercalation of marine limestone (Jaitique F.) divides the continental sediments into two members: ”Lower” and ”Upper red beds”. The ”Lower red beds” of Valle de Angeles are mostly terrestric (fluvial) in origin. Nevertheles restricted marine environment is developed at the transition with underlying limestones of Yojoa Group and overlying limestones of Jaitique Fm. Sedimentation of continental deposits of ”Lower red beds” (Valle de Angeles Group) is associated with a volcanic event in lower part. Eruption of rhyolitic magma produced layer of welded ignimbrite, currently completely devitrified. The age of ”Lower red beds” is aproximately Albian to Cenomanian. Upper Cenomanian amonites (*Calycoceras*) and oysters (*Ilymatogyra (Afrogyra) laeviplexa*) were found in wackestones of Jaitique Formation (Kemper and Weber, 1979). In the ”Upper red beds”, polymictic conglomerates with layers of quarztose sandstones of molasses dominated. Regional unconformity was documented on the base of ”Upper red beds” deposits, as well as on its top, where Oligocene (or even later Miocene) ignimbrites of Morazán Formation or Chalatenango Formation respectively sedimented after long hiatus. Neither older data nor new founds were available for precise age determination of Superior red beds. Small, fluvially transported, pumice fragments found in the upper-most aleuropelites of the Superior red beds were not assigned to any known volcanic event.

Studies of vertical succession of lithological units and their limits is complicated (but not disabled) by intensive tectonic fragmentation of the area and presence of overthrusts recognized in outcrops and quarries.

Research of Mesozoic formations in western El Salvador were carried out in cooperation of the ČGS (Prague) and SNET (San Salvador) with financial support of the Czech Ministry of Foreign Affairs within the framework of the Czechaid.

REFERENCES: DROBE J., 1998: U-Pb age constraints on Early Cretaceous volcanism and stratigraphy in central Honduras. Abstracts with Programs -Geol. Soc. Am. 30(5): 12.

DÜRR F. and STOBER Y.G., 1956: Sucesión normal de los estratos de Metapán. -An. Serv. geol. nac. El Salvador, 2: 44-54. San Salvador.

KEMPER E. and WEBER H. S., 1979: Über einige Cenoman-Fossilien aus El Salvador und ihre biostratigraphische und paläogeographische Bedeutung. -Geol. Jb., B 37: 3-29. Hannover.

VILAND J.C. and HENRY B., 1996: Late Jurassic deformation in Honduras. Proposals for a revised regional stratigraphy. -Jour. of South Am. Earth Sci. 9(3-4): 153-160.

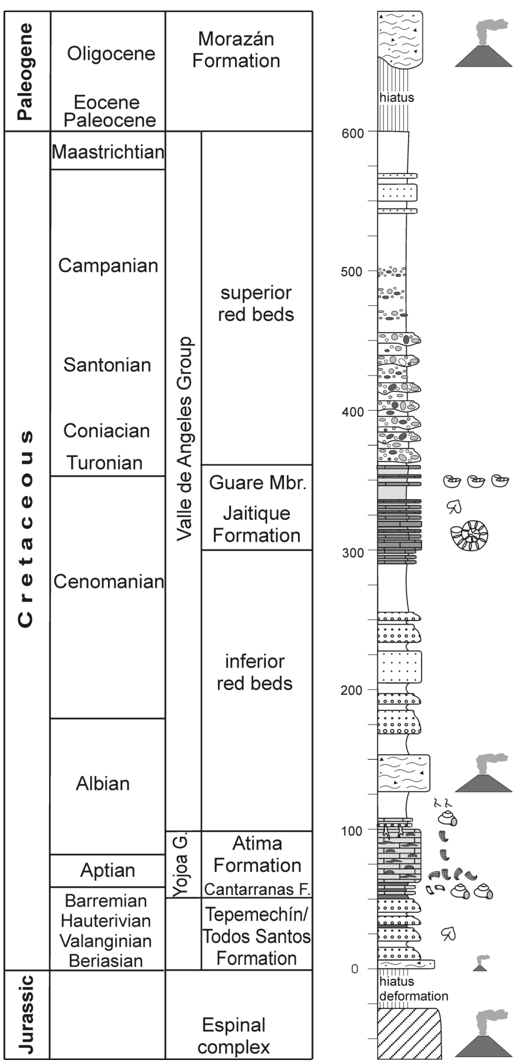


Figure 1: Stratigraphic scheme of the western El Salvador.

BAP04

Schafhauser, A., Belcher, C., Casey, D.M., Davies, R.B., Dlubak, M., NG, L., Oxford, M., Romain, H., Sharland, P.R., Simmons, M.D., Sutcliffe, O.E. (Neftex Petroleum Consultants Ltd.)

SEQUENCE STRATIGRAPHY OF CENTRAL AND SOUTH AMERICA: GLOBAL COMPARISONS

E-Mail: `armin.schafhauser@neftex.com`

Sharland et al. (2001; 2004) demonstrated the occurrence, across the Arabian Plate, of 65 synchronous Maximum Flooding Surfaces (MFS) during the Late Precambrian - Phanerozoic. Ongoing work, incorporating all the stratigraphy of North Africa and the western former Soviet Union, and examination of other regions, can now demonstrate the occurrence of several more such 1^{st}, 2^{nd} and 3^{rd} order surfaces, and intervening sequence boundaries, all correlateable over different regions and sedimentary basins.

Each MFS and its associated sequence boundary (SB) are defined in a reference section. This is a location with good sedimentological and/or wireline log evidence for a MFS or SB, supported by biostratigraphy. The biostratigraphy also provides constraint on the correlation of the MFS or SB to its occurrence in other locations.

Given the clear synchronicity of these MFS and SBs throughout basins of differing subsidence and sedimentation rates, these surfaces must be eustatic in origin.

It be demonstrated that our sequence stratigraphic model, originally developed in the Middle East, can be successfully applied to the stratigraphy of South and Central America.

As an example, Goldhammer & Johnson (2001) developed a chronostratigraphic chart for the Mesozoic units of northeast Mexico. There is very good correspondence between the major MFS recognised in the Arabian Plate model and the major transgressive events recognised by these authors. Similarly, K40 SB (*campylotoxus* Zone, Early Valanginian), seen, for example, at the base of the Zubair Formation in Kuwait and southern Iraq, can be identified at the base of the lowstand sediments of the Mulichinco Formation from the Neuquén Basin, Argentina (Schwarz & Howell, 2005), with biostratigraphic calibration provided by ammonites. It can also be located at the base of the Hosston sands of the Texas Gulf Coast (Scott et al., 1988) or the La Caja Formation of NE Mexico (Goldhammer & Johnson, 2001).

There are profound hydrocarbon exploration and production implications for the application of the sequence stratigraphic model that we have developed. The model provides a precise and reliable framework for correlation and mapping and the subsequent identification of petroleum system elements such as lowstand reservoirs and transgressive source rocks.

Goldhammer, R.K. & Johnson, C.A., 2001. Middle Jurassic-Upper Cretaceous Paleogeographic Evolution and Sequence-stratigraphic Framework of the Northwest Gulf of Mexico Rim. *AAPG Memoir,* 75, 45-81.

Schwarz, E. & Howell, J.A. 2005. Sedimentary evolution and depositional architecture of a lowstand sequence set: the Lower Cretaceous Mulichinco Formation, Neuquén Basin. *Geological Society Special Publication*, 252,109-138.

Scott, R.W., Frost, S.H., Shaffer, B.L. 1988. Early Cretaceous sea-level curves, Gulf Coast and southeastern Arabia. SEPM Special Publication, 42, 275-284.

Sharland, P.R., Archer, R., Casey, D.M., Davies, R.B., Hall, S.H., Heward, A.P., Horbury, A.D., & Simmons, M.D., 2001, *Arabian Plate Sequence Stratigraphy*, GeoArabia Special Publication 2, 371pp.

Sharland, P.R., Casey, D.M., Davies, R.B., Simmons, M.D. & Sutcliffe, O.E., 2004, Arabian Plate Sequence Stratigraphy - revisions to SP2, *GeoArabia*, 9, 199-214.

Web page: http://www.neftex.com

BAP05

Baggio, H. (UNIMONTES), Horn, A. H. (NGQA-CPMTC-UFMG), Trindade, W. (UNIMONTES), Veloso, E. (Unimontes)

THE MATA DA CORDA GROUP IN THE HYDROGRAPHIC BASIN OF THE FORMOSO RIVER, MINAS GERAIS, BRAZIL. A STUDY OF ITS CORRELATIVE MORPHOLOGIC FORMS.

E-Mail: hernandobaggio@yahoo.com.br

INTRODUCTION: The study area is inserted in the Basin of the São Francisco river, the sub-basin of the Formoso river, in the northwestern part of Minas Gerais State, Brazil and belongs to the central part of the Sanfranciscana basin within the limits of the São Francisco Craton, more specifically in the Cretaceous Basin. The identified geomorphic compartments for the basin are: (Chapadas Units 880m-800 m/alt; Plateaus Units 800m-720m/alt and Valleys and Terraces Units 500m-720m m/alt). The Neoproterozoic Bambui Group constitutes the basal unit of the São Francisco river basin in the region, and its contact with the Areado Group is an angular unconformity. The basement is recovered by the cretaceous sandstones of the Lower Cretaceous Areado Group, by the volcanoclastic rocks of the Upper Cretaceous Mata da Corda Group and the arenaceous coverings of the Chapadão Formation (Tertiary/Paleogene). In the Upper Cretaceous, the Mata da Corda sedimentation and volcanism and its lithofacies represent the tectonics reaction occurred in the Sanfranciscana Basin, affecting the Alto Paranaiba Arc. The basal Unit of this Group, the Patos Formation, is part of magmatic alkalinerocks that constitutes the great Alkaline Province Minas-Goias embodying volcanic rocks and the subvulcanic-kamafugites. In Brazil the kamafugite volcanism occurs in the Mata da Corda Province and the Alto Paranaiba Arc in the Sanfranciscana Basin. Overlapping the Patos Formation, deposited the Capacete Formation, composed by volcanoclastic rocks, carried by alluvial fans. Geomorphologically the Três Barras/Areado and Capacete/Mata da Corda Formations are situated in the plateau units with topographical measured 850m, supporting abrupt scarps.

RESULT AND DISCUSSION: The morphometric altimetry variations from 825m to 869m, and that from 837m - 849m the horizontal distribution of the Mata da Corda Group, can be seen as circular outlines in the topography, a kind of rock belt, capping the convex scarps and evidencing convex hill short slopes. The inclined parts of the Plateau structure of scarps where the Capacete Formation outstands is oxidated and kaolinizated, due to an advanced stage of alteration, recovered by levels of ferruginous laterite of thick variety, in association with the presence of these Formations, there is an erosive pattern differentiated of that of the Areado Group rocks. In these areas the lithic/volcanic sandstone is capping the Três Barras Formation of the Areado Group, generating in the morphology a sequence of convex hills lined up preferentially in the direction SW-NE, presenting short slopes with accented declivity going down into the valleys.

CONCLUSIONS: The geochronology and the chronocorrelation of the Mata da Corda Group, with the end of the deposition of the Areado Group, more specifically, with facies lithosediment of the volcanic lithic sandstone that occur in the studied area, indicate that the deposition of the volcanoclastic sediments of this facies, confer a more intense resistence to the erosive processes which occur since 80 Ma up to the present. The covering material in the high slope segment is composed basically by small neosoils of 2.5Y.R. Within the high/middle slope segment, is a superficial covering of ferruginous laterite which can reach about three meters thick, forming a protective barrier to the vertical percolating of rain waters; and, in the segment low/middle, there is a colluvial covering, constituting of heterogeneous matter and involved for a sandy-silt-argillaceous matrix.

BAP06

Brandes, C., Winsemann, J. (Institut für Geologie, Leibniz Universität Hannover)

Gravitational tectonics in the Rio San Juan Delta, North Costa Rica

Gravitational tectonics is a global phenomenon that occurs in large river deltas like the Niger Delta or the Mississippi Delta. Based on seismic data it is often difficult to decide whether the extension in a delta is related to tectonic forces sensu stricto or whether it is gravity induced. The Rio San Juan Delta, which is located at the east coast of SE Nicaragua and NE Costa Rica is a rather small delta, but it shows an intense internal deformation. A grid of 2D seismic reflection lines provides insights into the Costa Rican part of the delta body and allows a detailed spatial and temporal analysis of the deformation. The seismic sections display several large listric, northeastward dipping normal faults in the shelf and slope area. All normal faults trend NW-SE and sole into a common detachment. The rheology at the detachment is interpreted to be controlled by the lithological change from limestone to shale, which was detached from the underlying limestone. The normal faults in the shelf area show activity until Plio-Pleistocene times. They terminate in Quaternary deposits. The faults in the slope area seem to have been active in the Late Miocene to Early Pliocene. Tip lines of these faults are buried under Late Pliocene deposits, indicating that the activity already ceased in the Pliocene. The normal faults in the slope area are associated with small basins. These basins have a wedge-shaped geometry with the greatest sediment thickness close to the fault. This indicates syn-sedimentary tectonics. At the base of the slope there is evidence for toe thrusting. A southwestward dipping fault trace can be observed and a small thrust sheet that developed in the hangingwall of the fault. Gravity induced deformation is very likely for the San Juan Delta because of the linked extensional and compressional fault system. The faults and the detachment were mapped on the individual seismic sections and a 3D model of the delta body was reconstructed. The model provides an excellent insight into the geometry of normal faults, related offsets and the lateral evolution of the basal detachment.

BAP07

Dristas, J. A. (Bahía Blanca, Departamento de Geología, Universidad Nacional del Sur and CIC. Buenos Aires.), Martínez, J.C. (Bahía Blanca, Departamento de Geología, Universidad Nacional del Sur and CONICET.), van den Kerkhof, A.M. (Göttingen, Geowissenschaftliches Zentrum der Georg-August-Universität), Frisicale, M.C. (Bahía Blanca, Departamento de Geología, Universidad Nacional del Sur and CONICET.)

APATITE ASSOCIATED WITH ”HYDROTHERMAL PALEOKARST” IN UPPER PRECAMBRIAN LIMESTONES, BARKER, TANDILIA, ARGENTINA

The Tandilia Range, situated in the southernmost part of the Río de la Plata Craton (Buenos Aires Province, Argentina) is mainly composed of (1) an igneous-metamorphic Lower Precambrian basement, the Buenos Aires Complex, and (2) overlying Upper Precambrian-Lower Palaeozoic sediments, which are grouped in the La Tinta Fm.

The upper portion of the La Tinta Fm is well exposed near Villa Cacique (Barker) in the Loma Negra quarry (LNQ), which was exploited for Upper Precambrian black micritic limestone (Loma Negra member, La Tinta Fm.). Leanza & Hugo (1987) reported marine sedimentary phosphorite at the base of the Cerro Negro Fm, i.e. at the contact with the underlying Loma Negra member. They identified the P-mineral as fluor-apatite and interpreted the limestone breccia as “" the heaping up of a softy channelled paleorelief eroded on the top of the Loma Negra limestones, due to a regression of the sea level”.

A meteoric karst model was proposed by Barrio et al. (1991). The studies of Zalba (1992), Andreis et al. (1992) and Zalba & Andreis (2001) confirmed the ”" paleosurface-related” formation of P-mineralization and ftanite (chert). However, new field evidence, mineral analyses and cathodoluminescence microscopy give rise to an alternative genetic model for the limestone dissolution, brecciation, and phosphate and silica deposition at Barker, namely as a result of hydrothermal alteration.

ii) Field evidence: Our study was focused on a mega-breccia and white veinlets of secondary calcite, which occur throughout the black micritic limestone. The altered clasts and the collapse-folding of the Cerro Negro Fm. lower beds towards the dissolution cavities of the micritic limestone, indicate that karst formation postdates the deposition and lithification of the overlying rocks. In the same way, we cannot hold the formation of the micritic breccias by a regression event on the basis of several others field arguments.

ii) Hydrothermal activity and phosphate genesis: The mega-breccia can be genetically related to the hydrothermal breccias, underlying the ortho-quartzitic rocks in the western Barker area (Dristas & Frisicale, 1992). The reactive wall rock in the upper stratigraphic positions (micritic limestone, Loma Negra member) indicates zoned alteration characterized by respective ankeritization, silicification, and calcite re-crystallization. The finding that the mega-fragments are assigned to the underlying stratified lithologies, supports our interpretation that these rocks are “intrusive breccias”.

Frisicale (1991) reported discordant fluor-apatite veins in hydrothermally altered clays from El Diamante quarry (5 km E of Barker). Furthermore, Dristas & Frisicale (1996) and Dristas et al. (2003) recognized aluminium-phosphate-sulphate (APS) minerals in Cerrito de la Cruz quarry, located within the hydrothermally altered rocks at the contact between the basement and sedimentary cover. In the upper portions of the sediments, close to the Loma Negra Fm, Martínez et al. (2006) found hydrothermal phosphates associated with Na-alunite. The source of P and LREE was explained by lixiviation of migmatites from the basement, which contain apatite and allanite, and were affected by pervasive hydrothermal alteration.

iii) Mechanisms controlling karst, phosphate and breccia formation: Leanza & Hugo (1987) distinguished a phosphatic stratigraphic member (up to 2.85 m thickness) at the basal part of the Cerro Negro Fm, which comprises the limestone and phosphate breccias, chert with phosphate, phosphate levels, phosphatic ortho-quartzite and phosphatic quartz-wacke. These authors considered these rocks as products of chemical precipitation during sedimentation. However, the wide variety of phosphate-rich rocks, which occur in a relatively thin layer, can be explained only by secondary fluid-controlled processes. Horizontal fluid migration along the contacts between the different lithologies may have been responsible for partial replacement (pyroclastic basal rock, Loma Negra member, channel filling ortho-quartzites). Channelways formed in the micritic Loma Negra member due to calcite dissolution and the selective dissolution of epitaxial quartz cement in the ortho-quartzite along “dust lines”. Corbella et al. (2005) in their study on the Rocabruna barite deposit denoted that dilute and alkaline solutions are most effective in dissolving dolomite and cause “hydrothermal karst”. An increase of the CO2 content may have rised confining pressures, which resulted in hydraulic fracturing of the micrite and adjacent rocks, and the development of fluid channelways. Calcite deformation twins in the white veins indicate tectonic activity after mineralization. At this stage rock fragments and pressurized fluid were expelled into cavities and open fissures and formed clastic dykes and breccias. On lowering pressures and temperatures, calcite was precipitated as cement in the arenite veinlet swarms and in the breccia, and partially replaced the ortho-quartzites. During this process small aggregates of fluor-apatite, chlorite and pyrite precipitated from the residual solution together with secondary calcite and quartz. The calcitic arenite veinlets reached also the overlying Cerro Negro Fm, which, to a lesser extent, was also affected by hydraulic fracturing. The mineral association of pyrite, sericite, chlorite and fluor-apatite suggests a reduced and weakly alkaline environment. Ascending solutions also partially affected the claystones of the Cerro Negro Fm along the contact with the micritic limestone (Loma Negra Fm), resulting in carbonatization, chloritization and smectite crystallization. The hydraulic fracturing affected also the early-formed fluor-apatite, which was included in a mass of secondary quartz (“" phosphate breccias”). After hydraulic fracturing and pressure drop, the mixing of the mineralizing fluid with oxidizing ground water resulted in solutions of increasing acidity, which provoked intense dissolution cavities in the black micritic limestone and the precipitation of Fe-hydroxide. Secondary quartz-sericite and barite found in the dissolution cavities correspond with this late stage of hydrothermal evolution. Pure and highly crystalline 1T kaolinite in the dissolution cavities must have also formed from the acidic solutions, before final neutralization by the carbonate.

BAP08

Frausto Martinez, O., Ihl, T., Giese, S. (Universidad de Quintana Roo)

MAP OF EXOKARSTIC FORMS IN THE NORTHEAST OF THE YUCATAN PENINSULA, SCALE OF RESOLUTION 1:50.000

E-Mail: ofrausto@correo.uqroo.mx

The map of exokarstic forms refer to a set of analyses of topography, superficial relief and direct reflection. The map is based on an interpretation of aerial photos in a scale 1: 50.000 from INEGI, satellite images from Landsat ETM and a vector data set of the topographic information in a scale of 1:50.000 from INEGI, as well as field work and registries of the reported karstic forms in the specialized bibliography. It is constructed to a data base of topographic and thematic themes, which include the altitude, the inclination, the processes of water bodies and inundations, which constitute a GIS Application of the exokarstic forms of the northeast of the Yucatan Peninsula, in a resolution of 1:50.000. The main results are:

1. The maps of exokarstic forms are the first in its type of the Yucatan Peninsula and refer to three forms: dolines, uvalas and poljes, differentiated according to its depth (of 0 m and up to 30 m) and its topographic location (up to 40 meters of altitude), also to the flood pattern (ordinary, permanent or extraordinary). Furthermore the map includes a section of density of these forms by a predefined distance.

2. The collection of these maps constitutes 28 sheets on a scale of 1:50.000. But specific applications make it necessary to enlarge the relief information to amedium sized scale of 1:250.000. These maps enrich the compendium that constitute the knowledge and handling of the natural resources, especially for applies in resource water.

3. The Map is available in a simple format of consultation throughout GIS, which allows a dynamic character for prints and continuous updates. The project is supported by FONDO MIXTO CONACYT- thanks for the financial engagement of the Government of the state of Quintana Roo: ”ESTUDIO GEOHIDROLÓGICO Y EVALUACIÓN DE FUENTES CONTAMINANTES DEL ACUÍFERO NORTE DE QUINTANA ROO, MÉXICO” and of the Department of Sustainable Development, University of Quintana Roo.

Web page: http://www.cozumel.uqroo.mx

CO

Continental Geology, Tectonics and Structure

COP01

Heit, B., Sodoudi, F., Yuan, X., Kind, R. (GFZ), Bianchi, M. (University of Sao Paulo)

Structures of the Crust and Mantle Lithosphere in South America:

E-Mail: heit@gfz-potsdam.de

During the past years, a series of seismological investigations have been carried out to study the crustal and mantle structures all over the world. In South America, this investigation has not been an easy task as there are different regions where the geodynamics involves the subduction of the Nazca plate, the building of the Andean mountain range, old cratonic areas as the Brazilian Shield and the presence of active deformation fronts. Here we use S-wave receiver functions to investigate the structure and thickness of the crust and mantle lithosphere in such a complex area using data from permanent and temporary stations.

The S receiver function technique looks for the S-to-P converted waves at seismic discontinuities beneath a seismic station in a similar way as the conventional P receiver function method dealing with P-to-S conversions. The S receiver function technique has proved to be useful to map the Moho discontinuity and the LAB in many regions where other methods (i.e. surface waves) failed to provide this information.

We present here the results of the S receiver function technique that has been applied to the data of all available temporary seismic experiments (e.g. BANJO, SEDA, REFUCA, BLSP, CHARGE) and permanent stations from the different networks (e.g. GEOSCOPE, GTSN, GSA, GEOFON). We have been able to map the upper mantle discontinuities at all the depths beneath the stations. We obtained coherent Moho depths along the entire Andes and in other South American continental regions. The Lithosphere-Asthenosphere Boundary has been clearly detected below some stations, particularly those that are located far away from the subduction zone. By comparing our results with those obtained from the P receiver functions, we have been able to further constrain the thicknesses of the crust and lithosphere in different regions including shields, mobile belts, basins and mountain ranges. Beneath some stations we have also been able to map the 410 and 660 km upper mantle discontinuities in South America. The topography of these discontinuities should reflect the changes in temperature and thermal state of the materials in the mantle transition zones, and may correlate with the tectonic events at depth of the lithosphere.

COP02

Dusin, I. A. (UFRGS), Horn, A. H. (CPMTC-IGC), Dayvisson, J. (UFRGS)

GENETIC CONSIDERATIONS OF THE INTRUSIVE COMPLEX IBITUBA-ITAPINA, MINAS GERAIS AND ESPIRITO SANTO STATES, BRAZIL. BASED ON MINERALOGY, GEOCHEMISTRY AND ZIRCON TIPOLOGY.

E-Mail: `hahorn@ufmg.br`

Introduction: The granitic Intrusion Itapina (180Km2) belongs to the Intrusive Complex Ibituba-Itapina, located in the Mantiqueira Structural Province, which is a part of the Neoproterozoic Intrusive Sequence, related to the Brasiliano Event. It is situated at the margins of the River Doce Valley, in the western portion of the Espirito Santo State. This intrusive body is formed by two distinct Magmatic Suites:

a. Charnockitic Suite with hypersthene granite and a migmatized marginal zone caused in the host rock by the intrusion. b. Granitic Suite with calcalkaline - alkaline granite, amphibole rich diorite, pegmatites, aplites and an intermediate to acid border zone with enclaves of the host rocks. The age determinations in the zircons and monazites, show the Brasiliano age for all of the rocks of the Intrusive Complex (from 537Ma to 520Ma), confirming the close intrusion sequence of the two Magmatic Suites. The samples were collected contemplating the main petrografic variations of the intrusive bodies. Afterwards were done normal procedure for analytical geochemistry (ICP-AES, XRF), thinsections analyses (microscope, microprobe) and for zircon observation a separation of the heavy minerals from the grained rock, using dense liquids, magnetic separation and chemical dissolution of undesired minerals. The zircon crystals were preparated for their typology determination by MEV in according to Pupin metodology.

Results: The mineralogical and chemical data support a combined evolution of two types of magmas, one formed by fusion of parts of an upper crust and other by fusion of highgrade conditions in a lower crust in a doubled crust system. The first porphyritic granitoids suite is characterized by higher ASI range from 0.82 to 1.35, K2O contents from 2 to 8.4wt%, the total (Na2O+K2O) contents from 5.45 to 10.6wt% and more ferriferous, Fe2O3 contents from 0.52 to 6.56wt%. The porphyritic granitoids suite reach their highest ASI under unusual high MgO values (2.1 wt%) and low SiO2 (63 wt%), The ASI increase up to 1.35 under MgO values (0.7 wt%) and SiO2 values (70 wt%), and decrease after. This behavior may be related to the influence of the two magmatic sources, metasedimentary and (Fe, Mg)-rich mantle (lamprophyres). The Al2O3, TiO2, MnO, MgO, CaO contents decrease linearly with increasing SiO2. Na2O show broadly decreasing trends. The K2O contents increase with SiO2. These granitoids are characterized by very low Ni, (1-9ppm), Co (0.8-7ppm), Th (3-22ppm), Sr (56-467ppm) and Rb (61-217ppm) contents and high Ba (464-2940ppm) contents. The REE patterns of the different facies show close similarities. The LREE contents are relatively high (20<(La/Yb)CN<33) and have a lower or even absent Eu anomalies. The second are metaluminous rocks and with an agpaitic index ((Na+K)/Al) ranging from 0.45 to 0.77. These granitoids show a broad range of SiO2 content, from 51 to 71wt%.The total (Na2O+K2O) increase from 5 to 10wt% with SiO2 and is broad overlap alkaline and subalkaline granitoids field. In all facies Al2O3, Na2O and CaO decrease linearly with increase SiO2, indicting to the plagioclase crystallization from the melt during the magmatic differentiation. In all facies, P2O5, TiO2, MgO, Fe2O3, MnO, Zn and Ni decrease also linearly with SiO2. The MgO/TiO2 ratio of these rocks is low near to 1, and this is a typical feature of sub alkaline granites The Ba/Sr, Sr/Rb, Ba/Rb, Zn/MgO and Sc/MgO ratios of these granitoids pointing to the important role of fractional crystallization of pyroxene and plagioclase in first time and amphibole, biotite and k-feldspar in second time. The total (Zr+Nb+Ce+Y) content is higher from 500 to 1000ppm and compared to post tectonic granitoids. All facies exhibit similar chondrite normalized REE patternswhich are characterized by a greater REE abundances (200-800ppm), wide LREE, low HREE ($10<(La/Yb)N<200$) and small or no Eu anomalies. Host rock enclaves have suffered thermal metamorphism which is shown by transformation of the garnet in the migmatites to green spinel. The enclaves are not equilibrated shown also by their different REE pattern. Zircon studies point out the tendency of an evolution in the field of the granitic-calc-alkaline series to granitic-calc-alkaline crustal series rich potassium. The morphologic investigations of the Granite samples show a typological evolution from the field of the granitic calc-alkaline series to granitic crustal series. A preliminary evaluation of the zircons indicates a great form similarity with those of Ibituba. The Hipersthene Granite and the Granite seem to have their origin in close crustal levels, intruding, during the Brasiliano Event, in a narrow temporary interval. This behavior is very similar to the Intrusive body Ibituba. The typological studies point out an origin of granitic and tonalitic rocks for Hypersthene Granite Itapina and of monzogranitic to granodioritic crustal rocks for the Itapina Granite. Hypersthene Granite samples, treated in the typologic diagrams for tectonic discrimination, determine clearly to the charnoquitic field pointing towards the field of the granitic calc-alkaline series.

Conclusions: It is possible to assume a formation of two magmatypes by the same event, probably a crustal duplication with strong temperature and pressure ampliation. A first melt (hy-rock suite) is formed by direct dry fusion in the lower crust and intrudes upper crust rocks with temperature around the melting point of the granite and para-rock contributions. During a multistage intrusive system in extensional regime were formed the ring-like bodies with several pulses of genetical envolving magmas. The interaction between this pulses dreated the wide variety of granitic to mafic rocktypes. It is able to correlate this sequence with temporal and mineral and chemical features.

COP03

Parica, C.A. (CONICET Universidad de San Martin), Remesal, M.B. (CONICET Universidad de Buenos Aires)

The Geology of Danco Coast at Cierva Cove. Antarctica.

E-Mail: cparica@unsam.edu.ar

The geological analysis of Danco Coast at the area of Cierva Cove, nearby the Argentine Antarctic Station Primavera was carried out (64 09 S and 60 57 W). The first step for this job was the repositioning of the area with GPS technology (Geodesic Datum WGS 84). The stratigraphy of the area is represented in the lower levels by the Antarctic Peninsula Volcanic Group, which is assigned to upper Jurassic to lower Cretaceous by Pankhurst (1982), Rinaldi et al. (1999) between other authors. The outcrops of these rocks in the area are dark green andesitic lavas strongly vitreous with crystals of plagioclase. The highest level is represented by green andesitic breccia lavas. Analyzed by major elements geochemical data these rocks classified as calcalkaline. Gerlache Formation (proposed name by these authors). The most conspicuous outcrops in the area (most of the surface of Danco Coast) belong to an intrusive body with stopping phenomena. The compositions established are tonalitic, dioritic and quartz diorite. The geochemistry let to classify this plutonic body as calcalkaline, suitable with the tectonic environment for the area. The age of the Gerlache Formation according to K Ar ages is aptian albian (ca. 110 Ma). Several dikes cross the area in agreement with the main structural directions measured, E W, NNE SSW and SE NW. The composition of the dikes is mainly basaltic, one meter width. The area is deeply fractured where gravity faulting is clearly observed, diaclases, and other deformation structures are frequently observed. The main directions for most of the structures were analyzed: E W, 30 degrees and 120 degrees. The geomorphology is represented by glacierfeatures (marks, tracks, erosion) and deposits like moraines. Water resources. At Cierva Cove, there are water resources represented by lagoons and streams, all of them as the result of outwash processes. The main problem to get water for human use is the pollution produced by the penguin colony. The analyzed samples provide results with pH between 4.8 to 5.7 and just one stream close to the Argentine Station 7.8. High contents of NO3 48.8 to 58 mg litre, concentrations which exceed largely the 25 mg litre recommended, this is non human drinkable water. High ammonia, out of the potability conditions too. In spite of the high pollutant contents all of the samples present low mineralization. The waters were classified according Piper, Stiff modified and Schoeller Berckaloff diagrams with these results: HCO3 Ca, and Cl Na waters.

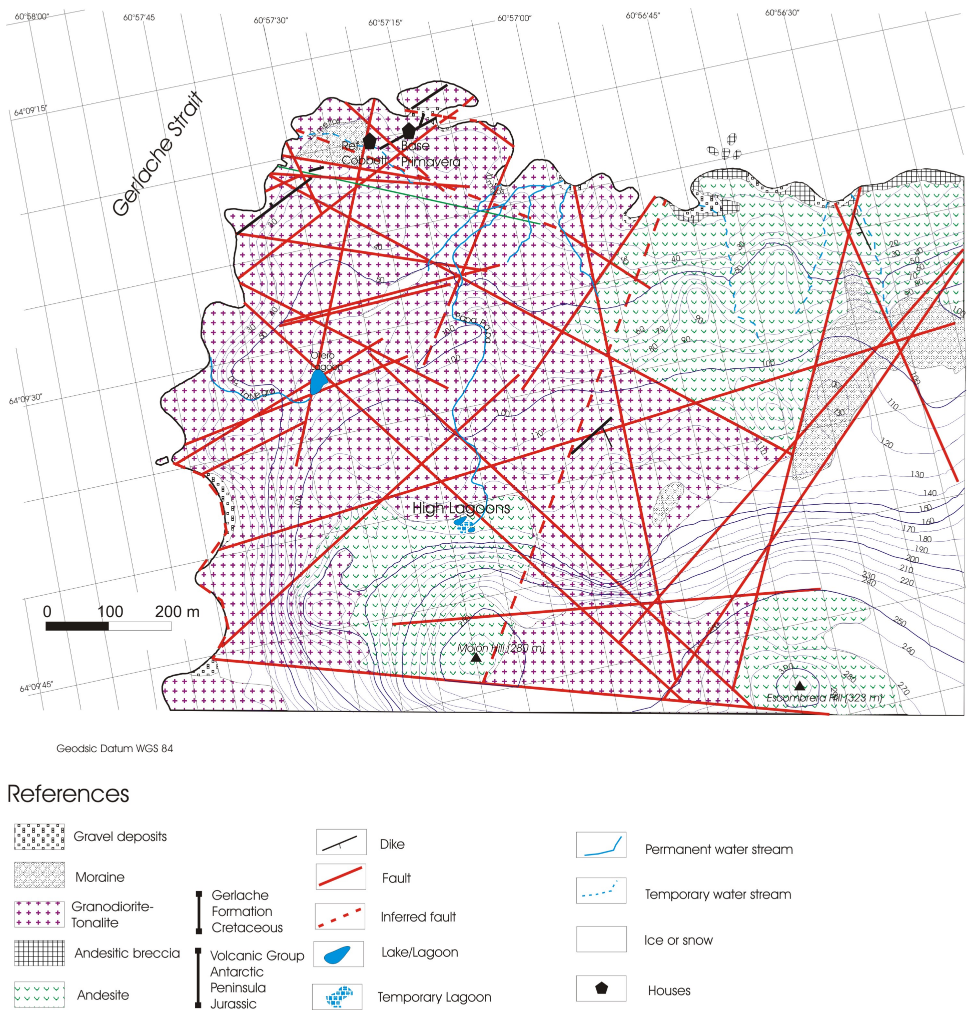


Figure 1: Figure 1.- Geological sketch of Cierva Cove at Danco Coast

COP04

Parica, C.A. (CONICET Universidad de San Martin), Remesal, M.B. (CONICET Universidad de Buenos Aires)

The Geology of Half Moon Island, South Shetland Islands, Antarctica.

E-Mail: cparica@unsam.edu.ar

Half Moon Island is one of the South Shetland Islands Archipelago, on the North of the Antarctic Peninsula, is located inside the Luna Bay of Livingston Island. The island was repositioned with GPS technology (for geodesic datum WGS84). Parica et al.(2002) defined the stratigraphy of the island. The oldest rocks are vulcanites of cretaceous age with the presence of lavas and brecciated lavas, of andesitic and basandesitic composition. It is very important the hydrothermal alteration. On exposed surfaces the lavas are deeply dark, with textures of auto breccia and scoria. The cretaceous plutonism is represented by tonalites, monzodiorites and gabbros. The main outcrops of gabbros are located in southernmost of the island, Fliess Point-Rosales Beacon (penguin colony). The gabbros have medium grain, with grey dark colors crossed by dikes. They are rocks of hypidiomorphic texture,with plagioclase (An64-50), clinopyroxene with unmixing textures. Chlorite is the main alteration of these minerals. Some exolution of oxides are also ecognizable too. The best outcrops of tonalites and monzodiorites are located at the Capanegra Hill and the south section of the Saddleback Hill. The tonalites are the most frequent composition in the island with subordinated monzodiorites. The color of these rocks is green grayish. These rocks are composed by plagioclase (An25-60). The amphibole (hornblende) in some cases is found with uralitization. The pyroxenes (augite) are extremely obliterated, with remains of relicts in some nuclei of alteration. Some crystals of biotite were recognized. The quartz is present just in low percentages in xenomorphic crystals and poor growth. Intergrowth between quartz and feldspar is present in different ranks. Small crystals of apatite, zircon, titanite, pyrite, chalcopyrite and some oxides were also recognized. The tonalites were dated in a Rb-Sr diagram with a good array, ages between 76 to 67 Ma were obtained. The basaltic dikes are assigned to Tertiary. Most of them related to diaclases structural array in the area. With geochemical data most of the plutonic rocks were classified as tonalites, diorites, monzodiorites to gabbros with a wide range of silica. The main petrogenetic process for the plutonic rocks is related to polinomic trends obtained in most of the variation graphics with a good degree of adjustment suitable to understand fractional crystallization processes with possible concomitant assimilation (AFC). The petrological geochemical feature indicates these rocks were forming in the pre plate collision stage (subducting active plate age). The profiles of multielement and rare earth diagrams areinterpreted as evidence of increasing degrees of crystallization in agreement with the increasing of elements into an inverse ratio of the content of SiO2 in the analyzed samples. For the Quaternary several manifestations are described. -Fossil beaches levels: the coasts of Half Moon Island are characterized by gravel material of different shapes and composition (Bertola & Isla, 1994). -Moraine deposits: these deposits are recognized at the northern and eastern of the island. -Outwash deposits: the outwash deposits are located mainly at the northeastern sector of the island. These go down to a small depression during the warmest times because melting of ice at the top of the Saddleback Hill. -Soils: at the top of the Saddleback Hill can be observed an incipient develop of polygons. -Falldown of blocks, gravity deposits: on the southern wall of the Capanegra Hill canbe observed large deposits coming down from the intrusive body. Structures of the island. Half Moon Island exposes significant structures because the faulting. The most important faults are located in the northeastern of the Saddleback Hill, there are two; the first one has an attitude N-S and the second one NW-

SE, in both cases the lower block is the eastern. At the Capanegra Hill many plains were established, both on the external surface of the intrusive body (SE-NW and ENE-WSW). All faults in the island belong to a gravitational type. The central zone of the island is interpreted as the resultant of faulting on the flanks of the Capanegra Hill and the Saddleback Hill (with two main peaks, Paglietino and Vago). The water resources for the support of the Argentine Station Camara can vary time to time in the same season and year to year. Since 1991 to present the authorscould observe how the central lagoon, named Mutto Lagoon diminished its level in a dramatic situation. The impermeable surface for this lagoon is the active permafrost level. With a low increasing of temperatures (Skvarca, et al. 1998, 2003) in recent years, the permafrost level is under a process of destruction, in this way some holes are open giving an efficient channel of drainage of water to lower levels across the gravel sediments of the fossil beaches. Some small streams, in summertime, let to pump a few litres of water to the tanks in the station. When the temperatures are lower, some thin surface of permafrost is developed and the Mutto Lagoon and the pool can be preserved. This event can be compared with the Boeckella Lake at Hope Bay, Trinity Peninsula (Ermolin, 2003). The strata on destruction are interpreted as underground buried ice and the structural ice.

COP05

Chaves, A. O., Rios, F. J., Neves, J. M. C., Alves, J. V. (Belo Horizonte, CDTN - CNEN), Sgarbi, G. N. (Belo Horizonte, IGC - UFMG), Peregovich, B. (Belém, NAEA - UFPA)

Weakness Surfaces Related to Mafic Dykes as Structural Control of the Meso/Cenozoic Magmatism of Central/Southeast Brazil

E-Mail: aoc@cdtn.br

At least seven distinct mafic dyke swarms, mainly tholeitic in composition, intruded the Brazilian central/southeast lithosphere from Archean to Mesozoic (Figure 1). The bigger swarm (Pará de Minas, approx. 1.72 Ga - Silva et al., 1995) is probably plume-related as revealed by anisotropy of magnetic susceptibility studies (Raposo et al, 2004) and field evidence (Chaves & Neves, 2005), which showed subhorizontal magmatic flow through several hundreds of kilometers. This flow is understood as magmatic fracturing during lateral movement of the plume-related basic magma. Dykes of an other swarm, named Paraopeba (2.2 Ga - Chaves & Neves, 2005), intruded anddeformed along transtensional sections of vertical ductile shear zones developed during the Transamazonian Orogeny.

A wide net of vertical surfaces was created in the Brazilian central/southeast lithosphere either by magmatic fracturing or development of shear zones from Archean to recent time in association to mafic dyke intrusion processes. Such vertical features are deep weakness surfaces, which represented preferential places for intrusions during following magmatic events (Vearncombe & Vearncombe, 2002; Stott & Halls, 2002). Among these is the Meso/Cenozoic magmatism, during which kimberlitic pipes, felsic alkaline rocks, carbonatites, lamproites and kamafugites (90 to 50 Ma, Gibson et al., 1995; Thomaz Filho & Rodrigues, 1999; Sgarbi et al, 2004) intruded along vertical surfaces. The pipe coordinates presented in figure 1 were obtained from Rodrigues & Lima (1984) and Sgarbi (2005). It is worth pointing out that the NW trend (AZ-125) of the Mesozoic intrusions in Minas Gerais and Goiás States is the same of the vertical surfaces related to Pará de Minas dykes.

REFERENCES

Chaves, A. O. & Neves, J. M. C (2005) Radiometric ages, aeromagnetic expression and general geology of mafic dykes from Southeastern Brazil and implications for Africa-South American correlations. Journal of South American Earth Sciences, 19(3): 387-397

Gibson, S. A., Thompson, R. N., Leonardos, O. H., Dickin, A. P., Mitchell, J. G. (1995) The Late Cretaceous impact of the Trindade mantle plume: evidence from large-volume, mafic, potassic, magmatism in SE Brazil. Journal of Petrology 36(1): 189-228.

Raposo, M. I. B., Chaves, A. O., Lojkasek-Lima, P., D'agrella-Filho, M. S., Teixeira, W. (2004). Magnetic Fabrics and Rock Magnetism of Proterozoic dike swarm from the southern São Francisco Craton, Minas Gerais State, Brazil. Tectonophysics, 378: 43-63.

Rodrigues, C. S. & Lima, P. R .A. S (1984) Complexos carbonatíticos do Brasil. In: CBMM - Geologia 2-13.

Silva, A. M., Chemale J. R. F., Kuyumjian,

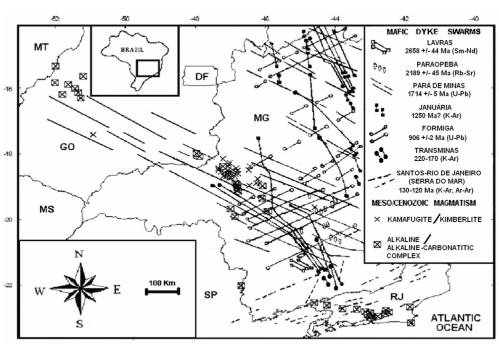


Figure 1: Figure 1: Mafic dyke swarms and Meso/Cenozoic magmatic rocks of the central/southeast Brazil. Proterozoic and phanerozoic covers are not shown (modified from Chaves & Neves, 2005). Brazilian States: MG = Minas Gerais, GO = Goiás, SP = São Paulo, DF = Federal District, RJ = Rio de Janeiro, MT = Mato Grosso, MS = Mato Grosso do Sul.

R. M., Heaman, L. M. (1995). Mafic dyke swarms of Quadrilátero Ferrífero and Southern Espinhaço, Minas Gerais, Brazil. Revista Brasileira Geociências, 25(2): 124-137.

Sgarbi, P. B. A., Heaman, L. M., Gaspar, J. C. (2004) U-Pb perovskite ages for brazilian kamafugitic rocks: further support for a temporal link to a mantle plume hotspot track. Journal of South American Earth Sciences 16: 715-724.

Sgarbi, G. N. C., Sgarbi, P. B. A., Filho, J. P. L. (2005) Relatório Final do Projeto ”Critérios decampopara reconhecimento de condutos vulcânicos no Oeste Mineiro”. Fapemig: 96.

Stott, G. M. & Halls, H. C. (2002) Project Unit 02-007. Paleomagnetic, Geochemical, and U-Pb Geochronologic studies of mafic dykes in Northern Ontario: relevance to mineralization associated with the Nipigon Embayment and kimberlites. Ontario Geological Survey, Open File Report 6100: 13-1 to 13-10.

Thomaz Filho, A. & Rodrigues, A. N. (1999) O alinhamento de rochas alcalinas Poços de Caldas-Cabo Frio (RJ) e sua continuidade na cadeia Vitória-Trindade. Revista Brasileira Geociências, 29(2): 189-194.

Vearncombe, S. & Vearncombe, J. R. (2002) Tectonic controls on kimberlite location, southern Africa. Journal of Structural Geology, 24: 1619-1625.

Web page: http://www.cdtn.br/

COP06

Oyhantcabal, P. (Departamento de Geologia, Universidad de Republica, Montevideo), Siegesmund, S., Wemmer, K. (Geoscience Center Göttingen), Frei, R. (Geological Institute, University of Copenhagen), Layer, P. (Geophysical Institute, University of Alaska, Fairbanks)

Post-collisional transition from calc-alkaline to alkaline magmatism during transcurrent deformation in the southernmost Dom Feliciano Belt (Braziliano - Pan African, Uruguay)

In the southernmost Dom Feliciano Belt of Uruguay, highly fractionated calc-alkaline granites, mildly alkaline granites, shoshonitic volcanics, and peralkaline intrusions and volcanics are spatially and temporal associated with the evolution of shear zones. Four representative magmatic unities of diverse association were petrographic and geochemically investigated: the Solis de Mataojo Complex, a medium to high K2O calc-alkaline granite with signature typical of mature continental arcs and post-collisional settings; the Maldonaldo granite, highly fractionated calc-alkaline to alkaline, with characteristics that are transitional between both types of series: the Pan de Azucar Pluton, with characteristics typical of post-collisional alkaline granites and the Las Flores shoshonitic basalts.

Geochemistry and geotectonic setting point out that the slab breakoff was the mechanism associated with the generation of high-K calc-alkaline magmas (Solis de Mataojo and Maldonaldo) shortly after collision. Extension associated to the formation of molassic basins and emplacement of dikes with shoshonitic affinity (Las Flores basalts) was linked with lithospheric thinning through delamination and finally a shift to magmas with alkaline signatures (Pan de Azucar) simultaneous with a second transpressional phase occurred. This evolution took place between 615 and 575 Ma, according to available data. Contrary to previous proposals, which considered this granitic magmatism to be the root of a continental magmatic arc, a post-collisional environment, transitional from orogenic to anorogenic, during transcurrent deformation is proposed.

COP07

Oyhantcabal, P. (Departamento de Geologia, Universidad de Republica, Montevideo), Siegesmund, S., Wemmer, K. (Geoscience Center Göttingen), Frei, R. (Geological Institute, University of Copenhagen), Layer, P. (Geophysical Institute, University of Alaska, Fairbanks)

Evolution, kinematics and deformation conditions of the Sierra Ballena Shear Zone in the southernmost Dom Feliciano Belt (Braziliano - Pan-African, Urugay)

The Sierra Ballena Shear Zone (SBSZ) is a part of a high-strain transcurrent system that divides the Neoproterozoic Dom Feliciano Belt of South America into different domains. In the basement at both sides of the Shear Zone, a deformation stage previous than the transcurrent episodes is recognized as a high temperature mylonitic foliation associated with migmatization. Diffusional creep enhanced by partial melting was the main deformation mechanism associated with this foliation. The age of this episode is estimated in the 800-635Ma range.

The deformation observed in the SBSZ took place in regional low-grade conditions, as indicated by metamorphic paragenesis in the country rocks. The first transpressional phase was pure shear dominated, with conjugate dextral and sinistral shear zones forming at this phase. Syntectonic granites of this phase show frequently evidences of important flattening and steeply plunging lineations. The age of these intrusions allow us to estimate an interval of 635 to 600 Ma for this event. The granitic mylonites formed during this phase show quartz microstructures characteristic of the dislocation creep regime 2 and brittle behaviour of feldspar demonstrating middle greenschist facies conditions during transpressional deformation. Extension associated with the emplacement of basic dikes and development of molassic basins represents a third evolution phase estimated to have occurred between 600 and 590Ma.

The fourth evolution stage was a simple shear dominated sinsitral strike-slip event at about 586 - 576Ma. Mylonitic porphyries and quartz mylonites resulted from deformation of alkaline porphyries and quartz veins emplaced in the shear zone. Quartz veins seem to be the consequence of silica released during breakdown of feldspar associated with the evolution of the granitic mylonites to phyllonites and shear zone weakening. Quartz microstructures characteristic of the transition between regime 2 and regime 3 and incipient recrystallization in feldspar indicate deformation in upper greenschist to lower amphibolite facies (ca. 500°C). This medium to high temperature of deformation in a regional low-grade crust level is ascribed to temperature rise produced by emplacement of the porphyries.

Correlation of the above-described stages, with those proposed for the Purros Shear Zone of the Kaoko Belt in Namibia suggests a connection in the evolution of both belts at around 570-580Ma.

CT

Caribbean Tectonics

CT01 – Thu., 12.4., 10:10 - 10:30 · HSF

Schmitz, M., GEODINOS and BOLIVAR active seismic working groups (FUNVISIS, Caracas)

Origin of the deep crust beneath the Eastern Venezuela basin - insight from deep seismic observations

Venezuela is located on a complex plate boundary zone between South America and the Caribbean plates. A relative movement of 2 cm/year is accommodated by a system of transpressive, dextral strike-slip faults running from the Andes in the west to Trinidad and Tobago in the east. Within the framework of the GEODINOS (Geodinámica reciente del límite norte de la placa Sudamericana) and BOLIVAR (Broadband Ocean-Land Investigations of Venezuela and the Antilles arc Region) projects, the geodynamics of the plate interaction is being investigated using interdisciplinary geological and geophysical methods. Deep seismic refraction and reflection measurements were done in 2004 in northern Venezuela between longitudes 64°W and 70°W along four deep seismic profiles with roughly north-south strike crossing the Caribbean Mountain System perpendicular to the plate boundary zone. This presentation focuses on the analysis of chemical land shots recorded along the easternmost profiles (longitudes 64° W and 65° W) with up to 800 single-channel recording instruments (RefTek Texans), provided by the IRIS/PASSCAL Instrument Centre. Additionally, air gun shots from the marine refraction lines, recorded by the broadband stations of the Venezuelan national seismological network were used to build seismic sections with first arrivals to offsets greater than 200 km. Generally good signal to noise ratios enable the identification of signals from upper crustal structures as well as the reflections from the Moho. Whereas the derived crustal thickness for northern Venezuela generally varies between 35 and 40 km, crustal thickness increases to about 50 km in depth beneath the eastern Venezuelan basin between longitudes 64°W and 65°W. First images from receiver functions reveal a slightly lower crustal thickness than the interpretations derived from wide angle seismics. Deep seismic reflection images along a 80 km portion of the 65°W profile show good reflectivity down to 12 s twt, but no later reflections which might help to identify recent lower crustal structures. Tectonic processes related to the plate interactions of the Atlantic/South American and the Caribbean plates are responsible for these features. Several hypotheses to be tested may be proposed to explain this. Crustal material might have been attached by magmatic underplating generated during Proto-Caribbean opening, or by underplating of crustal material from the south dipping Proto-Caribbean subduction beneath the South American continent or from the recent northwest dipping Atlantic subduction beneath the Caribbean. The complete data set shall provide new information on the crustal and mantle structure in the plate boundary region to the northern edge of the South American craton and help to resolve the nature of the deep crust in eastern Venezuela. (Contribution to projects FONACIT G-2002000478, PDVSA-INTEVEP - FUNVISIS - 04-141 and NSF - Continental Dynamics Program EAR-003572).

Web page: http://www.funvisis.gob.ve

CT02 – Thu., 12.4., 10:30 - 10:50 · HSF

Denyer, P. (School of Geology, University of Costa Rica), Cortes, J. (San Jose, School of Biology, University of Costa Rica)

Tectonically controlled coastal uplifting of the Caribbean coast of Costa Rica

E-Mail: pdenyer@geologia.ucr.ac.cr

Costa Rica is located in the southern Central America (see figure). Tectonically, this zone is controlled by several regional structures. In the Pacific face of Costa Rica the subduction of the Cocos plate beneath the Caribbean plate, and the Panama Fracture Zone is the boundary between the Cocos and Nazca plates. In the Caribbean face, the northern edge of the North Deformed Panama Belt is the most remarkable structure. The Limon earthquake took place in April 22, 1991 (Ms7.6) in the Caribbean face of Costa Rica, 1991, with an epicenter located, 36 km SW of the Limon downtown, at 10 km depth (Plafker and Ward, 1992, Goes et al., 1993, Lundgren et al., 1993, Suarez et al., 1995). One of the most spectacular effects of this earthquake, was the coseismic uptlifting of the shoreline, ranging between 1,85 m and 0,75 m in the Limon area, and between 0.6 m and 0.5 m in the Cahuita-Gandoca area (Fig. 1). Inland deformation was calculated by surveying of tower lines of ICE (Instituto Costarricense de Electricidad) reaching around 4.5 m of uplifting (see figure). The occurrence of this earthquake put in evidence the stepping-way of Pleistocene land growing of the Caribbean side of Costa Rica, in relation to the action of the North Deformed Panama Belt. Due the presence of coral material in ancient uplifted platforms, it was possible to sample and survey in order to study the history of Holocene tectonic history. We mainly sampled Acropora palmata and Diploria clivosa coral species, same species that were exposed and died in 1991. The study was based on about 20 C-14 ages. The C-14 ages were calibrated and the nowadays elevation was corrected with the eustatic sea level curves. Based on the obtained data we determined the existence of a neotectonic secondary ENE fault in the Cahuita area, where the NW block relatively upped respect to the SE block. The average velocity of uplifting was determined as 1.75 mm/year through the Holocene.

References

Goes, S.D.B., Velasco, A.A., Schwartz, S.Y., Lay, T. 1993. The April 22, 1991 Valle de la Estrella, Costa Rica (Mw 7.7) earthquake and its tectonic implications: a broadband seismic study. Journal of Geophysical Research 98(B5): 8127-8142.

Lundgren, P.R., Konreich Wolf, S., Protti, M., Hurst, K.J. 1993. GPS measurements of crustal deformation associated with the 22 April 1991, Valle de La Estrella, Costa Rica earthquake. Geophysical Research Letters 20(5): 407-410.

Plafker, G., Ward, S.N., 1992. Backarc thrust faulting and tectonic uplift along the Caribbean Sea coast durin the April 22, 1991 Costa Rica earthquake. Tectonics 11(4): 709-718.

Suarez, G., M. Pardo, J. Domínguez, L. Ponce, W. Montero, I. Boschini, W. Rojas. 1995. The Limon, Costa Rica earthquake of April 22, 1991: Back arc thrusting and collisional tectonics in a subduction environment. Tectonics 13(2) 518-530.

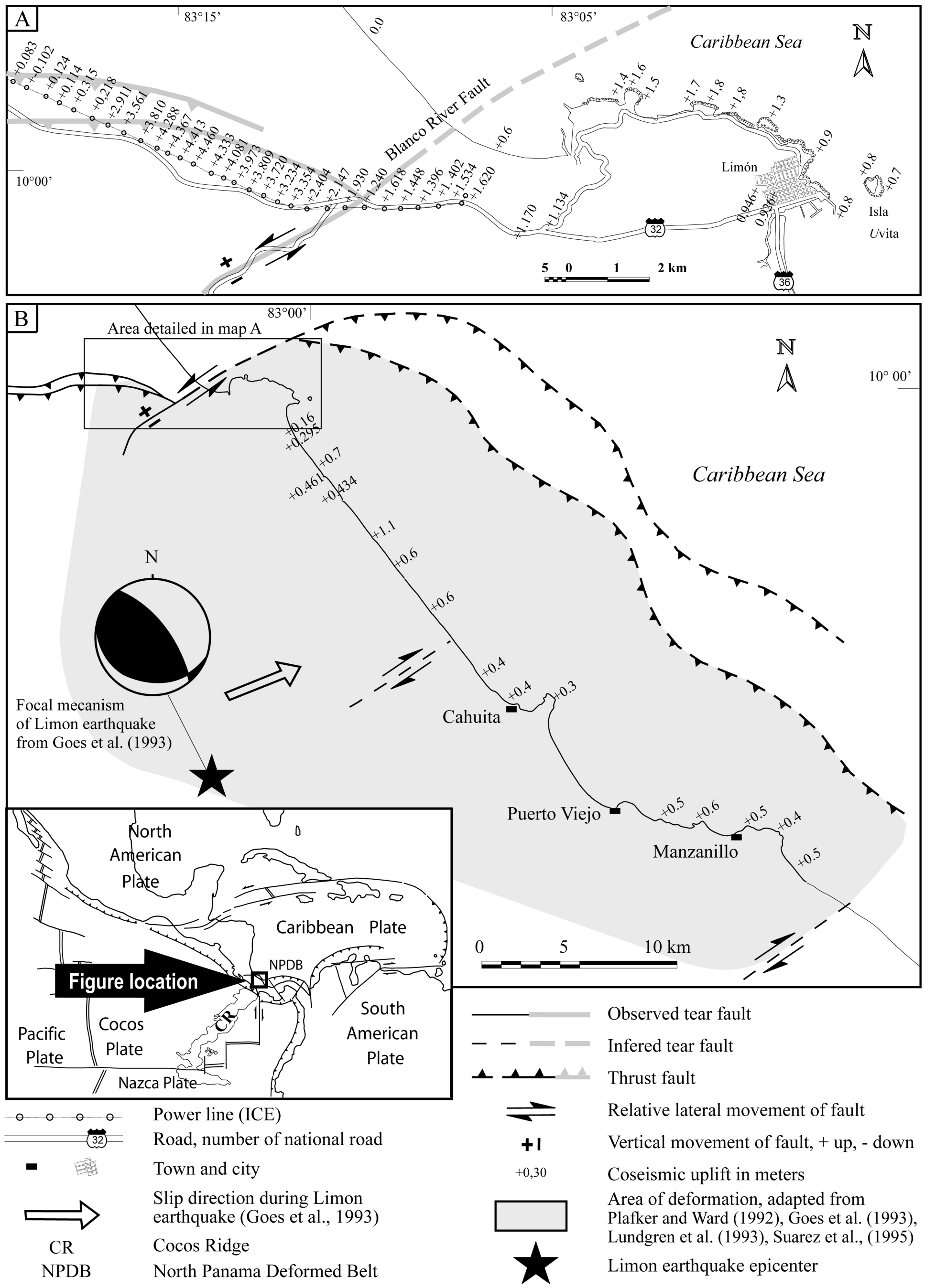


Figure 1: Limon earthquake coseismic effects. A: Detail of the area shown in map B, include the inland coseismic uplifting. B: General coseismic effects, including the shoreline uplifting. A tectonic location map is included in the left-button.

CT03 – Thu., 12.4., 10:50 - 11:10 · HSF

Wobbe, F., Stanek, K.P., Gloaguen, R. (TU Bergakademie Freiberg, Freiberg)

Applied geomatics in geomorphology: Tectonics from river profiles, case study, Oriente, Cuba

E-Mail: wobbe@geo.tu-freiberg.de

The thrusting of the Cuban Oriente block onto the Bahamas platform and the transform movement between the Caribbean and North American plate cause oscillating uplift in the east of Cuba, manifesting itself in tilted blocks, coral reef terraces and rivers cutting deep into the bedrock. Objectives of this work are to identify active tectonic boundaries and derive relative uplift rates in Oriente using power-law scaling relation between channel slope and contributing drainage area to obtain a more detailed picture of the tectonic processes of the study area.

Topographic data is provided in form of a SRTM and an ASTER DEM of the working area. Data is cross-checked with topographic maps and GPS measurements in the field. Further analysis comprises automatic extraction of the drainage network and catchment area after eliminating spurious pits and flats using the D8 method. The obtained longitudinal river profiles are evaluated with respect to breaks in scaling permitting the mapping of associated active tectonic boundaries. Shaded relief models are calculated and are used as basis for an interactive visual interpretation of terrain models with respect to lineaments. Lineaments are also digitized on screen from slope and aspect. Finally, they are compared to the results of the longitudinal profile analysis.

Data analysis shows an inhomogeneous distribution of relative uplift rates within the Cuban Oriente block. Detection and mapping of active tectonic boundaries canbe achieved at low cost and results are available rapidly. The results are in accordance with lineaments derived from geomorphological interpretation and seismicity. This method allows for the estimation of deformation over large areas, the localization, and the quantification of vertical displacements.

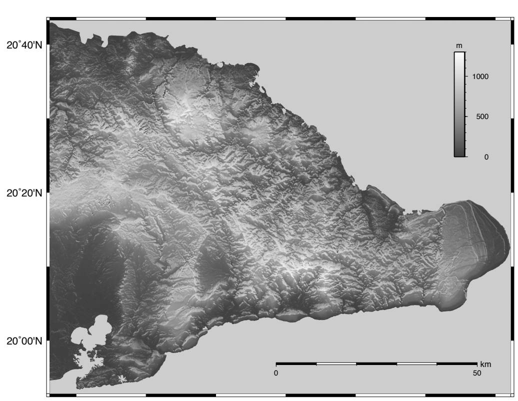


Figure 1: Shaded relief model of Oriente, Cuba derived from SRTM data.

CT04 – Thu., 12.4., 11:40 - 12:00 · HSF

Cobiella-Reguera, J. (Pinar del Rio, Universidad de Pinar de Rio, Cuba), Meschede, M., Hüneke, H., Sommer, M. (Greifswald, Institute of Geography and Geology, University of Greifswald, Germany)

Campanian to Eocene geological history of Cuba and surroundings of the northwestern Caribbean-SE Gulf of Mexico region

During the Late Cretaceous, the Mesozoic Protocaribbean oceanic plate was consumed in the Cuban sector of the Greater Antilles volcanic arc (GAA) until the Campanian. At that time, volcanic arc magmatism ceased along Cuba and the first clasts derived from the Protocaribbean ophiolitic suite accumulated on the Earth surface. From Late Campanian to Danian, Cuba and its surroundings were a collisionzone where the accretion of the GAA to the North American paleomargin occurred. Thick sections of Early Paleocene-Middle Eocene volcanic arc rocks in SE Cuba, the Cayman Ridge and Hispaniola? record an almost east -west trending volcanic arc, with a backarc basin to the north. The related circa 2000 km long northdipping subduction zone should act as the boundary between the early Cenozoic SE North America and the Caribbean plate. From the Paleocene to Middle Eocene, dense Caribbean lithosphere traveled northwards approaching to the subduction zone and diving in it. The location, strike and polarity of the proposed subduction Paleogene zone are very different from those described by other models that assume an E-NE traveling Caribbean plate with a volcanic arc and subduction zone in its northern leading edge, colliding firstly with the North American paleomargin in western Cuba and later with the Bahamas platform in central and eastern Cuba . Coeval with the volcanic arc, the Cuban Orogeny developed in western and central Cuba. During this tectonic event the northern ophiolite belt of Cuba and the Cretaceous volcanic rocks were thrusted tens of kilometers, onto the MesozoicNorth American paleomargin. Small piggyback basins filled with turbidites developed on top of the sheets whereas a foreland basin caught the sediments derived from the erosion of the northward moving tectonic units. In the Middle Eocene subduction stopped. Simultanously(?) a change in the regional stress field originated the near E-W trending sinistral Oriente fault zone, whose position and genesis were probably tied to the weakened hot crust located between the Paleogene volcanic arc axis and the vanished subduction zone. In the Middle-Late Eocene, an orogenic event was active in SE Cuba deforming the Paleogene volcanic arc rocks. Highlands developed south of the Oriente fault (the Bartlett land), accompained by strong erosion and northward transport of the resulting sediments.

CT05 – Thu., 12.4., 12:00 - 12:20 · HSF

Meschede, M. (Greifswald, Institut für Geographie und Geologie), Hüneke, H. (Greifswald), Cobiella-Reguera, J. (Pinar del Rio, Kuba), Sommer, M., Rabehl, S., Brust, J. (Greifswald)

Two-stage arc evolution of the Cuban orogenic belt

E-Mail: meschede@uni-greifswald.de

The Cuban orogenic belt records subduction, volcanic arc formation and accretion along the pre-Eocene NW leading edge of the Caribbean plate. A two-stage island arc developed with a change in subduction polarity from a SW dipping Cretaceous to a N-dipping Paleocene-Eocene volcanic arc. Five main tectonic units can be subdivided: (1) the North American paleomargin representing the passive margin of the North American plate during the Meszoic, (2) the ophiolite belt which apparently represent remnants of oceanic lithosphere that formerly separated the Cretaceous volcanic arc and the North American paleomargin, (3) a Cretaceous volcanic arc with S-dipping subduction polarity, (4) metamorphic complexes in Cuba (Escambray massif and Isle of Youth) which may comprise parts of a Middle to Late Cretaceous subduction-accretion complex, and (5) the Paleocene to Eocene „Turquino „volcanic arc with a N-dipping subduction polarity in Southern Cuba.

Collision between the Cretaceous volcanic arc and the North American paleomargin started in the Late Campanian leading to the formation of the Cuban fold-and-thrust belt. Strike-slip faults bound domains that display an eastward younging trend in the termination of the thrusting process. A north-dipping subduction zone was established in the back arc area of the Cretaceous volcanic arc during the Danian. The Cayman-Turquino arc developed where oceanic lithosphere of the Caribbean plate was consumed during the Paleocene until the Middle Eocene. The arrival of the Caribbean Large Igneous Province (CLIP) stopped the subduction and the relative northward movement of the Caribbean plate towards the North American plate. Sinistral transform faulting was initiated in its place along the east-west striking Oriente transform fault. This fault truncated the Cayman-Turquino volcanic arc and formed the present day northern boundary of the Caribbean plate.

CT06 – Thu., 12.4., 12:20 - 12:40 · HSF

Stanek, K.P. *(Freiberg), Maresch, W.V. (Bochum)*

The history of the Great Antillean Island Arc - example from Central Cuba

In the Lower Cretaceous, after the separation of the North and South American continental plates an intra-oceanic island arc has been formed by subduction along the Paleo-Pacific-Atlantic border line. Nowadays, remnants of this island arc were widespread throughout the Caribbean plate margins, recording the geotectonic history of the microplate. In the northern Caribbean the Greater Antillean arc (GAA) was thrust onto the southern edge of the Bahamas platform. In this process, large parts of the GAA have been exhumed and form the recent backbone of the Cuban main island. Up to now the early, pre-Tertiary development of the GAA and the related subduction- accretion complex was subject of various speculations about the age of the magmatism, type of subduction and the arc polarity. For the first time an integrated set of geologic, geochemical and geochronological data could be applied in Central Cuba. Similar to Puerto Rico the GAA in Central Cuba can be divided in a bimodal tholeiitic serie (Primitive Island Arc suite - PIA) and calc-alkaline to alkaline series. Geochemical data verify the increasing maturity from the tholeiitic to the calc-alkaline-alkaline series. U/Pb geochronology on zircon and titanite indicates the beginning of the subductionrelated magmatism at least in the Lower Cretaceous (110-104 Ma) continuing until the early Late Cretaceous (86 Ma). Based on only scarce data PIA-like igneous rocks can also occur in an fore-arc environment during the Middle Cretaceous. Ar/Ar cooling ages on volcanic and igneous rocks indicate an rapid uplift at least between 75-70 Ma. In the Upper Campaign the island arc was eroded and has been covered by platform-type sediments. At this time (74-72 Ma) small stocks of biotite granites intruded the uplifted arc. We suggest that the formation of these granites was related to the collisional crustal thickening. So the starting point of the collision between the GAA and the Bahamas/Yucatán sedimentary wedge could be dated about 10 Ma earlier than reported final thrusting in the Bahamas platform. The subduction-accretion complex of the GAA traces the northern suture line and crops out in dome like massifs in the hinterland of the thrust front. Various p-T-paths of HP-rocks give an impression of conditions of subduction during the onset, the island-arc formation and the collision. The p-T-t-d data set of a metamorphic nappe stack of the subduction-accretion complex supports the above presented geotectonic history of the GAA. The eastern part of the Escambray Massif in Central Cuba comprises at least four nappes, of which three indicate high-pressure (HP/LT) metamorphism and trace a former subduction-accretion complex. Boudins of eclogite and blueschistfacies rocks corroborate maximum conditions of 16-25 kbar and 580-630C. An island-arc unit (Mabujina unit - MU) with LP/HT metamorphism of 7 kbar at 620-700C was thrust over the HP-nappes. Late Cretaceous (88-81 Ma) granitoids crosscutting the sheared MU and foliated granitoids of the MU give a time of tectonicdeformation between 85-90 Ma. SHRIMP zircon ages of 170 Ma likely date the eclogite protolith and U/Pb, Rb/Sr and Ar/Ar data suggest a Middle to Late Cretaceous (106- 88 Ma) age for HP-metamorphism of the metasediments and eclogites, which originated off southeast Yucatán. The origin of the subducted rocks, the arc polarity, the timing of metamorphism, and preliminary paleomagnetic data support a Pacific origin for the Cretaceous Great Antillean island arc and its final exhumation together with the subduction-accretion complex in the Caribbean, along the southwestern edge of the Bahamas platform.

CT07 – Thu., 12.4., 12:40 - 13:00 · HSF

Krebs, M., Maresch, W.V., Schertl, H.-P. (Ruhr-Universität Bochum), Draper, G. (Miami, Florida International University)

Fossil petrological evidence (Rio San Juan Complex, Dominican Republic) and numerical simulation yield analogous histories for the Great Arc of the northern Caribbean

The well-preserved fossil collision zone in the Rio San Juan complex (RSJC) of northern Hispaniola provides an excellent opportunity for studying the dynamics of this part of the intra-oceanic Great Arc of the Caribbean from $\sim$ 120 Ma to at least 55 Ma. The innumerable blocks of metamorphic rocks entrained in the serpentinite mélanges of the RSJC allow pressure-temperature-time paths of mass flow to be delineated in the subduction zone channel of the Great Arc. Comparison with paleogeographic reconstructions on the one hand and with numerical models available for this relatively straightforward intra-oceanic subduction geometry on the other provides a multi-method approach for arriving at a coherent dynamic history of this part of the Greater Antilles island arc.

Comprehensive petrological and geochronological data have been obtained on a suite of various metamorphic rocks, primarily eclogites and blueschists, that allow the dynamics of mass flow to be reconstructed over the above time span of 65 m.y. Krebs et al. (2007) have recently summarized exemplary pressure-temperature-time paths that allow a series of different but interrelated pressure-temperature-time paths to be delineated that clearly show the uninterrupted, gradual thermal evolution of the subduction zone. Eclogites indicate a low P/T gradient during subduction and record conditions in the nascent stages of the subduction zone. Lu-Hf data yield 103.6 $\pm$ 2.7 Ma for peak metamorphic conditions of 23 kbar / 750°C. An anticlockwise P-T path is defined. Other blocks record the continuous cooling of the evolving subduction zone and show typical clockwise P-T-paths. Omphacite blueschists reach maximum P-T conditions of 17-18 kbar / 520 °C at 80.3 $\pm$ 1.1 Ma (Rb-Sr age data). The mature subduction zone is typified by jadeite blueschists recording very high (´´cold´´) P/T gradients. A Rb-Sr age of 62.1 $\pm$ 1.4 Ma dates peak metamorphic P-T conditions at 16-18 kbar / 340-380 °C. The array of P-T-t data allows overall cooling rates of the subduction zone at depths of c. 60 km to be constrained at 9°C/Ma. Cooling rates and exhumation rates (i.e., vertical component of retrograde trajectories) of the metamorphic blocks are 9-20 °C/Ma and 5-6 mm/a, respectively.

The derived P-T-t array is compared with a 2-D numerical subduction-zone model published by Gerya et al. (2002; 45°slab dip, 40 Ma lithosphere age, convergence rates of 10 - 40 mm/a), which incorporates weakening of lithospheric mantle of the hanging wall by fluids emanating from the downgoing slab, resulting in an increasingly more funnel-shaped subduction channel system with time. The numerically derived array of simulated P-T-t paths as well as the calculated rates of exhumation and cooling agree well with the P-T-t data derived from the metamorphic blocks of the Rio San Juan serpentinite mélanges when convergence rates of 15 to 25 mm/a are chosen. This value is also in excellent agreement with available paleogeographic reconstructions calling for a long-term average of 22 mm/a of orthogonal convergence. On the basis of the comparison, the onset of subduction in the Rio San Juan segment of the Caribbean Great Arc can be constrained to approximately 120 Ma. This segment was thus obviously active for more than 65 Ma. An orthogonal convergence rate of 15 - 25 mm/a requires that a minimum amount of 975 - 1625 km, respectively, of oceanic crust must have been subducted. Both petrological/geochronological data and numerical simulation underscore the broad spectrum of different P-T-t paths and peak conditions recorded by material subducted at different periods of time as the subduction zone evolved and matured.

Gerya, T.V., Stöckhert, B., and A.L. Perchuk, 2002. Exhumation of high-pressure metamorphic rocks in a subduction channel: A numerical simulation. Tectonics 142, 6-1-6-19.

Krebs, M., Maresch, W.V, Schertl, H.-P., Baumann, A., Draper, G., Idleman, B., Münker, C., and E. Trapp. 2007. The dynamics of intra-oceanic subduction zones: A direct comparison between fossil petrological evidence (Rio San Juan Complex, Dominican Republic) and numerical simulation. Lithos, in press.

CTP01

Dominguez, L. (Geology Department, Higher Institute of Mining and Metalurgy of Moa, Cuba), Stanek, K.P. (Institut für Geologie, TU Bergakademie Freiberg), Wobbe, F. (Institut für Geologie, TU Bergakademie Freiberg), Gloaguen, R. (Institut für Geologie, TU Bergakademie Freiberg), Rodríguez, A. (Geology Department, Higher Institute of Mining and Metalurgy of Moa, Cuba)

Neotectonics of Eastern Cuba from remote sensing geomorphological analysis

The Eastern part of Cuba (Oriente block) is characterized by high geological and tectonical complexity. Horizontal displacements are caused by the opening of the Cayman trough and the transform movements between the Caribbean plate and the North American plate since the Middle Eocene-Late Eocene. Recently, vertical movements generate horst and graben structures along this plate boundary. The oscillating uplift of the eastern part of Oriente has been marked by the development of peneplains and coral reef terraces since Miocene. Active seismicity attests the still on-going deformation on thispart of Cuba as witnessed by recent neotectonic movements and geomorphological features. The present work is based on the application of geomorphological methods on newly generated Digital Elevation Model and using specific images processing in the Baracoa-Yamanigüey coast zone, located on the northern part of Oriente. The mapping has been carried out using topographic maps and high-resolution orthorectified satellite data in order to understand the majorvariations in morphology. Ground truth was acquired during several field seasons. Morphological analysis reveals important details of the landscape structures as well as the tectonic movements. The quantitative analysis of the drainage system, topographic and river profiles was also conducted. Geomorphological and morphometrical data allows us to get an insight into the evolution of the landforms and the relationship between tectonics and external coastal processes. We determined and mapped the principal active structures in this zone. We identified three morphological systems. The first system with principal direction SE-NW and NE-SW originates from the development of collisional processes between the Bahamas margin and units of the Cretaceous volcanic arc, as well as the beginning of the collision between the Caribbean plate and the North American plate. The second system is associated with the development of new plate boundaries in the Caribbean, which started moving towards the east, causing the N-S tectonic collision to stop in Cuba. This system is related with the recent vertical movements. They are also related to the neoplatformic stage. The third system is characterized by horizontal displacements. This system is originated by the opening of the Cayman trough and the transform movements between the Caribbean plate and the North American plate.

CTP02

Orozco, G. (Moa, Professor)

FIRST RECORD OF PHILLIPSITE AND ANALCITE IN TUFFS OF THE FARALLONES REGION, MOA, EASTERN CUBA

The region of Caimanes-Farallones, Moa, eastern Cuba, is known for the presence of natural zeolites. Here clinoptilolite is dominant in green tuffs included in the Sabaneta Formation (Early Tertiary) and is interpreted as an alterationproduct of volcanic glass (Orozco, 1996). Subordinately, some mordenite is also present. In this contribution, the occurrence of the zeolite-group minerals phillipsite and analcite is reported for the first time from this region, based on zeolite analyses by X-ray diffraction, SEM and polarized-light microscopy with a top-set digital camera.

Phillipsite and analcite occur within brown tuffs interbedded within the green tuffs. These brown tuffs mainly crop out in the community of Farallones, approximately 30 km SW of the city of Moa. Apart from phillipsite and analcite, the brown tuffs also contain montmorillonite. In contrast to the zeolitized clinoptilolite-rich green tuffs, the brown ones are presumed to be compositionally more basic. This would point to a compositional bimodality of the two tuffs and will be a matter of further studies. Until today, the presence of analcite in the Sabaneta Formation has only been reported from outcrops in the town of Sabaneta, south of Sagua de Tánamo (Orozco, 1987).

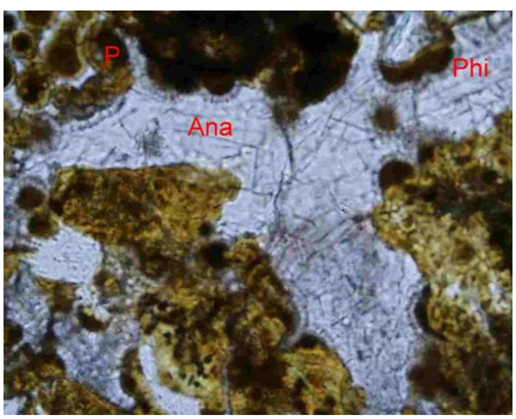


Figure 1: Porous space with phillisite and analcite

Based on these studies, the possibility of mining and practical use of the zeolitic tuffs in the Caimanes-Farallones region can be envisaged.

EN

Environment, Climate and Landscapes

EN01 – Wed., 11.4., 11:10 - 11:30 · HSK

Zech, R. (Bern, University of Bern), Kull, Ch. (Bern, PAGES IPO), Kubik, P.W. (Zurich, Institute of Particle Physics, ETH), Veit, H. (Bern, University of Bern)

Glacial chronologies along the Andes (15-40°S) based on 10Be Surface Exposure Dating

E-Mail: `roland.zech@giub.unibe.ch`

The Central Andes in South America are a key region for the reconstruction of paleoclimatic conditions during the Late Quaternary, because they mark the transition zone between the tropical and the extratropical atmospheric circulation system. Any changes in the position and intensity of the westerlies, as well as changes of the South American Summer Monsoon (SASM), should therefore be recorded in paleoclimate archives. As glaciers are sensitive to temperature and precipitation, moraines provide valuable information about past climate conditions. We applied 10Be Surface Exposure Dating on moraines along a N-S transect from Bolivia (∼15°S) to the Chilean Lake District (∼40°S), in order to determine timing and extent of the last glaciation.

In the Cordillera Real and the Cordillera Cochabamba, Bolivia, exposure ages indicate that glacial advances occurred at ∼20 ka ago and again at ∼12 ka. We suggest that reduced temperatures played an important role in triggering the glacial advances. Precipitation was probably not a major limiting factor. To the west and to the south, in the rain shadow of the Cordillera Occidental, glaciers become more precipitation-sensitive and advanced synchronous to lake transgressions phases, i.e. during the Late Glacial (Tauca and Coipasa). There is no evidence for glacial advances during the global LGM (Last Glacial Maximum: ∼20 ka). Exposure ages from northern Chile at ∼30°S (15-12 ka BP) indicate that glacial advances were probably still triggered by increased tropical precipitation, but a more extensive glaciation could be dated to ∼30 ka. This earlier advance clearly predates the LGM and is attributed to increased moisture advection from the Pacific. We tentatively suggest a northward shift and/or an intensification of the westerlies at that time. In the Valle Rucachoroi (39°S, Argentina) the most extensive moraine also dates to ∼30-35 ka. Apparently, conditions were too dry to trigger significant glacial advances during the LGM. Valleys became ice-free, however, only by ∼15 ka, which we interpret as evidence for rapid warming. A minor re-advance may have occurred at ∼11 ka, probably indicating a short temperature reversal just before the beginning of the Holocene warm conditions. Only south of ∼40°S, the westerlies seem to have provided sufficient moisture throughout the past to allow local LGM advances being triggered by low temperatures (i.e. ∼20 ka).

Ongoing research has tosolve controversial issues, like e.g. the selection of the scaling system used for the exposure age calculations (to account for the latitude and altitude dependence of the cosmic radiation) and the reference production rate. Hitherto unrecognized systematic uncertainties are especially large in Bolivia and are responsible for the apparent disagreements with previously published glacial chronologies suggesting an early local LGM in the tropical Andes (∼30 ka) and readvances at ∼17 ka.

EN02 – Wed., 11.4., 11:30 - 11:50 · HSK

WALDE, D.H.G., GONZAGA, G.M. (Brasilia)

EDIACARIAN ALTITUDE GLACIATION RELATED TO THE BRASILIANO EVENT IN BRAZIL

E-Mail: detlef@unb.br

It is important to distinguish between two glacial events in the Neoproterozoic: one of continental nature (∼750 Ma) and a later of altitude, related to different tectonic stages of the Brasiliano event in the Ediacarian that may extend to the early Cambrian.

The multiple depositional cycles related to asynchronism of the evolution of the many Brasiliano belts originated multiple glaciogenic deposits, asynchronous and without large lateral continuity which hinders an automatic correlation.

Most of the edicarian glaciogenic deposits are glacio-marine as the continental facies are eroded more easily. This leads to the more frequent occurrence of reworked deposits like turbidites. Banded iron formations associated to cold waters and phosphorites associated to hot waters are frequent and characteristic of these deposits.

Intercalation of carbonatic and other non-glaciogenic rocks are frequent and occur associated to non-glacial intervals and paleogeography which is not influenced by altitude. The intensity of the glacial events varied considerably in relation to the temporal and geographic variation for more than 70 Ma.

The ideas presented in here are a development of the works of Gonzaga (2001) and Walde & Gonzaga (2005a, b, c), which point to the inexistence of a „snowball earth“, idea which has been recently admitted by many researchers as Olcott et al (2005) and Kaufman et al (2005). We have suggested this model for the Brasiliano Event in South America; however, Bertrand-Sarfati et al (1987) had already suggested a similar model to the Pan-African event in Africa.

References

Bertrand-Sarfati J., Moussine-Pouchkine A. and Caby R. 1987. Les correlations du Protérozoïque au Cambrien en Afrique de L'Ouest: Nouvelle Interprétation Géodynamique. In: Bull. Soc. Géol. France, 8. III: 855-865.

Gonzaga G.M. 2001. Glaciação Samburá (Neoproterozóico - Vendiano?) como possível agente transportador de diamantes no Estado de Minas Gerais. Rev. Bras. Geoc.,31(4):597-604.

Kaufman, A. J., Olcott, A., Sessions, A., Brody, K.B., Eigenbrode, J., Cody, G., Geboy, N., Williams, B., Corsetti, F.A., Oliveira, T.F., Azmy, K. and Misi, A. 2005. Biomarker and stable isotope evidence for extreme productivity associated with Neoproterozoic glaciation on the São Francisco Craton. In: III Simpósio sobre o Cráton do São Francisco. Salvador. Anais. pp 274-278.

Olcott, A.N., Sessions, A.L., Corsetti, F.A., Kaufman, A. J. and Oliveira, T.F. 2005.
Biomarker evidence for photosynthesis during Neoproterozoic glaciation. Science, 310: 471-474.

Walde D.H.G. and Gonzaga G.M. 2005a. Neoproterozoic Glaciation in Brazil related to the Brasiliano Orogeny: discussion and model. 19th Colloquium on Latin American Geosciences. Potsdam. Abstract. P 138.

Walde, D.H.G. and Gonzaga, G.M. 2005b. Evidence of a second glacial event during Neoproterozoic in Brazil: Selected examples. In:X Simpósio Nacional de Estudos Tectônicos (SNET). Curitiba. Boletim de Resumos Expandidos. Pp 294-296.

Walde, D.H.G. and Gonzaga, G.M. 2005c. Evidence for mountain glaciation events in the Brasiliano Fold Belts surrounding the São Francisco Craton. In III Simpósio Sobre o Cráton do São Francisco. Salvador. Anais. pp 303-305.

EN03 – Wed., 11.4., 11:50 - 12:10 · HSK

Rondanelli, M. (Los Angeles,CHILE)

Palynological characteristics of sea bottoms associated to glacier retreat in chilean western Patagonia

E-Mail: mrondane@udec.cl

Samples of tidewater glaciers collected by scientific cruise R/V Palmer (USA) in 2005, in the proximities of San Rafael glacier (Northern Ice Fields) 46º S, Pinguinos glacier (Southern Ice Fields) 51º S and Marinelli glacier (Darwin Range, Tierra del Fuego) 54.5º S were palynologically analysed so as to contribute to the understanding of glacier dynamic behaviour in the far south of South America. This study is part of a National Science Foundation project (Controls of Sediment Yields from Tidewater Glaciers from Patagonia and Antarctica) conducted by american researchers Dr. B. Hallet from University of Washington and Dr. J. Anderson from Rice University on the linkages between glacier climate and erosion; a study which is based on current debate - from a glaciological perspective - on how erosion influences orogenetic processes and how glacier sediment sequences exhibit climate variability. Sediment samples taken from the ecosystems of San Rafael, Pinguinos and Marinelli correspond with glacier environments that are present in the western area of the far south region of South America. Through a phenomenological approach, this palynological study aims to interpret the historical changes these ecosystems have undergone in association with the dynamic retreat of glaciers. Preliminary results of the research, centred on the most superficial levels of each one of the three core samples, show, in a latitudinal sense, a temporary retreat of the presence of plant elements in the sediments, from the most northern (San Rafael glacier) to the most southern (Marinelli glacier) ecosystems. Samples from San Rafael ecosystem exhibit extremely poor palynological evidence; however, they are not sterile. There is evidence of Myrtaceae, Fagaceae and Monimiaceae pollen. Farther south, the ecosystem of Pinguinos reveals a scarce palynological component and usually quite distorted that shows presence of Poaceae, Cyperaceae and Asteraceae. Attention should be paid to the fact that in contrast to San Rafael ecosystem, where the vegetation component is associated with Valdivia temperate-rain forests, Pinguinos exhibits mainly a prairie ecosystem. Marinelli glacier, in the far south area of the continent, reveals abundance of pollen and a larger variety of species, Nothofagus being the dominant one. There is evidence of Podocarpaceae of the Lephidothamnus fonkii type, coniferous tree characteristic of humid and cold opened forests.

EN04 – Wed., 11.4., 12:10 - 12:30 · HSK

Wallner, J. (FSU Jena), Abarzúa, A.M. (UACH Valdivia), Brückner, H. (PU Marburg), Daut, G. (FSU Jena), Schellmann, G. (OFU Bamberg), Mäusbacher, R. (FSU Jena)

Late Glacial/Holocene Landscape Evolution at Lago Budi, Chile (38,9°S) - Paleolimnological and Paleoseismical Investigations on Lake Sediments -

E-Mail: john.wallner@uni-jena.de

The coastal lagoon Lago Budi (73°17´W, 38°52´S; surface: 52 km2, no major affluents), approx. 100 km north of Valdivia/Chile, is actually connected to the Pacific Ocean by a less than 500 m wide ephemeral channel. In contrast to the numerous lakes of the adjacent Andes main cordillera formed by glaciers, the probably fluvial genesis of Lago Budi is considered to have been controlled by tectonic factors (e.g. earthquakes) interacting with glacio-eustatic sea-level changes. Lago Budi provides an excellent geo-archive since it has served as a natural sediment trap for past tsunami events that have hit the South Pacific coasts. Furthermore, it exhibits an ideal marker for relative sea-level changes during the Holocene.

The aims of this study are: (i) origin, age and landscape evolution of Lago Budi; (ii) identifying and dating former earth-/seaquakes by using characteristic tsunamigenic sediment layers; (iii) palynologic reconstruction of vegetation and climate history outside the glacial area of the southern Andes.

After a hydro acoustic survey (4-12/100 kHz) several sediment cores were taken from Lago Budi and its shores with lengths of up to 15 m. Sedimentological (grain size, bulk-/clay mineralogy, magnetic susceptibility) and geochemical analyses (CNS, main elements, biogenic Si, P), supported by several AMS-14C data, were achieved to determine the history of the landscape evolution. Transfer functions via diatoms, foraminifera or mollusc fragments were used to decipher the environmental milieus of deposition and their changes.

The deepest core segments consist of consolidated silts and sands of probably terrestrial origin with infinite 14C ages (>41,2 ka BP, >46,9 ka BP). After an erosive unconformity, which supports a link of the system to a lower erosive base level during the Last Glacial stage, terrestrial sediments were deposited around 10,3 ka BP; they contain layers with a high amount of floral macro remains (trunks, leaves). Between 8,1 and 7,0 ka BP the foraminifera and diatom association documents a first marine ingression. In the central part of Lago Budi it persisted at least until 4,9 ka BP when brackish conditions evolved and nearly contemporaneously a climatic transition to rather warmer and drier conditions occurred. The diatom association shows no pronounced freshwater phase until recent times.

At least two catastrophic tsunami events were identified in the Lago Budi sediments which occur in the younger Holocene for the first time. These striking layers are intercalated in the middle and upper core sections. They are blackish grey medium to fine sands consisting of several up to 2 cm thick sterile strata with clear normal gradation. They show a definite unconformity to the underlying stratum. Up to now accurate AMS-14C data for the single tsunamigenic layers are still outstanding.

These data show, that tsunami waves did not reach the Lago Budi basin before the younger Holocene, although a connection to the Pacific existed. This may be due to a pre-existing coastal morphology, that shielded the potential tsunami impacts and/or due to an exceeded distance between the lagoon and the Pacific Ocean. The latter implies noticeable morphologic coastal changes since the sea level raised to the actual position.

Preliminary results of the palynologic investigation reveal evidence for early human settlements in the study area at least since 5 ka BP.

EN05 – Wed., 11.4., 12:30 - 12:50 · HSK

Cristofolo, V. (UNIMONTES), Horn, A. H. (NGQA-CPMTC-IGC-UFMG), Baggio, H., Trindade, W., Velozo, E. (UNIMONTES), Figueiredo, W. (NGQA-CPMTC-IGC-UFMG)

HIDROGEOCHEMICAL AND ENVIRONMENTAL STUDY OF VEREDAS, FORMOSO RIVER, DISTRICT OF BURITIZEIRO, MINAS GERAIS, BRAZIL. THE ECOSYSTEM OF THE CERRADO.

E-Mail: hahorn@ufmg.br

The district of Buritizeiros is located in the Northwest part of Minas Gerais State, in the upper to middle São Francisco basin, draining an area of approximately 826 km2. The access to the area is made by the federal road BR-365 and BR-496, and state road system MG-161 and MG-408. The relief is characterized by extended plateaus with deep eroded courses of the fluvial system and is compartmentalized by two great units: São Francisco Plateaus and Sanfranciscana depression with their morphologic variations, due to de differences in litology, morphology, topographical position and erosive reworking. Wide and extensive coverings of cretaceous rocks occupy the top of those planed mountains formed by erosion of the tributaries of the São Francisco river. Those coverings were deposited by the action of fluvial-atmospheric systems that marked the complete closing of the Sanfranciscana Basin during the Superior Cretaceous. The São Francisco plateau is formed by tabular relief, predominantly by arenític rocks (s. l.), covered by savannah type vegetation, the so named Cerrado, and is interrupted by a flat disperse drainage system, known as Veredas. This are a peculiar humid subsystem, found in the Biotope Cerrado and grew under very defined and limited conditions of humidity, temperature, vegetation, including the buriti (Mauritia vinifera) typically together in buritizais, an important ecological factor for groundwater renovation contributing to the important Brazilian Basins (e. g. Amazonas, São Francisco; Rio Grande), and an important esthetic ensemble of paisagístic and turistic value, inserted in the Sub-basin of the Rio Formoso. In these areas of the Biotope Cerrado occur a recent strong expansion of the human activities like forestry and agriculture (s. l.) carting an uncontrolled exploration of the natural and environmental sources. These expansion of the agriculture, the so called Aricultural Frontiers of Brazil, is causing enormous modifications in the Geotopes of the Cerrado area. The volume and the intensity of these activities affect directly and very negatively the water resources, in quality and quantity, altering the environmental and biological state of the Veredas putting them in permanent risk. This work understand the study of the physical, biological and socioeconomic factors and parameters of the Sub-basin of Rio Formoso, establishing relationships among physiochemical parameters chemical results, total tenors of heavy metals and important elements (Cu, Cd, Cr, Ni, Pb, Zn, Fe, Al, Mn, Mg), trying to improve the understanding of dynamic cycles, the effects of human interference in relation to changes of these natural geodynamic cycle of the Veredas. The identification and evaluation of the changes of the chemical and physical parameters and of the metals content in the sediments is based on the values established by the CONAMA Resolution no. 357/2005 and the Canadian Sediment Quality Guidelines - CS and QGs. 45 representative Veredas were selected with different characteristics and degree of human interaction. In these Veredas were investigated in several field campaigns taking the following parameters for trying to obtain the actual situation of quality of the Veredas: altitude, geomorphology, agricultural environment, form, depth, water content (permanent-seasonally- dry), chemical-physical parameters and determination of selected elements in the water, sediments and soils. This may contribute to the development of an intensification of geo-ambiental researches contributing to the recovery and preservation of this important humid subsystem inserted in the Cerrado

Biome. RESULTS: The primary constitution of the Veredas is mainly fixed by litogeopedologic parameters acting in the environment of the Cerrado, determining the form, orientation, depth, sediment type, quality and quantity of water. With the intensification of the human activities occurs a negative and significant alteration in these natural patterns. Contamination with heavy metals was observed in areas close to plantations and forestry activities showing correlation with the seasons, higher in the summer and lower in the winter, probably caused by variations of intensive use of agrochemicals. A correlation between the distance of the farming activities and the negative alterations in the quality of these waters (pH, color, turbidity, composition) was determined, once again of seasonal stamp. The pH varies more in the summer than in the winter as well as the temperature, the oxidation and the organic/inorganic load of the water. The presence of high tenors of Al is partially an effect caused by extensive deforestation of large areas, showing intensive entrance of argillite-minerals in the Veredas and water courses. The tenors of Fe and Mn, initially from a natural lixiviation of the Fe-Mn-rich soils and rocks of the Areado Group, increased significantly with the human influence and the pH alterations caused by. The fine, medium and coarse detritic material deposited in the Veredas, is coming from natural fluvial erosion and human activities, too, and has changed the granulometric profiles of Vereda-sediments. Actually the principal sources are areas of deforestations, burning, preparation of soil and pastures. The coarse sediments are transported by water and the fine ones are originating from air transport, altering the morphologic features of the Veredas, reducing the depth and changing their form. This effect is very visible in the lower part of the basin, which belongs to the flood plain of Sã Francisco River. Colorless and limpid water, formerly normal in the Veredas, now is limited to areas with low human influence and strong presence of remaining primary vegetation. At the majority of the Veredas the coloration of the analyzed water presents a reddish-yellow coloration, related with the high iron oxide and hydroxide content, linked to the fine material in suspension brought by wind and rain from the increasing denuded agriculture areas. It was also possible to establish a clear correlation between the physiognomic alteration of the Veredas and the changes in quality and quantity of their water with the increase of the presence and the human activities in the area. For an easier evaluation of the Vereda quality, the dynamic and a better quantification of the human impact, a code using numbers to identify several important factors in the alteration of the Veredas was created.

EN06 – Wed., 11.4., 12:50 - 13:10 · HSK

Silva, A.G.A., Pereira, B.R.B., Plácido, J.S., Vital, H. (Natal-UFRN)

Space-Time variations of the Presídio's Barrier Island, NE Brazil

E-Mail: `andregiskard@hotmail.com`

Modern barrier islands are the most expensive and most vulnerable of all coastal environments. Pressure from developers for residencial, industrial, and recreational development has caused most of our barriers to become significantly impacted by human activity (Davis Jr, 1994). This paper brings a short term analysis of the importance which barrier islands plays in the coast protection and erosion. The Presidio's barrier island is located on the coast of the Guamare City, Rio Grande do Norte State-Brazil, and comprises 8.018,15 m of shoreline (fig. 1). This area is situated on a very dynamic coast which is subjected to a strong westward littoral drift (Vital, 2005; Vital and Guedes, 2006; Silveira et al, 2006). The shoreline at this region has an East-West direction, as well has the barrier island.

This barrier island is inserted on the Potiguar Basin, which underwent a complex evolution, merging elements from both the Equatorial and the Southern Atlantic tectonic zones. It includes an offshore segment with an area of about 27.000 km^2 and an onshore segment that covers 22.000 km^2 (Milani and Thomaz Filho, 2000). This basin is the most productive oil basin onshore in Brazil, and the second most productive offshore (Soares et al, 2003). The NE-SW oriented rift-valley which forms the basin consist of four half grabens (Matos, 1992) separated by basement highs.

This paper uses satellite images (CBERS, which has 20m spatial resolution,) to trace the evolution of the coastline in an annual temporal scale of the West extremity in the Presidio's barrier island. The methodology used was according to Grigio et al, 2005). Analysis has concentrade on the years 2004, 2005 and 2006. The results are very interesting in that the evolution of the coastline shows a longitudinal progradation in the West direction of 673,72 m (fig. 2). Between 2004 and 2005 was observed a decrease in the area of the island of 10,930.48 m^2. On the other hand, between 2005 and 2006 was measured an increase of 49.265,45 m^2 in the barrier island area. Therefore, within the period from 2004 to 2006 was observed in the Presidio's barrier island, and increase in land area of 38.334,97 m^2. The sediment which were trapped to provide the increasing in island area, it is believed to had been brought by the down drift of the longshore current and sediment reworking from the own island.

However, thebarrier progradation to West, acted erosionaly on the adjacent shoreline, in which was observed a severe shoreline retreat. The total retreat of the shoreline from 2004 to 2006 was 133,03 m (fig. 2).

Figure 2: Shoreline variation of the Presidio's barrier island from 2004 to 2006. This

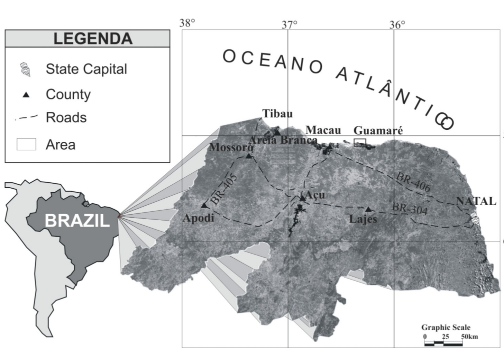


Figure 1: Studied area location

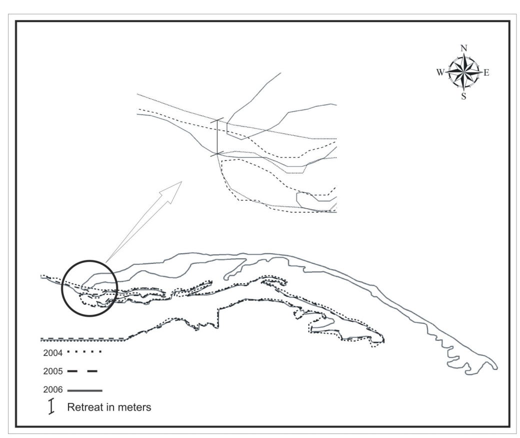


Figure 2: Shoreline variation of the Presidio's barrier island from 2004 to 2006.

severe retreat was attributed to the closure of a tidal inlet due to the growth of the Presidio's barrier island to the West direction. This shortening of the tidal inlet provided an increase on the ebb- and flood-tidal currents, which increased the fluid capacity to put into transportation coarser sediments. This situation will continue until the complete connection of the barrier island with the main land, closing completely the tidal inlets. If this not happen, then the shoreline will continually retreating until reach the complete stabilization of the system.

REFERENCES

Davis Jr, R.A. 1994. Geology of Holocene Barrier Island Systems. New York. Springer – Verlag, 464p.

Grigio, A.M., Amaro, V.E., Vital, H., and Diodato, M.A., 2005, A method for coastline evolution analysis using GIS and remote sensing – a case study from the Guamaré city, northeast Brazil: Journal of Coastal Research, v. 21, p. 396–405.

Matos RMD (1992) The Northeast Brazilian Rift System. Tectonics 11:766-791 Milani, E.J., Thomaz Filho, A. 2000. Sedimentary Basins of South America. In: Cordani, U.G., Milani. E.J., Thomaz Filho, A., Campos, D.A. (eds) Tectonic Evolution of South America. RJ. 31st International Geological Congres. 389–449.

Silveira, I. M., Vital, H., Amaro, V. E., Sousa, M. E., and Chaves,M. S., 2006, The Evolutionary Study of Environmental Conditions of The Guamare Coast (Northeastern Brazil): Journal of Coastal Research, Special Issue, v.39, p.237—241.

Soares, U.M., Rosetti, E.L., Cassab, C.T. 2003. Bacia potiguar. Phoenix. Fundação Paleozóica Phoenix, 56:0–13.

Vital, H., 2005, Erosão e Progradação no litoral do Rio Grande do Norte, in Muehe, D., ed., Erosão e progradação do litoral brasileiro. Brasilia, Ministerio do Meio Ambiente, p.159–176.

Vital, H., and Guedes, I.M.G., 2006, Erosion of areas of oil and gas exploration along the coast of northeastern Brazil: the Guamaré hotspot, in Brebbia, C.A.. ed., Environmental Problems in Coastal Regions VI including Oil Spill Studies: Wessex Institute of Technology, Cambridge Printing, Great Britain, p. 175–182.

ENP01

Denyer, P., Cardenes, G. (San Jose, School of Geology, University of Costa Rica), Kruse, S. (Tampa, Department of Geology, University of South Florida)

Historical coastal evolution of the Puntarenas sand bar, Costa Rica

E-Mail: `pdenyer@geologia.ucr.ac.cr`

Puntarenas sand bar is part of an estuarine system, the Nicoya Gulf, which is located in the northern pacific side of Costa Rica, in the western side of the Barranca River (Fig. 1). The Puntarenas sand spit appears in maps from the XVIII century. The spit is 600 m-wide, 7 km-long trends E-W with an average elevation of 3 m above sea level. A geomorphologic analysis of historical maps and aerial photographs reveal systematic growth of the spit over the past 137 years (Fig. 2). The sand bar shows lateral growth in the western edge of the spit, known as La Punta. The spit growth ceased 50 years ago with the onset of coastal engineering developments as dragging and frames, which were made to protect the population infrastructure. Based on previous photogeological and geophysical studies and new geophysical surveys we identify two paleochannels, in the right marginof the present position of Barranca river channel, between Puntarenas sand bar and the mouth of the river. We infer a NW to SE migration of the Barranca channel, driven by neotectonic activity on the Barranca fault. The lateral growing rate of the Puntarenas spit for the period 1860-1945 (prior to human control) was 14 m per year; extrapolating this rate back in time yields an origin for the spit approximately 500 years

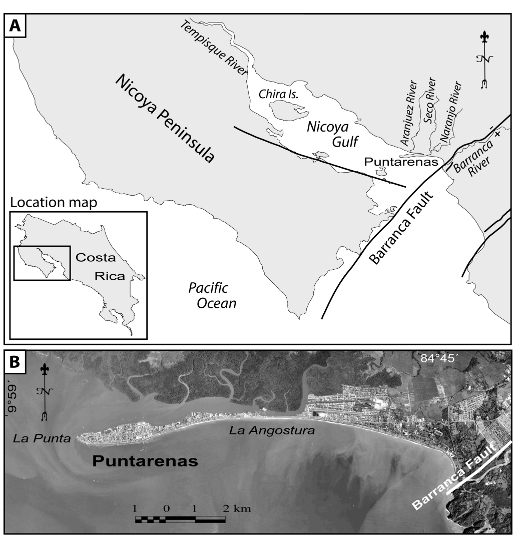


Figure 1: A: Estuarine system of Nicoya Gulf. B: Puntarenas sand bar (aerial photograph, TERRA project, 1997).

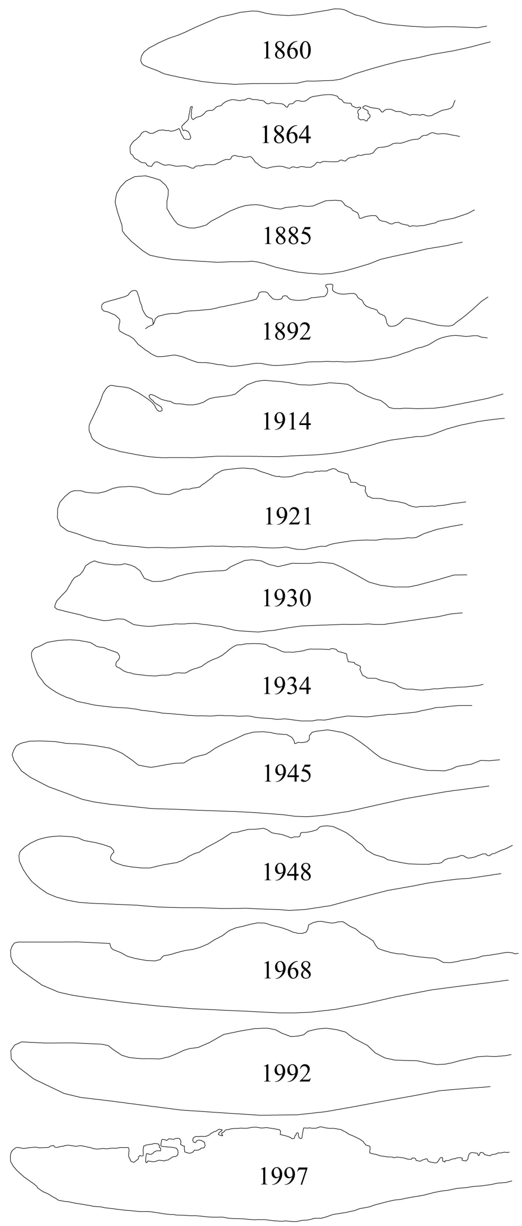


Figure 2: Morphologic reconstruction of the Puntarenas sand bar from 1860 to 1997.

ago.

ENP02

Garcia, R. (Popayan)

PRE-EL NIÑO PHASES IN NORTHWESTERN ANDES

E-Mail: rgarcia1945@yahoo.es

Rainfall in pre-El Niño phases is analized in three areas of northwestern Andes (SW Colombia) with similar rainfall regimes but different topographic and humidity conditions: subhumid lowlands of an interandean valley, humid edge of a plateau, and a low-dry valley. The characterizations are those of 1982-1983 and 1992-1993 El Niño events, taking into account the preliminary stages, i.e. October 1981-June 1982 and December 1990-July 1991.

According to the results no relation was found in the pre-events between the humidity and the rainfall distribution, althoughthe relationship was high between the two referenced periods and among them and the mean annual rainfall.

ENP03

Hofmann, M., Hoppe, A. (Darmstadt, Institut für Angewandte Geowissenschaften, TU-Darmstadt, Germany), Büchi, A., Karfunkel, J., Pagung, R. (Belo Horizonte, Instituto de Geo-ciências da UFMG, Brazil)

Geology, land use planning and erosion in the northern periphery of Belo Horizonte, Brazil

Belo Horizonte is the fast growing capital of Minas Gerais with today 2.4 million inhabitants inside the city limits and over 5 Million inhabitants in the metropolitan area. The newly built highway between the international airport Confins and the city of Belo Horizonte is accelerating the urbanization of the neighbouring municipalities, especially as tax reductions for industrial plants and easy access are favouring rapid development of the region. Lagoa Santa is one ofthe cities that is affected by this trend, and the prices for real estates in its municipal area are rising even before the new highway is finished. Still, Lagoa Santa is situated in a fragile environment, as the hills it is built on are of highly erodible siltite rocks and many gullies are already threatening the infrastructure. Also in the neighbouring valley of the Riberão da Mata whose alluvial plain serves both as sand, clay and gravel resource and as one of the few plain building sites, concentrated overland flow increases the risk of inundations. For estimating the risk of gully erosion for future land use scenarios, the existing gullies are evaluated with respect to topography, soil and infrastructure. The amount of overland flow which is one of the main factors for gully development is directly linked to urbanisation through increase of sealed area and flow concentration along roads. Thus, the infrastructure needs to be taken into account as well as soil data, especially rates of saturated infiltration that have been measured with a double ring experiment. Based on this data, a natural erosion hazard map regarding topography and soils is created and compared to a hazard map regarding topography and infrastructure, which indicates the points where concentrated flow from sealed areas reaches the landscape. Both maps are then evaluated using the evidence of existing gullies that are documented on aerial photos, satellite images and detailed contour lines. These first investigations are embedded within a project studying the northern periphery of Belo Horizonte. The complete study area comprises 830 sqkm including six municipalities. Its south-western part lies on Archaean gneiss/granite basement dissected by swarms of basic dykes while the north-east is covered by Late Proterozoic carbonate sediments and pelites of the Bambuí Group. The aim of the study is the understanding of geo-resources and geo-hazards which are of high importance for land use planning and a sustainable growth of the city. GIS-based visualizations and calculation methods are used for assessing geo-resources and geo-hazards in this region, the above mentioned erosion risk being part of the first step. The different factors will be later on used as input for a computation of a future scenario using multi-criteria-decision-aid tools integrated in a GIS.

ENP04

Hinderer, M., Hoppe, A., Rottenbacher, P., Sass, I., Schiedek, T., Schueth, C. (Darmstadt)

Tropical Hydrogeology, Engineering Geology and Environmental Management (TropHEE): a Master Course at Darmstadt University of Technology, Germany

E-Mail: trophee@geo.tu-darmstadt.de

In debates on the future needs of society, sustainability has become the major issue. This requires a sound knowledge of the underground and the potentials of the subsurface in order to e.g. find fossil fuels, metals and raw materials, exploit groundwater and describe the capacities of different soils and their vulnerabilities.

The Darmstadt Master Course, a fulltime 2 year course which is given in English, concentrates in particular on methods and modern techniques enabling the participants to find ways for a sustainable development of tropical and subtropical countries from a geoscientific point of view. The students of TropHEE obtain a broadfundamental and an excellent theoretical knowledge in the fields of hydrogeology, engineering geology and land use planning with emphasis on geoscientific recommendations. Their scientific competence will be complemented by their competence of methods as well as their competence of systems.

Holding a MSc. from the TropHEE course, the graduate gain competences and skills which open the following professional areas and fields of research: research in the field of transport and fate of contaminants, with specific knowledge concerning humid tropic and semiarid areas; research and development in the field of sustainable groundwater protection with emphasis on tropic areas; planning, design and implementation of groundwater protection areas and catchment areas as well as catchment management; site investigation and remediation of brown fields and contaminated water and soil; research in the field of soil erosion and protection; planning, design and implementation of soil protection measures and measures to avert soil erosion; investigation, assessment and sustainable exploitation of geo-resources, such as raw materials or water; investigation and evaluation of geohazards, such as subrosion, volcanoes, earthquakes or mass movements; consulting in the fields of water and dam construction.

Web page: http://www.trophee.tu-darmstadt.de

ENP05

Horn, A. H. (NGQA-CMTC-IGC-UFMG), Oliveira, M. (IGC-UFMG), Friese, K. (UFZ)

Trace element distribution in sediments from the São Francisco River upstream and downstream of the Zn reduction plant of CMM near Três Marias, Minas Gerais, Brazil.

E-Mail: hahorn@ufmg.br

INTRODUCTION: Near Três Marias, at the left margin of the São Francisco River, a Zn reduction plant of the Companhia Mineira de Metais (CMM) which belongs to the Vontorantim group was installed in the 60th. This locality was chosen due to the possibility, to produce cheap electric energy which is necessary for the manufacture process, and due to the good traffic connections which permit the evacuation of the final products and the transport of the ores, silicate ore from Vazante and Zn-sulfite ore from Morro Agudo, used in the process.

The Zn-reduction plant is responsible for strong environmental contaminations, which occur from the 60th till the 90th, producing a sequence of hazards at the São Francisco River and for the resident population, which lives from fishing on the river and uses the water for the households. The sediments, principally formed by a mixture of sand and argillites captured a big part of the introduced heavy metals. To evaluate the initial contamination and the residual composition two sampling campaigns were done, in 1990 and 2002/2003, where sediment samples from the river were taken and analyzed for selected trace elements (Zn, Pb, Cu, Cd, U).

TREATMENT: The samples were transported cool, dried, sieved in several fractions and quartered. The grain size fraction >0,063 were send to the laboratory of CPMTC-IGC, were the final preparation for analyzing was done. The selected trace elements, Al2O3, Fe2O3, MnO, P2O3, TiO2 and SiO2 of the totally dissolved fine fraction of the sediments was analyzed by XRF, ICP-AES and AAS using international and laboratory standards for comparison.

RESULTS: In 1990 nearby all samples along the plant and downstream were contaminated by high values of heavy metals. At the Conciência River, the principal output channel of waste water and also at the freshwater capture for the reduction process the highest concentrations were detected. The contamination situation improved from 1990 to 2002 , due to protection works done by CMM. Nevertheless high concentrations of trace elements like Zn, Pb, Cu, Ni and Cd can still be found in some samples. Especially, the samples along the dam of the former cleaning basin, parallel to the São Francisco margin, and samples from the Conciência River are still highly contaminated but generally the liberation of contaminants to the water decreased.

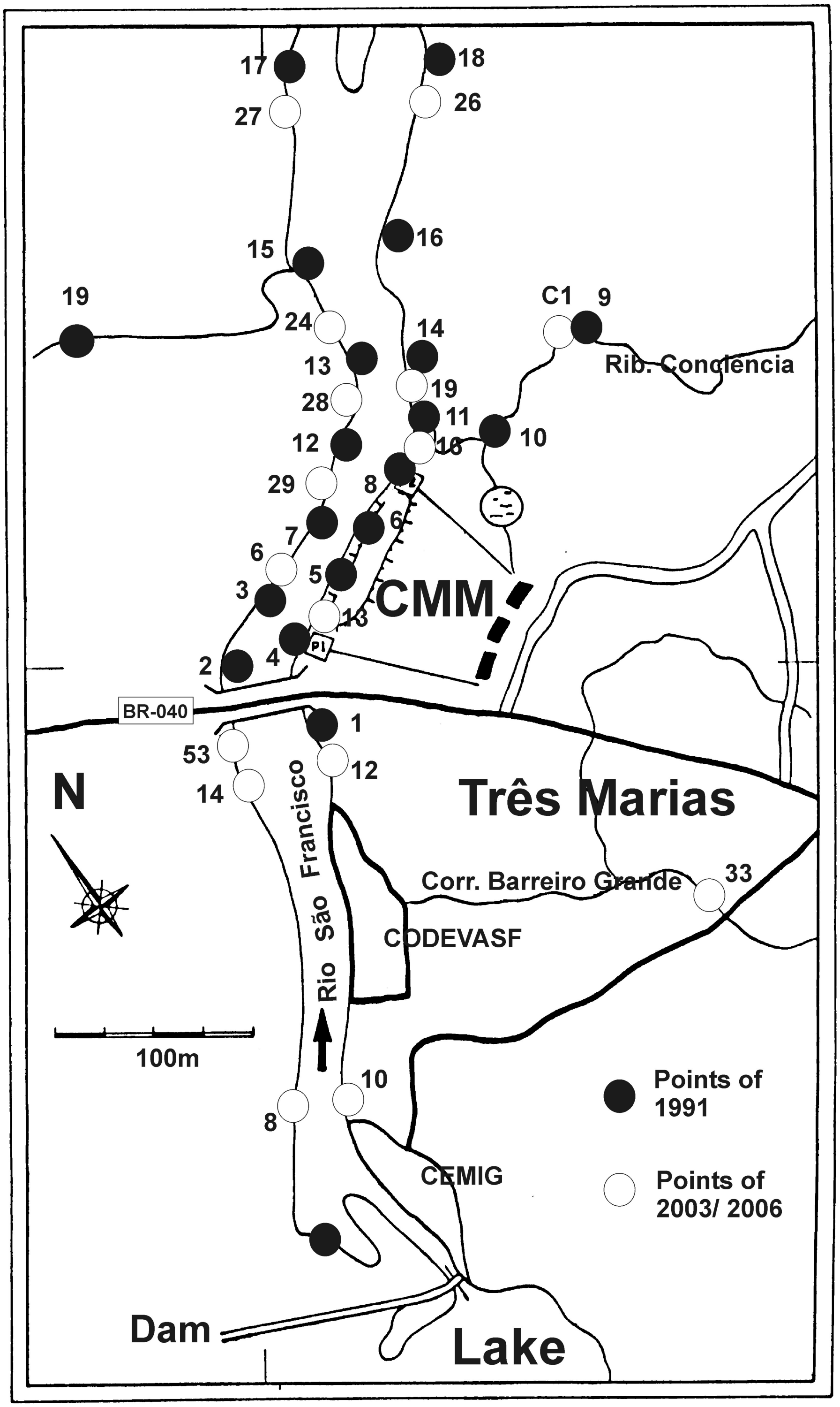


Figure 1: Fig 1.: Situation near the Zn-plant of the CMM showing the sediment sampling points of the two campaigns.

ENP06

Horn, A. H. (NGQA-CPMTC-UFMG), Farias, B. (CPMTC-UFMG), Bilal, E. (EMNSE), Karfunkel, J., Moraes, M. K. (CPMTC-UFMG)

Atmospheric mineral pollution NE of Belo Horizonte, Minas Gerais, Brazil. A case study of Pedro Leopoldo ciment industry.

E-Mail: hahorn@ufmg.br

The county of Pedro Leopoldo with 50.000 inhabitants, occupies an area of about 300 km2, and is situated 40 km NE of the Minas Gerais State Capital, Belo Horizonte. The more important industry is the cement industry, although others, like whitewash, iron, steel, asbestos and textiles contribute to it too. Geologically Pedro Leopoldo lies near the contact of Achaean Basement and the Upper Proterozoic Bambuí Group. The base of the latter, the Sete Lagoas Formation, is composed of carbonates and phylites, the economic base of the local industry. These carbonates of the region play a significant role in the cement industry of Minas Gerais e.g. Holdercim Brasil SA (CIMINAS), Camargo Corrêa (Cimento CAUÊ SA), ITAU SA, besides smaller extractive activities selling their product for fertilizers and civil constructions. The extraction of carbonate rocks and the cement industry causes, nevertheless, therefore also the main environmental impact problems. They deliver solid particles into the air like CaCO3, CaMg(CO3)2, SiO2, Al2O3, Fe2O3, production typical compounds like Thenardite, Arcanite, Portlandite and Kaolinite beside the residuals from incomplete combustion of coal and organic residuals. The coarser particles (>PM10) come from local quarries, while smaller particles can be linked to the cement and lime industry, beside the local road traffic. The present study has been undertaken from 2002 through 2005 with the task to study qualitatively as well as quantitatively the aerial distribution of the mentioned solid mineral particles. Analyses included counting of particles on an adherent foil with the petrography and electron microscope (SEM), Grimm Dustmonitor 1.104, as well as chemical analyses. The results, plotted on maps, show the regional distribution of the different particles in relation to emission sources. Climatic factors like seasonal wind directions/intensity, rainfall and humidity, have been taken into account too. Six diameter intervals were distinguished: >0.07mm, 0.02-0.07 mm, <0.02 mm, and PM10, 5 and 2.5. CONCLUSIONS: a. Majority of large particles come from different mechanical sources; b. Smaller particles are produced by the different industrial and burning processes; c. Distribution values are compatible with the size of industry chimneys and wind directions; d. The TSP values during the rainy months December and January are surprisingly not lower compared with other months; e. Before rain-fall PM5 and PM2.5 increase; f. The maps indicate clearly that particle concentrations of all sizes are higher in the vicinity of factories; g. Near CIMINAS values are low due to modern equipment and technological procedures, whereas near CAUÊ values are higher; h. The region with the highest TSP is oriented in a NW-SE strip, parallel to the main valley (Pedro Leopoldo Graben) and wind directions. This valley incorporates all mentioned major industries.

ENP07

Moraes, A. F. (FEAM), Horn, A. H. (NGQA-CPMTC-IGC-UFMG), Campelo, M. (IGC-UFMG), Baggio, H. (Unimontes), Cristofolo, V. (NGQA-IGC-UFMG), Egger, V., Gallupo, L. (IGC-UFMG), Braga, L. (Geoexplorer)

DANOS AMBIENTAIS PROVENIENTES DA EMISSÃO DE POLUENTES ATMOSFÉRICOS NA REGIÃO CÁRSTICA DE ARCOS-PAÍNS-DORESÓPOLIS.

E-Mail: hahorn@ufmg.br

INTRODUCTION: The carstic area of Arcos-Paíns-Doresòpolis is located in the southern part of the Rio Sã Francisco basin in the Minas Gerais State. There calcareous rocks crop out and that substrate, allied to climatic factor generated a typical environment of high fragility with soils, relief, hydrological system and characteristically flora known as carste. At the excavation and crushing down of the rocks occur a significant production of particulate material which settle down on the surface of vegetables reducing the photosynthetic tax of them. The limestones of the Bambuí Group possess in their structures disseminated metallic sulfides; liberated during treatment they can penetrate the human breathing system, too, causing health damages. The calcinations facilities (industrial and handicrafts) sometime make use of several fuels for the process and the incomplete combustion of them generate much pollutant like particulate materials, gases and liberates heavy metals and organic and organ metallic compounds. All these materials are transported by air and deposited by outfall and outwash. The objective of the present work is to evaluate quali- and quantitatively the emission of inalable particulate materials measured in strategic points of and to compare them with limits established in legislation. The sampling points were defined by taken into account the geographical location of the atmospheric polluting sources,, the local topography, the predominant winds directions, localization of regions with environmental fragility and the distribution of human activities and habitations. At this georeferenced points the reading of the atmospheric particular pollutants was executed, using the mobile Dust Monitor series 1100. The obtained data pass, in most, the established limits determined by the WHO in 2005 (Figure 1). This fact indicates the existence of risks to the human health. The scenery vary by put together the high concentration of crystalline particles like CaCO3, CaMgCO3 and SiO2 with carbon and organic and metaloorganic chemical compounds, also products of the industrial activities like whitewash burning in the handicraft and industrial ovens. That is especially serious, in urban environment with housing, school activities with the constant presence of people (Paíns, Corrego Fundo, Arcos), where only the minimum values are acceptable. RESULTS: a. Some variations observed between 2004 and 2005 show possible activities to reduce particle emission made by the companies (cement, whitewash), due to FEAM control. b. A homogeneous distribution of higher concentrations is noted around the ovens and in the area of the quarries and limestone breakers. c. These specific crystalline particles may cause serious prob-

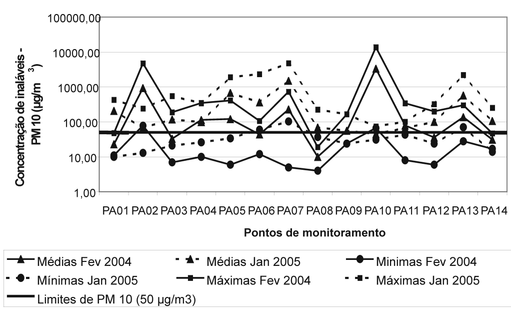


Figure 1: Figure 1: This figure shows the concentrations of the small atmospheric particles (PM10) in selected sampling points in February 2004 and January 2005. Were executed daily measures and calculated the middle, minimum and maximum values. The black horizontal line is the concentration limit determined by EPA. The sign PAnumber is the sample point identifications.

lems to the human health, economic losses in the agricultural production as well as they influence negatively the aquatic system of the carste. d. The particles liberated by the ovens are a mixture of crystalline substances and organic and organ metallic compounds by incomplete burning of industrial waste and coal. It is evident that a reduction of the particulate emission both, in amount and in mineralogical and chemical composition (crystalline minerals, organometallics etc.) is necessary. This may be possible by an integrated action of competent authorities together with a monitoring of the socioeconomic impacts, to allow a progress in environmental conservation without creating a negative trend in the local development.

ENP08

Ihl, T., Frausto, O. (Cozumel)

A GIS APPLICATION FOR AN SALT WATER INTRUSION IN THE KARSTIC AQUIFER OF NORTHERN QUINTANA ROO, MEXICO

E-Mail: thomas@uqroo.mx

The permanent expansion of the tourism industry in the region Cancun, Riviera Maya, Tulum and Playa del Carmen, lead also to an increase of the population. The water consumption will be raise enormous. The groundwater resources andthe groundwater quality are examined. The region is situated over a karstic aquifer. Saltwater intrusion is one of the main threats. A GIS Application is used as a management instrument. The GIS include the following layer amongothers: Satellite images, land use, geology, relief, climate, Hydrology and wells with analyses. With all these information of the different layer it is possible to create a modelling process. The poster shows the modelling process and a possible salt water intrusion at an example of the conductivity. The point information of the wells will be interpolated to the area by a kriging method. The advantage of kriging is the use of variograms to express the spatial variation, and to minimize the error of predicted values which are estimated by spatial distribution of the predicted values.

The project is supported by FONDO MIXTO CONACYT- thanks for the financial engagement of the Government of the state of Quintana Roo: ’ESTUDIO GEOHIDROLÓGICO Y EVALUACIÓN DE FUENTES CONTAMINANTES DEL ACUÍFERO NORTE DE QUINTANA ROO, MÉXICO’ and of the Department of Sustainable Development, University of Quintana Roo.

ENP09

La Rotta, E., Pabon, J. (Bogota)

CLIMATIC VARIABILITY ASSOCIATED WITH EL NIÑO-LA NIÑA

E-Mail: `elarotav@unal.edu.co`

Weather conditions may considerably vary and, as a result, the availability of runoff. Variations in the quantity of water, in turn, have effect on the environment and hence on the socio-economic activities.In the north-western Andean region the interanual climatic variability is associated with the El Niño-La Niña phenomena. A better understanding of the mechanism of such a phenomena will provide a wider basis to manage the water resources, every time more and more scarce. The study area is located in the high Andean mountain grasslands páramo of Colombia between 2.300 and 3.900 meters above sea level, east of Bogotá. From the methodological point of view the climatic variability is studied based on air temperature, rain, and discharge. The main results show that there is thermal anomaly both in an interseasonal and interanual temporal scale. During El Niño the air temperature raises up to 1.5 centigrades, while during La Niña it drops up to 2.0 centigrades below the average. Accordingly, the discharges are reduced in about twice from the average, particularly at the end of the first year of El Niño, and raise normally to twice during La Niña. In extreme events reaches up to four times.

ENP10

Nielsen, S.N., Glodny, J. (GeoForschungsZentrum Potsdam)

Tropical water temperatures during the early Miocene in the southeast Pacific (south-central Chile)

E-Mail: nielsen@gfz-potsdam.de

Introduction

The classic mollusk fauna from the Navidad, Ranquil and Lacui Formations of central to southern Chile, which is known since Darwin's voyage on the Beagle (Darwin 1846), contains a number of species indicating a nearshore environment and tropical to subtropical water temperatures. Correlation of several associated molluscan taxa from the Navidad Formation with Cenozoic faunas from Peru (DeVries and Frassinetti 2003) resulted in the proposal of a latest Oligocene to middle Miocene age for the Navidad fauna. Recent micropaleontologic work by Finger et al. (2007), however, reveals that the Navidad, Ranquil and Lacui Formations are all late Miocene to early Pliocene in age and were deposited at bathyal depths. Finger et al. (2007) gave ages based on planktic foraminifera around 4.5 and 10 Ma (Zones N19a and N16a) for most of their localities; their localities of the Navidad Formation are the same as those that yielded the mollusks interpreted by DeVries and Frassinetti (2003). Finger et al. (2007) concluded that the most plausible explanation for the age discrepancy is that yet unknown older strata were reworked and displaced into greater depths. To test this hypothesis and to check for the possibility that the species survived much longer in Chile than in Peru, we analysed the Sr isotope ratios of several mollusks from these same localities.

Strontium isotope stratigraphy ages

Shell material of a variety of gastropods and bivalves and of a cephalopod has been analysed to compare Sr isotope ratios of taxa with different shell structure from one locality for possible differences. Sr isotope ratios were determined on a VG Sector 54 multicollector TIMS instrument (GeoForschungsZentrum Potsdam). For the NBS SRM 987 standard a 87Sr/86Sr value of 0.710255 ± 0.000020 (n=11) was obtained. Age calculation by correlation with the marine Sr isotope record is based on McArthur et al. (2001). Age uncertainties are generally <1 Ma.

The coastal warm water fauna

A number of typical tropical to subtropical molluscan taxa, many of them living at or near the coast, are known from the sampled formations. Several species of the keyhole-limpet genus *Diodora*, the trochoid *Tegula* (*Agathistoma*) *antiqua* and the neritimorph *Nerita* (*Heminerita*) *chilensis* were reported recently. *Diodora* prefers shallow water habitats, *Agathistoma* is today an exclusively tropical western Atlantic and eastern Pacific subgenus and *Nerita* is well known as inhabiting tropical intertidal or supratidal zones. *Strombus medinae* and *Xenophora paulinae* belong to exclusively tropical families as do the cypraeid *Zonaria frassinettii* and the ficids *Ficus distans* and *Ficus gayana*; also the personid *Distorsio thersites*, the pseudolivid *Triumphis maitenlahuensis*, the large terebrid *Terebra undulifera* and several species of architectonicids belong to tropical to subtropical taxa. Additional warm water taxa include species of the olivid gastropods *Olivancillaria* and *Lamprodomina* and the nautiloid cephalopod *Aturia cubaensis*.

Discussion and Conclusions

The age range of 24-16.5 Ma (Table 1) for the represented tropical to subtropical fauna spans the whole Early Miocene and predates the Miocene climate optimum observed around the Pacific at about 16 Ma. However, global climate was much warmer than today from the late Oligocene until the middle Miocene (Zachos et al. 2001). Our isotopic data is in line with the hypothesis of large-scale reworking during the late Miocene-early Pliocene interval (Finger et al. 2007) and confirms the correlation of the Chilean mollusks with those in Peru (DeVries and Frassinetti 2003).

Fm	Navidad									Ranquil								Lacui			
Sample	SR-01 RAP	SR-31 RAP	SR-20 PPP	SR-21 PPP	SR-22 PPP	SR-05 PPN	SR-09 PPN	SR-33 PTA	SR-03 MAT	SR-10 FRM	SR-11 FRM	SR-26 RQK	SR-27 RQS	SR-14 RAN	SR-23 RAN	SR-24 RAN	SR-18 LEB	SR-28 PNH	SR-32 CHE	SR-15 CUC	SR-16 CUC
Taxon	Pectinidae	*Lamprodomina*	*Xenophora*	*Lamprodomina*	*Struthiochenopus*	*Lamprodomina*	*Olivancillaria*	*Echinophoria*	*Lamprodomina*	Turridae	*Dalium*	*Oliva*	Pectinidae	Volutidae	Pectinidae	*Austrotoma*	Pectinidae	Naticidae	*Acanthina*	*Lamprodomina*	*Aturia*
Age	17.4	18.3	18.3	19.5	18.2	20.3	19.8	19.0	23.7	22.7	23.7	16.1	18.5	20.5	19.4	21.8	24.3	21.4	16.8	18.6	16.8

Table 1: Samples from the three formations analysed for 87Sr/86Sr isotope ratios, used taxa, and obtained ages in Ma.

References

Darwin, C. 1846. Geological observations on South America. Being the third part the geology of the voyage of the Beagle, under command of Capt. Fitzroy, R.N. during the years 1832 to 1836: Smith, Elder & Co., London, 279 p.

DeVries, T.J., and D. Frassinetti 2003. Range extensions and biogeographic implications of Chilean Neogene mollusks found in Peru. Boletín del Museo Nacional de Historia Natural, Chile 52: 119-135.

Finger, K.L., S.N. Nielsen, T.J. DeVries, A. Encinas, and D.E. Peterson 2007. Paleontologic Evidence for Sedimentary Displacement in Neogene Forearc Basins of Central Chile. Palaios 22: 3-16.

McArthur, J.M., R.J. Howarth, and T.R. Bailey 2001. Strontium isotope stratigraphy: LOWESS Version 3. Best-fit line to the marine Sr-isotope curve for 0 to 509 Ma and accompanying look-up table for deriving numerical age. Journal of Geology 109: 155-169.

Zachos, J., M. Pagani, L. Sloan, E. Thomas, K., and Billups 2001. Trends, rhythms, and aberrations in global climate 65 Ma to present. Science 292: 686-693.

ENP11

Ofelia, Morton Bermea., Elizabeth, Hernández., Erick, Martínez., Ana María, Soler., Jaime, Urritia Fucugauchi. (Mexico City UNAM)

Magnetic Properties and Heavy Metals in topsoils from Mexico City: Implications for Pollution

E-Mail: omorton@geofisica.unam.mx

INTRODUCTION.

The human activities in city areas with high urbanization and industrial growth rate have resulted in an increase in the levels of environmental pollution. Major pollution in an urban area is caused from a variety sources including industries, atmospheric depositation, vehicular traffic etc. Heavy metals in urban soils have been shown to be very useful tracers of environmental pollution since they have an excellent ecological transference potential. During the least few decades, many studies of the estimation of environmental contamination in urban areas in terms of the content of heavy metals have been reported. Although the severity of pollution depends not only on the total heavy metal content, but also on the proportion of their mobile and bioavaliable forms, it is necessary to know the total content of heavy metal to evaluate the antropogenic impact. Traditionally, the estimation of heavy metal pollution in soils has been carried out mainly by chemical methods. The most used chemical methods for this type of determination are FRX and ICP-MS. Considering the many pollution sources to which the urban soils are exposed, a detailed study would be very laborious and expensive. The need for fast and cheap monitoring tools of heavy metal pollution has taken to the search of other methods of determination. With this intention, soil magnetic susceptibility mapping was recently successfully applied in different countries for estimating heavy metal pollution in urban soils Dearing. The magnetic measurements are sufficiently sensible to detect the magnetic signal of the minority fraction of ferromagnecian materials in most of the cases with concentrations non superior to 1Mexico City is one of the most densely populated areas in the world with a population of 20 million in an area of only 2000 km2. Early studies in the urban area of Mexico City indicated elevated concentrations of heavy metals in urban topsoils, mainly related to vehicular traffic (Morton et al. 2001, Morton-Bermea et al. 2002). Recently (2005), the Mexican Ministry of Environment approved policy standard procedures recommending regulatory levels of metals in soils. These limits were derived primarily from international sources of information like the United States Environmental Protection Agency (USEPA), World Health Organization (WHO) and the European Union (EU). The present study focuses on the urban area of Mexico City. The aim of this work was to examine the degree of correlation between magnetic parameters and concentration of Fe, Mn, Cu, Zn, Ni, Cr, V and Pb in urban soils in order to find a tool that allows the identification of highly contaminated areas of a fast and cheap way reducing enormously the amount of chemical analyses. The results of the will be compared with the limits values recommended by the Mexican Ministry of Environment for heavy metals for the purpose of evaluating the environmental quality.

ENP12

Almeida-Abreu, P.A. (Diamantina, UFVJM, Inst. Agr .Sc.), Renger, F.E. (Belo Horizonte, Inst. Geociencias, UFMG), Fraga, L.M.S. (Diamantina, UFVJM, Inst. Agr. Sc)

Mesoproterozoic glacial valleys preserved on the Espinhaço Mountain Ridge, Minas Gerais, Brazil

E-Mail: frenger@terra.com.br

The southeastern border of the São Francisco Craton (eastern-central Brazil) is limited by the Espinhaço mountains (Serra do Espinhaço), which represent a Mesoproterozoic orogenic belt. The southern part of the Espinhaço range (sSdE) extends over 300 km in central Minas Gerais. Rocks of glacial origin have been recognized in the Serra do Espinhaço since the 1920's and gathered in the Macaúbas Formation by Moraes et Guimarães (1931) together with other lithologic sequences. Later on, some authors questioned the glacial origin of those rocks. However, records of abrasion and glacial sedimentation were identified in different areas together with diamictites of the Macaúbas Group (Isotta et al. 1969, Gravenor et Monteiro 1983, Karfunkel et Hoppe 1988).

Age, paleogeography and causes of Macaúbas Glaciation have been discussed during the last three decades. Geochronological and paleomagnetic data (D'Agrella-Filho et al. 1990) suggest that the glacial event was a consequence of a pole wandering bringing the São Francisco Craton to high paleolatitudes at about 1,05Ga. The passage of the craton at paleolatitudes between 45°-65°N would have provoked the glaciation and the return of the area to lower latitudes would have provided conditions for the deposition of the carbonate rocks of the overlying Bambuí Group. Geological mapping and sedimentological studies (Almeida-Abreu et al. 1997, Fraga 1999, Queiroz 2002) of the glaciogenic deposits (diamictites and rhythmites) of the Macaúbas Group, which outcrop on the mountain range and adjacent areas allowed the paleogeographic reconstitution of the glacial event, which can be characterized as a typical alpine glaciation, which had the sSdE as its dispersion centre.

The Late Mesoproterozoic Macaúbas Glaciation represents probably the first post-Huronian glacial event. The main factors which determined the triggering of this glaciation include, (a) the high latitudes of the São Francisco Craton between 1.01 and 1.08 Ga; (b) the high altitudes of the Espinhaço mountains at this time; and (c) the continental emergence during Late Mesoproterozoic times which provided the drawdown of atmospheric CO_2.

Detailed geological mapping to the northeast of the sSdE revealed remnants of glacial valleys shaped by glaciogenic sediments (Almeida-Abreu et Renger 2002), e.g., tillites as frontal and lateral moraine deposits, containing large quantities of sedimentary, igneous and metamorphic rocks deriving from sSdE. The Galvão Glacial valley (GGv) cuts quartzites of the Espinhaço Supergroup at 750 m above sea level 70 km north of the town Diamantina. The GGv is today a tributary of the Caeté-Mirim River in the Inhaí district. As the flanks and beds of all tributaries of that river show outcrops of tillites, as well as in local domains of the major rivers of this region, we can suppose that the present drainage is superimposed on the Mesoproterozoic glacial pattern.

The GGv is linear, striking 110°Az, and shows glacial e fluvial flux to SE. It is 200 to 250m wide and about 1600m long, shaped by sub-vertical (60°- 75°) walls 80 to 150m high until reaching the Caeté-Mirim River. Its geomorphology is exceptionally well preserved. The sidewalls of the U-shaped valley are recovered by tillites and form at the end an amphitheater, which characterizes the circle of the glacial valleys. The lateral moraines exhibit typical forms and dimensions of a tributary glacial valley (*moraines laterales du troisième type* according to Vivian 1975: 442).

Like the GGv, the *Rio Manso Glacial valley*

(RMGv) is sculptured in quartzites of the Espinhaço Supergroup about 30 km northeast of Diamantina. It is wide (1,5 to 2,5 km), deep (the walls reach more than 200 m and configuring the U-shape) and extent at least 25 km N-S. The dimensions of the valley, including thickness of the glaciogenic deposits, indicate it as a trunk glacial valley (Vivian 1975). The town Couto de Magalhães de Minas lays on the frontal moraine and others outlet deposits of the RMGv, with more than 100 m thickness.

The quarry near Couto de Magalhães de Minas exposes the outlet deposits with glacio-dynamic structures, including foliations and thrusts (Queiroz 2002), characterizing a frontal moraine deposits, exhibiting structures related to the advance and retreat of mountain glaciers in its terminal zone. The glaciogenic deposits of the RMGv, including lateral moraine and outlet deposits and its tributary glacial valleys, indicate a general flow from south to north down the mountains of the sSdE. The tillites contain clasts of different types of quartzites or arenites, as well as granite, gneiss, quartz and carbonate rocks, and occasionally phyllites, mica-schist and ultramafic rocks. The lateral moraine deposits of the GGv and RMGv define the valley walls that show unconform contacts with the regional quartzites of the Espinhaço Supergroup. The sharp contact between tillites and quartzites are convergent into the valley dipping 45°to 70°, whereas bedding of the quartzites shows lower dip-angles in different directions. The clasts of tillites, the unconform contacts and the glacial valleys by itself indicate that the Serra do Espinhaço was a mountain ridge already at the end of the Mesoproterozoic, and that the event of the Macaúbas Glaciation was of the alpine type. On the other hand, the clasts indicate that tectonic slices of different lithologies and stratigraphic levels occupied domains on top of the Espinhaço Orogen. It can be visualized that the study of the tillite clasts and its distribution around the sSdE will permit to outline the late Mesoproterozoic paleogeology of the Orogen. A detailed study of those clasts could be a new front for geological knowledge.

References: Almeida-Abreu, PA et al. 1997: Anais 9. Simp. Geol. Minas Gerais (O. Preto), p. 12-13; Almeida-Abreu, PA et Renger, FE 2002: Rev. Bras. Geoc., 32 (1): 1-14; D'Agrella-Filho et al. 1990: Palaeog. Palaeoclim. Palaeoecol., 80: 225-265; Fraga, LMS 1999: M.Sc. Diss., IGC/UFMG; Gravenor, CP et Monteiro, RLBP 1983: J. Geol., 91: 113-116; Isotta, CAL, Rocha-Campos, AC et Yoshida, R 1969: Nature, 222: 466-468; Karfunkel, J et Hoppe, A 1988: Palaeog. Palaeoclim. Palaeoecol., 65: 1-21; Moraes, L J de et Guimarães, D 1931: Econ. Geol., 26: 502-530; Queiroz, WP 2002: M.Sc. Diss., IGC/UFMG; Vivian, R 1975: Les glaciers des Alpes Occidentales; étude géographique. Grenoble.

ENP13

Torra, R. (Resistencia, Argentina)

Remote sensing applied to study the origin and age of the Pilcomayo, Bermejo and Salado Rivers. Central and North of Argentina, South America

E-Mail: roberto_torra@arnet.com.ar

I propose a new geomorphogic model in order to understand the origin and age of large flat valley rivers running on the Argentina pampas plains. The study catchment area has about of 350,000 square kilometers. The flows of the rivers range between seasons. Flows varies about 1,000 cubic meters until zero. The implicated rivers, Pilcomayo, Bermejo and Salado, have a minimum flow during eight continuous months. It main volume waters are discharge at the rainy season and they followed the regional inclination of the pampean plains blocks. They are characterized by a large fluvial plain of some about 30 kilometers of lengths as the case of Pilcomayo. Several canals of meandrous forms are common inside the fluvial valley. In order to study this region and principal courses of waters, I employed several satellite images. SAC - C Satellite images and LANDSAT TM/ETM images were used. Digital image processing was used during laboratory tasks. Georeferenced and not georeferenced mosaicks were created. Visual and digital supervised classifications were carried out. Field works were done to constrain results and validation first hypothesis. A light change in the general climatic conditions occurred at the beginning of 10,000 years BP. At this epoch dramatic paleontological changes occurred. The area evolved to a more humid environment due to air-masses circulations modifications. This phenomenon originated important cloudy masses (cumulus-towers giantcells) of rainy formed at the east-side of the extend foothill present at the Andean orogen belt during the summer periods. These spasmodic and seasonally heavy pluvial waters largely exceed the ranges of infiltration and evaporation. The flow volume waters exceed and so they look for other way to discharge. So occurred during the last 10,000 years BP. This temporary water flows eroding the friable sandy silty muddy beds, geometrically horizontal, through spasmodic and repetitive episodes. Some episodes of earthquakes could be responsible for some short change of direction in some segments of these rivers. Salado river flows its water in the large Laguna Mar Chiquita which is drying and constitute a natural close system. Bermejo and Pilcomayo run into the Paraguay river. During the last 6,000 to 3,000 BP. two restricted ingression-regressions occurred at the point of discharge of the catchment area at the Rio del Plata estuarine. This fluctuation modified the base level increasing the erosive potential. This phenomenon may be cause of acceleration in the erosive processes into the head tributaries and so rivers. On the other hand, the rivers incised the Post-Pampean terrains which correspond to the modified beds of the altered littoral shallow marine continental Miocene transgression. I can conclude that the Pilcomayo, Bermejo and Salado rivers developed under the following parameters during the last 6000 to 3000 years. Climate conditions related to Global Change could be the trigger or release of the regional processes. Restricted sea level variations well registered at the Rio de La Plata estuarine and Argentine Sea platform reinforce the idea. Topographic relief of the region, which is extremely flat, ranging one grade of regional slope, the properties of the sedimentary succession in which the river incised its fluvial valleys, the possible tectonic influence not well demonstrated at present days and related with recent earthquakes. A giant alluvial fan model, in the sense of classic sedimentology, of thousands kilometers for origin of these courses and its related sedimentary deposits as well as related geoforms is largely proposed for their origin. In my opinion this is not the case. These rivers responded to climatic conditions into the general topographic regional inclination east-east-south and small neotectonic vertical and horizontal movements. Major flows are incorporated in the medium course due to heavy rains during last 6,000 BP. Due recent origin of the Pampean plains region these rivers were incised and settled into the friable sediments of the Miocene marine period. I propose an origin strictly due to climatic conditions and soils characteristics functioning inside the plains that was triggered during the last 6,000 years BP. There are not times for the giant alluvial hypothesis model in order to generate so large geoforms and very selected deposits.

ENP14

Wendt, A., Casassa, G., Bown, F. (Centro de Estudios Cientificos, Valdivia, Chile)

Remote sensing of glaciers in Cordillera Darwin, Tierra del Fuego

Mountain glaciers and ice caps play an important role in sea level rise, contributing between 20 and 40% of the total rise (http://nsidc.org/sotc/sea_level.html), which was 1.5 mm/yr for the last century (Houghton et al., 2001), but has doubled now to 3.2±0.4 mm/yr since 1992 (http://copes.ipsl.jussieu.fr/Workshops/SeaLevel/Reports/Summary_Statement_2006_1004.pdf).
The Patagonian Icefields, the largest ice masses outside Antarctica within the Southern Hemisphere, are very susceptible to ice mass changes, due to their temperate nature and because southern South America has experienced a pronounced warming during the last decades (Rosenblüth et al., 1997). Whereas the Northern and Southern Patagonian Icefields (NPI and SPI) have been the subject of a variety of investigations (e. g. Rivera et al., 2002), little is known about Cordillera Darwin, the third-largest ice mass in South America.
The Cordillera Darwin Icefield (Fig. 1) is estimated to be 2,300 km^2 (Lliboutry, 1998) stretching from an altitude of more than 2,000 m to sea level. Satellite remote sensing provides a unique tool to study this remote region with difficult access. Synthetic Aperture Radar interferometry using data from the European satellites ERS and Envisat can be used to determine ice flow velocities and to describe the dynamic behaviour of the glaciers. We use optical remote sensing data from ASTER and Landsat ETM+ to set up a glacier inventory and to map glacier outlines, areas and altitudes. Comparison of data sets acquired in different years as well as with sparse historical information allows detecting changes in ice extent and ultimately the contribution to sea level rise.

Houghton, J., Ding, Y., Griggs, D. J., Noguer, M., van der Linden, P., Dai, X., Maskell, K. and Johnson, C. A., Eds. (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Lliboutry, L. (1998). Glaciers of Chile and Argentina. In Williams, R. and Ferrigno, J., Eds., Satellite image atlas of glaciers of the world. U.S. Geological Survey Prof. Paper 1386-I. http://pubs.usgs.gov/prof/p1386i/chile-arg/index.html.

Rivera, A., Acuña, C., Casassa, G. and Bown, F. (2002). Use of remotely sensed and field data to estimate the contribution of Chilean glaciers to eustatic sea-level rise. Annals of Glaciology, 34:367-372.

Rosenblüth, B., H. A. Fuenzalida, and P. Aceituno (1997). Recent temperature variations in southern South America. International Journal of Climatology 17, 67-85.

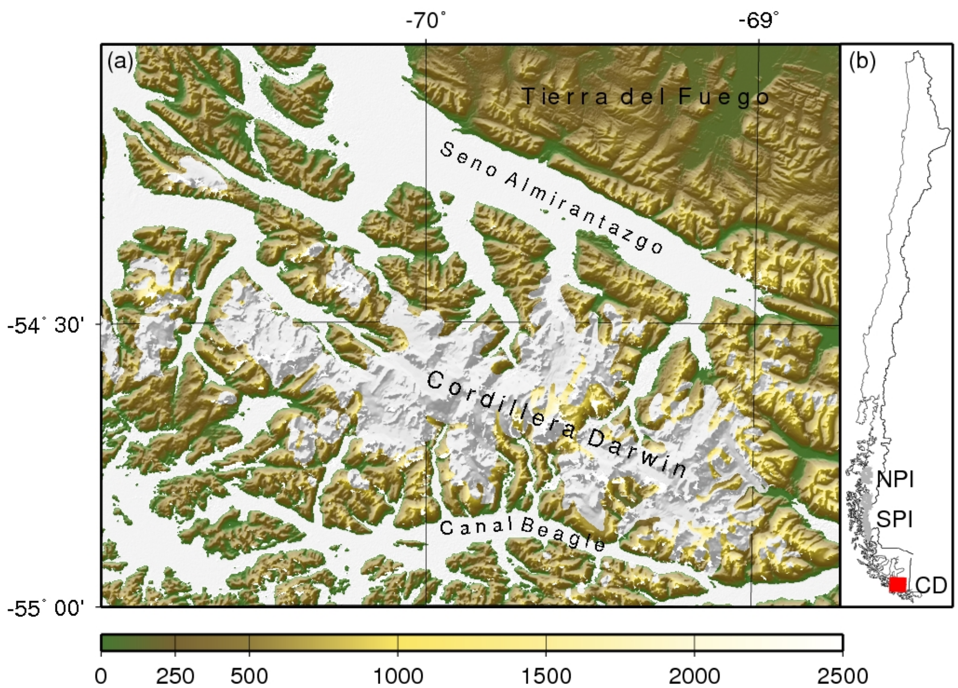


Figure 1: Cordillera Darwin, Tierra del Fuego. (a) Topography with glaciers shown in grey, (b) Location map indicating Northern Patagonian Icefield (NPI), Southern Patagonian Icefield (SPI) and Cordillera Darwin (CD).

ER

Economic Resources: Minerals, Energy & Water

ER01 – Wed., 11.4., 11:10 - 11:30 · HSF

Charrier, R. (Santiago, University of Chile), Alvarez, P. (Santiago, ENAP-SIPETROL S.A.), Campbell, D. (Calama, Sociedad Contractual Minera El Abra), Comte, D. (Santiago, University of Chile), Fanning, M. (Canberra, The Australian National University), Farías, M. (Santiago, University of Chile and Toulouse, University Paul Sabatier), Fock, A. (Santiago, Servicio Nacional de Geologia y Mineria SERNAGEOMIN), Maksaev, V., Muñoz, M., Pardo, M., Vera, E. (Santiago, University of Chile), Yáñez, G. (Santiago, CODELCO CHILE)

Late Cenozoic shifts of deformation and magmatism: association with Andean uplift and giant ore deposits, southern Central Andes (33º-36ºS)

E-Mail: rcharrie@cec.uchile.cl

Extensional basin development (Middle?-Late Eocene to Late Oligocene), basin inversion and shortening of the basin fill (Early to Late Miocene) and rapid, high-magnitude regional surface uplift (Late Miocene to Recent) characterize the Cenozoic tectonic evolution of the central Chilean Principal Cordillera (33º-36ºS). Extension was associated with crustal thinning and tholeiitic magmatism, while basin inversion was associated with crustal thickening and calc-alkaline magmatism.

Three contractional episodes (Fig.1) since begin of basin inversion have been detected and dated (U-Pb SHRIMP, 40Ar-39Ar and Apatite Fission Track ages) at: 1) Late Oligocene-Early Miocene (24 to 16 Ma) affecting the western Principal Cordillera, 2) Early-Middle Miocene, concentrated along the eastern basin-bounding El Diablo-El Fierro Fault System, inducing eastward sequential development of the fold-thrust belt on the eastern side of the cordillera, and 3) Late Miocene-Early Pliocene (<10 to 4 Ma), causing out-of-sequence reactivation of the thrust-fold belt next to the El Diablo-El Fierro Fault System and W-vergent backthrusts on the Cenozoic deposits to the west.

Exhumation/incision ages of <2 Ma in sequences involved in the fold-thrust belt indicate that denudation in response to deformation and uplift remained active until the Quaternary.

Abundant shallow seismicity below the Principal Cordillera, partly aligned with the El Diablo-El Fierro Fault System, indicates that this and other not exposed faults are still active, but with strike-slip kinematics (probably since 4 my ago).

Eastward shift of deformation between episodes 1 and 2 coincides with eastward migration of the arc. In contrast, the westward shift of deformation in episode 3, in Late Miocene-Early Pliocene times, (<10 to 4 Ma) to the eastern Principal Cordillera next to the present arc coincides with the westward shift of magmatism to the western Principal Cordillera (7-4 Ma), which is associated with the giant ore copper deposits in this region (Río Blanco-Los Bronces and El Teniente porphyries). In the western Principal Cordillera, fission-tracks do not report exhumation because Cenozoic rocks in this area were not buried enough to be heated above the annealing temperature, however in the eastern Chilean Principal Cordillera -where shortening was accommodated-, fission-tracks registered exhumation.

Disrupting tectonics, morphologic and magmatic-metallogenic events that took place in Late Miocene-Pliocene times represent a major Andean problem, which is presently being tackled by the multidisciplinary ANILLO ACT-18 Research Group.

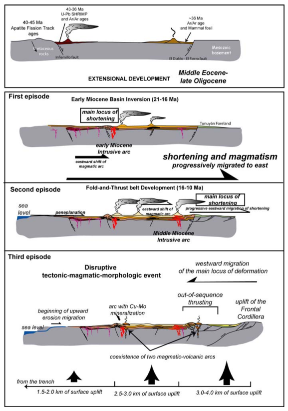


Figure 1: Tectonic evolution of the Andean Range in Central Chile and Central-Western Argentina. In spite of that most of shortening occurred in the first and second contractional episodes, during the third episode surface uplift and mountain building took place. After surface uplift occurred, shortening migrated farther east to the foreland, magmatic activity in the western Principal Cordillera ceased, and kinematics in the high cordillera evolved to strike-slip. Moreover, upward erosion migration exhumed the rocks in the high Andes at least 2 m.y. after uplift. Thus, the Quaternary age obtained by fission track dating and incision markers would correspond to the slow erosive response to uplift due to strong resistance of bedrock (igneous rocks) and probably to the onset of glaciations in this zone of the Andes.

ER02 – Wed., 11.4., 11:30 - 11:50 · HSF

Peregovich, B., Mathis, A. (BELÉM - NAEA/UFPA)

Transition from small-scale artisinal gold mining to large-scale corporate mining in the Tapajós Mineral Province, Brazil

E-Mail: peregovich@lycos.de

After more than 40 years of intense exploitation of alluvial, coluvial and eluvial gold deposits, the Tapajós Mineral Province (TMP) is facing a period of important transition.

Most of these superficial deposits, easily to explore and mine with simple, primitive methods are nearly exhausted or unprofitable using artisanal methods. These secondary deposits however, are often related to primary occurrences. Both, high grade vein-hosted, and low grade disseminated or "sheeted vein" style deposits have been discovered in recent years in the TMP. These deposits are usually relatedto structural dislocations and shear zones, and often show an association with andesite or mafic dykes.

In the past ten years or so, several national and international mining companies have shown interest in exploring for, and mining primary gold deposits in the TMP - partly because the mineralized gold occurrences are reasonably well known as a result of past garimpeiro activity; and conversely because the Tapajós is virtually unexplored using modern prospecting methods.

SERABI MINING PLC began exploring in the region in 1999, and is now, in 2006, producing about 100 kg of gold per month from the underground Palito Mine. The company utilizes modern sulphide-flotation and cyanide-leach technologies to produce both direct-shipping ore and dore, respectively. SERABI directly employs over 300 people, and indirectly more than 500 local inhabitants depend on SERABI for their livelihood. At least 12 other companies are actively exploring for gold in the Tapajós Mineral Province.

This studies aim at understanding and documenting the changes that are currently taking place in the Tapajós Mineral Province. Conflicts of interest between traditional artisanal miners, the local community, and modern corporate mining entities are inevitable. It is hoped this project will create and provide ideas for beneficial and profitable cooperation for all people and institutions involved in the TMP (i. e. small scale miners, landowners, exploration and mining companies, government authorities, local associations, etc.).

Historical analysis of production from various deposits as well as geological, mineralogical, structural and metallogenic studies of the TMP will help identify mineralized areas (small scale mines) which might be attractive targets for corporate gold mining.

Social and public interest investigations will study and document the various forms of cooperation and / or contracts between traditional mine owners and mining companies and determine the utility, benefits, possible conflicts and consequences for ongoing small scale mining activities as well as for mining companies.

Analyzing the roles of governmental organizations such as: CPRM; DNPM; IBAMA; SECTAM; SEICOM; SEMMA; and local government - as well as the roles of public / private associations and groups such as: AMOT; SDG; IBRAM and the parts they play in the process under institutional and political aspects will lead to remove bureaucratic barriers and improve the relations with them for both garimpeiros and mining companies.

Logistical and environmental affairs require to explore existing infrastructure (access to mining areas, transport, availability of food, fuel, tools, transport, goods, etc.) in order to recommend possible improvements as well as working out various prevention and remediation programs for impacted mining areas in order to restore damaged areas and prevent unnecessary harm to the environment.

Web page: http://www.gpa21.org

ER03 – Wed., 11.4., 11:50 - 12:10 · HSF

Benitez, E. (Asunción)

Integrated Water Resources Management in Paraguay

E-Mail: elenajefe@hotmail.com

Paraguay occupies 13 percent of the Plata River basin, is located in the centre of the basin, far away from the Atlantic coast (app. 1,000 km), and is thus characterized by a continental climate. The tropic of Capricorn divides the territory in two halves. As a result, the country has a climate generally warm, humid to sub-humid. Due to the absence of mountainous systems (the average height is app. 200 m above msl) to protect the region, strong north and south winds are common. The eastern region has mean annual precipitation of about 1,500 mm, potential evapotranspiration of 1,100 mm and temperature of 23°C, while the western region has a mean annual precipitation of 800 mm, potential evapotranspiration of 1,300 mm and temperature of 24.5 °C.

Paraguay shares the international aquifer systems of Guarani, Yrenda and Pantanal and the drainage basins of the rivers Paraguay and Parana. As the administrative boundaries do not coincide with the hydrological borders and due to the importance of assuming the hydrological basin as the planning unit for a sustainable use of the water resource, including both the hydrological cycle and the integrated management, DGPCRH-SEAM has designed a management policy considering all the actors in the hydrological basin (also under the aspects of transboundary basins and aquifers) as one planning and management unit.

The idea of an integrated water resources management seeks to avoid sectored or partial approaches for the solution of water problems. It aims to include all different uses and involved actors, promote a systematic compilation of basin-oriented hydrological andenvironmental data, and consider the integrated management of surface water, groundwater and atmospheric water. Only then it is possible to assess availability and demand in the basin for planning purposes and to observe the basin potentiality and vulnerability to allow new solutions especially considering users conflicts in the development and territorial zoning of critical areas due to lack of water, e.g. the western region.

With the integrated water resources management policy Paraguay plans new and different efforts to overcome the limitations set by the high level of poverty and the low access to safe water. The majority of the population lives in an environment rich in water resources without access to the benefits that this implies. Thus, the needed social and economical development requires a high effort of appraisal, awareness and education to understand the natural resources. This is the main challenge of the water resources management policy.

The National Constitution of 1992 defines Paraguay as a unitary country subdivided into 17 departementos. The environmental policy approved by the National Environmental Council strengths the decentralization process through the governorates and municipalities. Due to the fact that water is fundamental for life and a decisive factor for the development, the sustainable management of water resources must be grounded on a participative and decentralized democracy, including all users and actors.

Due to the interrelationship between water and environmental issues, water has a special meaning in the national environmental policy agenda. The agenda hasas a main objective the decentralized and participative management aimed to an appraise of the natural resources and to become a country sovereign and respectful of its natural resources with public policies of sustainable development that consider the different uses of water for life and biodiversity in harmony with the territorial zoning.

Integrated water resources management is presently applied to five hot spots: Ypacarai lake basin, Tebicuary River basin, transboundary Apa River basin, the Paraguayan part of the transboundary Pilcomayo River, and the Ñeembucu swamps. All these basins were selected based on their main land-use characteristics and their potentialities. The management policy is instrumented by the resolution SEAM 170/06.

The Paraguayan water resources management and administrationpolicy, while respecting the national autonomy, aspires to obtain a sustainable use of the resource, to recover the pristine natural water quality, and to enhance the life quality of men, women and children who suffer the consequences of wrong natural resources management, especially water. The policy describes actions for using and planning the water resources at a national level. It is expected that they will improve the inter-institutional relationship and thus facilitate the management of the resources, better the quality of water to enhance the access to safe water to the less privileged population, and to protect the biodiversity associated to the water resources. - The human being has the intelligence, the capacity, and the responsibility to manage the natural resources in a sustainable way.

ER04 – Wed., 11.4., 12:10 - 12:30 · HSF

Masuch Oesterreich, D. (Linares)

Water for the City of Monterrey, NE-Mexico: Assessment of the Santiago Extraction System

E-Mail: gis@fct.uanl.mx

In continuation of the assessment of the Buenos Aires wellfield located in the Huasteca Canyon south of Monterrey, Nuevo Leon, the potential of the Santiago groundwater and surface water extraction system was evaluated. Located just southeast of Monterrey the Santiago system is part of the citys water supply system that consists of a mix of surface water (Cerro Prieto Dam, Rodrigo Gomez Dam, El Cuchillo Dam) and groundwater sources (Buenos Aires wellfield, Mina wellfield, Monterrey Metropolitan wells). The Santiago system itself consists of the Rodrigo Gomez Dam, the Estanzuela Spring, the Cola de Caballo and San Fracisco tunnels, and the Los Elizondo gallery. Medium annual precipitation is in the range of 860 mm.

Monterrey, a metropolitan area of about 3.5 million inhabitants, presently requires roughly 11 m3s-1 of potable water to meet the demand for industrial and domestic uses. The most recent estimate of future growth of inhabitants is presented in the Plan Metropolitano 2021: Desarrollo de la Zona Conurbana de Monterrey by the State Secretary of Urban Development and Public Works. The Secretary expects a population of 4,589 to 5,190 million inhabitants for the year 2020 which implies further stress on existing water sources. Currently expert meetings are being held in the State of Nuevo Leon addressing the topics of future water supply, infrastructure, and sanitation.

Results 1. The recharge area of the Santiago system is about 267 km2. 2. The Rodrigo Gomez Dam is located precisely at the outlet of the hydrological basin. 3. The prevailing directions of surface runoff are W-E and SW-NE, except of the southwestern parts of the Cerro La Silla Anticline where surface runoff is N-S and NE-SW. 4. The main aquifers are the limestones of the Lower and Upper Tamaulipas formations (Lower Cretaceous). 5. Minor aquifers consist of the Zuloaga limestones (Upper Jurassic) and quaternary gravels. 6. Within the perimeter of the basin areas of direct recharge comprise 52.6 km2 (Lower Tamaulipas Formation), 2.2 km2 (Upper Tamaulipas Formation), 2.3 km2 (Zuloaga Formation), and 16.8 km2 (Quaternary). 7. The hydrogeologic basin extends into the central part of the Monterrey Salient and represents a system of highly productive and well connected aquifers that contributes significantly to the recharge of the Santiago system. 8. Extraction from the Santiago system constantly exceeded 2,000 ls-1 for the last ten years. To put this into perspective: extraction from the Buenos Aires wellfield is roughly the same with the hydrologic basin being more than four times bigger.

Conclusions 1. Considering the small size of its basin the Santiago system appears to be very well designed. 2. The basins groundwater potential presently does not seem to be fully exploited and leaves room for higher extraction. 3. In analogy to the Buenos Aires wellfield, the Santiago system may even temporarily serve as a swing provider of water during dry periods, a hypothesis that would have to be confirmed or discarded by more detailed studies.

Web page: http://www.fct.uanl.mx

ER05 – Wed., 11.4., 16:10 - 16:30 · HSF

Alfaro, G. (Concepción, Instituto GEA)

THE ENERGY CRISIS IN SOUTHERN SOUTH AMERICA: THE IMPORTANCE OF COAL DEPOSITS

In the last 4 years and with greater emphasis in 2006, Chile and Argentina have experienced an energetic crisis that has worsened due to economic growth, and the lack of hydrocarbon availability in Chile and the diminished reserve/consumption relation for natural gas and liquid hydrocarbons in Argentina. Crude oil production in Chile has diminished from 532,709 m^3 / year in 1996 to 192,032 m^3 / year in 2005. These figures mean that Chile produces no more than 3% of the petroleum consumed. In this same period, natural gas production has fallen from 3,632 million m^3 to 2,294 million m^3.

Since the end of the 1990s, Chile has depended on Argentine natural gas piped through several pipelines crossing the Andes Mountains and whose price was significantly lower than the international price. The Chilean energetic matrix in 2003 was hydroelectric energy (18%), petroleum (36%), natural gas (24%), coal (8%) and wood (13%). The lack of Argentine gas is replaced by diesel or fuel oil, whose prices are notably higher than natural gas prices.

With the arrival of President Kirchner and progressive improvement after the crisis in 2001 and 2002, Argentina has importantly increased its energetic demand, although the country has reached a situation in which the ratio of the demand for liquid in comparison with gaseous hydrocarbons presents a decreasing curve, a situation that has resulted in a partial or total diminishment of gas shipments to Chile, satisfying the important internal demand with direct purchases from Bolivia. However, Bolivia's political instability and the lack of clarity in the participation of producing companies make this an unsure solution in the future. Due to geological and geographic reasons, the Argentine energetic matrix differs from the Chilean one and consists in hydroelectric energy (6%), petroleum (41%), natural gas (45%), coal (1%) and nuclear energy (2%).

Chile has several coal-burning centrals, principally in the northern mining area, where it uses national (close to 14% in 2006) and exported sub-bituminous coal (86%, approximately 3.5 million tonnes) coming principally from Indonesia and Australia. Argentina has only one thermal coal plant located 200 km north of Buenos Aires and one single coal mine, Río Turbio, located in southern Argentina. The Río Turbio Mine, is state owned and has experienced structural problems and a fatal methane gas explosion in the last few years, paralyzing extraction (year 2003 coal production were 480,000 tonnes). The growing energy demand in Chile and Argentina should reconsider coal resources, which without being gigantic, could partially solve the actual energetic deficit, if and always if the following alternatives already being implemented in Chile are considered. These are a) coal blend combustion b) coal gasification and c) obtaining methane form coal bearing seams (CBM). Coal blend combustion produces the synergy necessary between 2 or more types of coal, providing greater efficiency that is greater than the sum of the individual coals during combustion. This mixture provides greater economic performance, a diminishment in furnace slagging and fauling, better control of particle emission, better coal combustion (elimination of residual coals in the bottom ashes and flying ashes), and the abatement of the SOx and NOx. In this method, national coals can be used, although with restrictions, with imported coal, generating the advantages identified. The results achieved in Chile are relevant and the results of industrial testing and mixture control models are mentioned in industry specialized and applied journals. This analysis should be followed to apply coal blend with other fuels, such as pet coke, bio-fuels, industrial waste, etc.

Coal gasification consists in using a chemical process to transform coal from a solid fuel into a gas fuel that is easier to handle and can be easily used in the chemical industry. Its relevant environmental advantage is the capture of CO_2, SOx, NOx, etc..

There are two coal gasification methods: i) in a reactor or surface gasification, and ii) in situ or subterranean gasification. The first method has been used since the 19th century, and its advantage consists in being able to mix coal with biofuels with good reaction control through oxygen injection. On the other hand, with subterranean gasification techniques, the reactor is the coal deposit and this method is in the experimental stage although the preliminary results are auspicious (e.g. the Chinchilla Project in Australia). Its principal advantage is that it does not contaminate the environment, avoids mining and the management of mining passives. The operating conditions depend exclusively on the geological characteristics of the coal deposit, such as unit thickness, roof and floor rock, structural conditions, and underground water level, etc.

Finally, obtaining methane from coal units is a process that uses simple perforations, controlled by the freatic level, to extract methane gas that is adsorbed in the coal and that is a product of the coalification processes. This technique is extensively used in several countries, principally the United States where there are 40,000 wells that produce 10% of the natural gas consumed there. The quantity of gas generated by a tonne of coal depends fundamentally on the carbonś rank, varying several m^3 per ton for the lower range until surpassing 100 m^3 for the upper rank coal. The best production/accumulation relation is found for the bituminous coals. Methane extraction from coal units has two fundamental implications: avoids methane into the atmosphere, avoiding the green house effect (21 times more than CO_2) and when there is underground coal exploitation after methane extraction, the risk of explosion diminishes notably. Finally, the different coal applications presented here can considerably help reduce the energetic deficit in Chile and Argentina.

ER06 – Wed., 11.4., 16:30 - 16:50 · HSF

Moya, P. (ICE)

Geothermal Energy Development in Costa Rica

The exploration and development of geothermal energy and its contribution to the electricity needs of Costa Rica are reviewed. A national reconnaissance resource study, carried out guring 1989 and 1991, indicated that the possible total geothermal potential of the country was about 900 MWe. The first deep geothermal exploratory wells in Costa Rica were drilled at Miravalles in 1979-1980. Electricity began to be produced at that geothermal field in early 1994. Since then, the installed capacity has grown from 55 MWe to 163 MWe. The two undeveloped Costa Rican geothermal systems that have been studied the most are those associated with the Tenorio and Rincón de la Vieja volcanoes. In 2001, a deep exploratory drilling program was begun at the Las Pailas geothermal zone on the southern slope of the Rincón de la Vieja volcano. At the same volcano, but in another geothermal zone called Borinquen, geothermal wells have been drilled starting in 2003 and 2004. Preliminary results of those drilling programs are presented. The contributions of different energy sources to the electricity system of Costa Rica are discussed. At the end of 2004, geothermal energy contributed 1,204.4 GWh, representing more than 15% of the total electricity generated, even though it accounted for only 8.6% of the country's installed capacity.

ER07 – Wed., 11.4., 16.50 - 17:10 · HSF

Giron, J. (Guatemala, INSIVUMEH), Hernández, W. (San Salvador, SNET), Guerrero, I. (Honduras, Fomento Minero)

Elaboration of a cross-border geological map in the Trifinio area, Central America

The Trifinio is defined as the fringe area of three Central American countries: Guatemala, Honduras and El Salvador. Nearly 700000 habitants are living in 45 municipalities of the Trifinio, which extends to an area of about 7541 square kilometers. Since the 1970s a regional development and crossborder collaboration is aspired. In terms of water management the Trifinio area is of special and regional interest. A part of the Trifinio area corresponds to the drainage basin of the Lempa River in El Salvador. The sphere of influence of this stream course covers nearly 50% of the Salvadorean territory also including the state capital, San Salvador, with about 2 Million of inhabitants. On the other hand deforestation and inappropriate land use cause intensive retrograde erosion and shallow land sliding problems in the Trifinio area. In order to avoid environmental problems, for example water pollution or erosion effects, a fundamental planning management is indispensable. Therefore basic information maps like geologic information are necessary. Although, each country has their own geological information and maps, there is a need to elaborate and standardize a crossborder geological map of that region. There are still stratigraphic problems to solve even in the correlation of the stratigraphic columns as in the distribution of the litological borders in the geological map. The results of the crossborder geological mapping will work for future analysis in the regional and urban planning (management) for example to support the derivation of the hydrogeological map or for regional analysis in geohazards.

ER08 – Wed., 11.4., 17:10 - 17:30 · HSF

Yutsis, V. (Linares,Mexico, Earth Science faculty, UANL), De León Gómez, H., Masuch Oesterreich, D., Izaguirre, F. (Linares, Mexico, Earth Science faculty, UANL), Garza Treviño, P. (Monterrey, Mexico, CNA)

GEOLOGICAL STRUCTURE, GEOPHYSICS, AND HYDROLOGY OF CERRO PRIETO DAM, NUEVO LEON, MEXICO

The geographical location of the State of Nuevo Leon, due to its physiographic features, has temperate and arid climate; undeveloped drainage, low precipitations, and high evapotranspiration rates, as well as rapid demographic growth. All these characteristics have generated domestic water supply shortage since 1979 making this a major problem for the state government. Monterrey city, the most important, industrialized in the state, with a population of about four million inhabitants, faces one of the most serious water supply scarcity. The present water supply is obtained from ground water sources (Campo de Pozos de Mina, Sistema Santa Catarina, Sistema Santiago I, y Campo de Pozos Monterrey) and superficial waters (La Boca, Cerro Prieto and El Cuchillo Dams). The ground water sources are geologically located in limestone aquifers with high storage and transmissibility coefficients fromthe Cupido/Aurora formations from the Cretaceous in the Sierra Madre Oriental. The ground water that flows through these limestone, are mainly due to karstic phenomena as well as to folded and fractured areas. The superficial sources, located in the foreland of the Sierra Madre Oriental, have a pluvial and underground origin and are collected by the respective hydrographic basins. The overall water supply demand for Monterrey city is calculated as a daily amount of 370 liters per capita, and 17m3/s for domestic, industrial and city demand. Nevertheless, this demand is satisfied with approximately 11m3/s. This shows a deficit of about 6m3/s. The Cerro Prieto Dam was constructed in 1982 in the River Pablillo Valley, NE Mexico. The Dam is located 130 km SE of Monterrey City. During the last years a hydrological monitoring was carried out. The hydrological data of the basin, registered in the hydrometric station Cerro Prieto, showed an annual precipitation from 415 up to 1130 mm/a , the mean evaporation of 705 mm/a (up to 2460 mm/a in 1996). The important characteristic is water level measured directly in the dam. The maximum water storage of the Cerro Prieto reservoir is 395 millions m3 which corresponds to a water level of 295 meters. By the end of June 2006 the water level was at 276.2 m which corresponds to a water volume of about 127,806,300 m3 which is less than a third of maximum storage. Analysis of hydrological data showed sufficient misbalance between water recharge (by rain, river flow) and loss due to evaporation, filtration, extraction, discharge, etc.

The reservoir is geologically located in the Llanura Costera del Golfo Norte, to the North on the San Felipe Formation, and to the South on the Mendez Formation, both from the Upper Cretaceous. The San Felipe Formation is made up of a heterogeneous sequence of limestone, silicified limestone, marls, shale, and sand. The Mendez Formation is made up mainly of shale and marls. The tectonic structure is influenced by a system of faults and fractures (lineal photo features), as well as by a series of anticline structures, and moderate to prominent synclines. Inverse faults and folds, along with normal faults, have generated a high permeability in the rock mass in underground local areas. The dam and dikes 1 and 2 were built on rocks from the San Felipe Formation where the faults and fractures have dominant directions perpendicular to the dam axis, to the position of the stratigraphy (parallel to the dam axis and the dikes), and an heterogeneous lithology have generated dam seepages, as well as in the drainage channel. The main sources for infiltration are located at the foot of the dam and the dikes. The filtration rate was calculated at about 1000 l/s. The purpose of geophysical research was study-

ing a near surface as well as a deep structure of the Cerro Prieto area with the goal of an analysis of geological reasons of this hydrological phenomenon. 160 gravity reading points, 400 onshore magnetic field readings as well as about 250 offshore magnetic points were carried out. The standard corrections as instrumental drift, latitude, elevation, IGRF, etc. were applied to obtained data. Data procession includes Fourier transformation, wavelength filters, upward continuation, vertical and horizontal derivates, etc. As a result a 2D geological-geophysical models and 3D maps were elaborated. The general trend of the magnetic field reduced to a pole is NW - SE on which background anomalies of northeast trend are obviously traced. The general trend of the gravity field received as a result of our works is the same. However, local magnetic and residual gravity anomalies have mosaic character and, being morphologically extended in a NE direction, grouped in chains of northwest trend. Potential data interpretation allows assuming a series of the superficial fractures focused in a NE direction, perpendicular (NW-SE) to the general deep fault. The analysis of the received data indicates a sharp variability of volume of fresh water in the basin, due to several complex factors. Major factors are: hydrogeological and climatic conditions of the region (1), intensive extraction of fresh water from surrounding areas (urbanization and agricultural activity of the city of Linares), which is reflected in strong fracturing of the subsurface layers and lowering of aquifer depth (2), presence of a deep fault trending northwest (3), and a high velocity of recent sedimentation (4).

ERP01

Avalos, Y., Jara, S., Schillinger, R., Oporto, O. (Asunción)

EVALUACIÓN FÍSICO QUÍMICA DE LOS RECURSOS HÍDRICOS EN LA MICROCUENCA DEL Aº EMPALADO EN EL DISTRITO DE CAAGUAZÚ - PARAGUAY

E-Mail: avalos@ordazur.org

Este trabajo forma parte del proyecto 'Ordenamiento Ambiental de Zonas Urbanas', corresponde a las actividades desarrolladas conjuntamente entre la Secretaría del Ambiente (SEAM) y el Instituto Federal de Geociencias y Recursos Naturales (BGR) de Alemania, dentro del proceso de descentralización del estado para el logro del fortalecimiento de los municipios y gobernaciones del país.

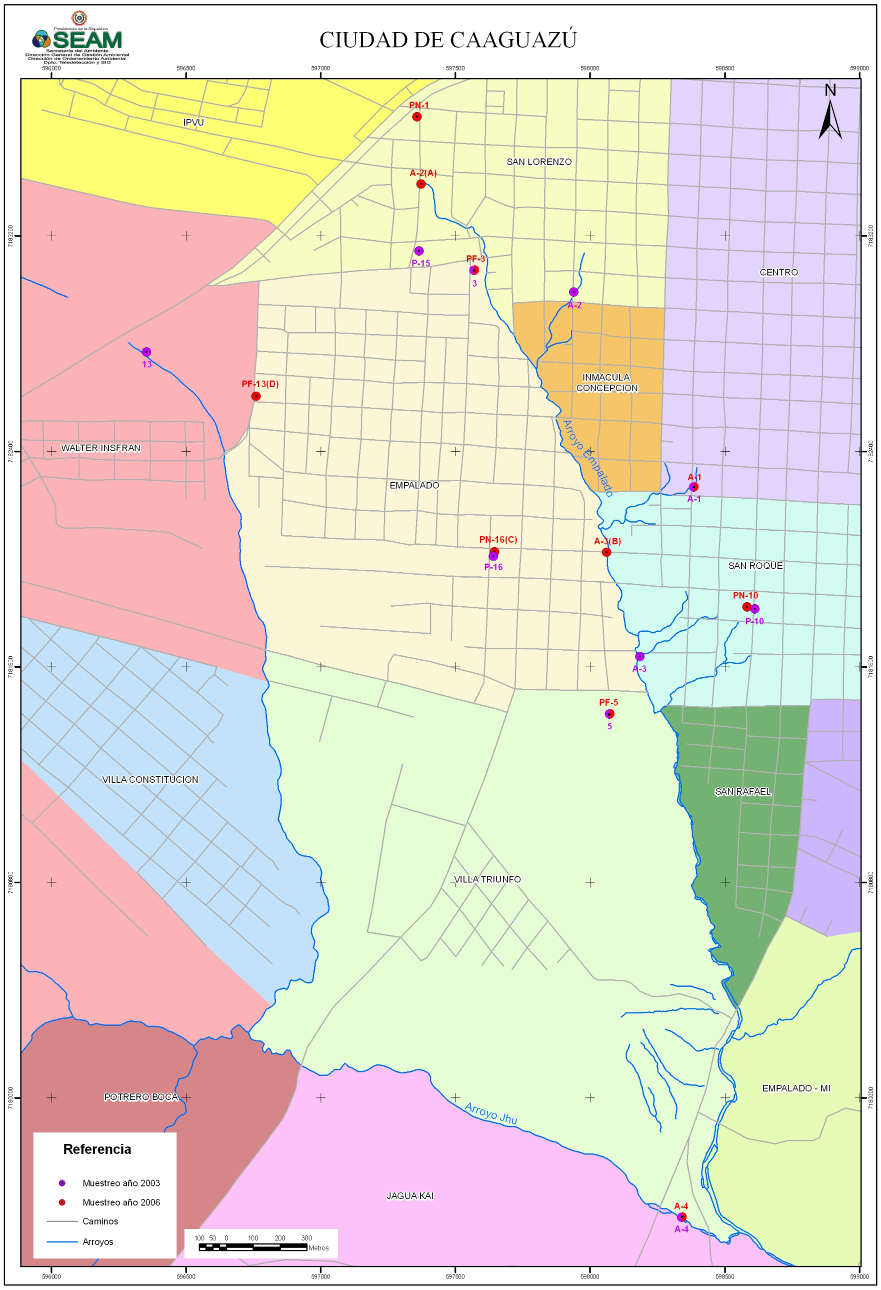
La microcuenca del Ao. Empalado (Mapa 1.1), abarca una superficie aproximada de 1000 ha, incluyendo los barrios San Rafael, Empañado Ari, San Lorenzo, San Roque, Villa Triunfo, Inmaculada Concepción y Empaladomi. Es una zona densamente poblada y corresponde al área urbana del distrito de Caaguazú, con una población urbana de aproximadamente 50.000 habitantes (Según DGEEC. Censo Nacional de Población y Vivienda, 2002). Topográficamente presenta dos lineamientos de lomadas paralelos a los límites este y oeste del curso de agua. Las partes más bajas del área se encuentran a un nivel alrededor de 200 msnm, y las zonas más altas del mencionado curso de agua a una altura de 360 msnm.

El informe presenta los resultados de una campaña de muestreo y análisis de laboratorio de las aguas superficiales y subterráneas en toda la zona de la microcuenca del Ao. Empalado y sus afluentes, llevada en principio, como una de las actividades fundamentales para obtener un mejor conocimiento de posible presencia de contaminación antrópica, para posteriormente, generar estrategias de protección en base a recomendaciones y planificaciones requeridas para el efecto.

Se evaluó en base a un listado, descripción y cruzamiento de datos de análisis laboratoriales obtenidos, juntamente con la observación de la potabilidad de las aguas y de las variaciones espaciales de la calidad en la zona de estudio, facilitando la interpretación de los datos. En total se analizaron en el laboratorio 11 muestras de agua, en dos periodos de tiempo (2003 y 2006). El agua de la región es en general poco mineralizado y de pH ligeramente ácido. En la zona urbana las aguas superficiales son altamente contaminadas, así como el agua subterráneo superficial.

Esta información proporciona el punto de partida para desarrollar ideas con respecto a las prioridades para la protección de la calidad de las aguas de la microcuenca del Ao. Empalado.

Web page: http://www.ordazur.org


CIUDAD DE CAAGUAZÚ
SEAM
IPVU
SAN LORENZO
CENTRO
INMACULA CONCEPCION
WALTER INSFRAN
EMPALADO
SAN ROQUE
VILLA CONSTITUCION
SAN RAFAEL
VILLA TRIUNFO
POTRERO BOCA
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JAGUA KAI
Arroyo Empalado
Arroyo Jhu
PN-1
A-2(A)
P-15
PF-3
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PF-13(D)
A-1
PN-16(C)
P-16
A-3(B)
PN-10
P-10
A-3
PF-5
A-4
N
Referencia
Muestreo año 2003
Muestreo año 2006
Caminos
Arroyos
Metros

Figure 1:

ERP02

Garza-Rocha, D. (FCT, Linares, México), Galván-Aguilar, E. L. (Schlumberger, Cd. Carmen, México), Sánchez-Pérez, L. A. (FCT, Linares, México)

Seismic refraction measurements for the determination of the thicknesses of the gravel channels in the Cañón de La Huasteca, Santa Catarina Nuevo León, México

E-Mail: dagarza@mail.uanl.mx

The metropolitan area of Monterrey is located in a region where the pluvial precipitation is erratic and concentrated. There are long periods of little precipitation and short periods of great abundance. The constant growth of the metropolitan area, as well as the extreme climatic conditions makes insufficient the supply obtained by the dams La Boca, Cerro Prieto and El Cuchillo. Due to previous thing it is necessary to carry out water extraction of groundwater of the Buenos Aires System in the Huasteca canyon. One of the first tasks to be able to establish a model of the acquifer of the Buenos Aires System, was the rise of geologic cartopgraphies to detail made by students of the Facultad de Ciencias de la Tierra, UANL and of the Technical University of Aachen. Another of the questions was the determination of the thicknesses of the gravel channels, in the zones of interaction between the free (gravel) and the deep acquifer (limestone). The methodologies for the exploration of the underground water in a certain area are based on superficial geology and the phreatic level of existing wells. Nevertheless, it is not only recommended to focus the exploration from the geologic point of view, but to always complement with applied Geophysical since this allow to make a view type X-rays of the subsoil, of indirect way, applying diverse geophysical techniques. These techniques, depending on the geophysical method, are based on the determination of physical properties of rocks, as it they are electrical resistivity, electrical conductivity,specific density and the velocity of propagation of the seismic waves, among others. The values of these physical parameters, that are obtained, allow to obtain a geologic model of the study area. This allows establishing a more precise conclusion of the existence or not of groundwater. In the present work were made 2 profiles of seismic refraction. The design of the first profile is a line of 24 geophones separated 10 m between each one, with the first point of shot to 5 m of the first geophone firing each 10 until completing the laying of detectors. On this profile were generated 25 seismograms. The first breaks were picked on the seismograms. To obtain the velocities of the underground were plotted the first arrival times against the position of the detectors and using the method of least squares can be determined lines of better fit. Determining the inverse of the slope of the corresponding line was obtained the velocity of the layer selected. The design of the second seismic profile is with 24 geophones separated 10 m each one, in this profile were made 3 shots, one at the beginning of the line another one in the central part and one in the final part of the line. From the data collected with these profiles two geologic sections were obtained and a model of velocities. From the seismic profiles were obtained the corresponding models. They consist of gravel channels whose velocity changes from 1000 m/s to 1300 m /s and thickness from 16 m to 53 m. Below the layer of gravel channels can be inferred the layer of limestones.

ERP03

Garza-Rocha, D., Méndez-Delgado, S. (Linares, México)

Shallow geoelectrical survey in the Cañón de La Huasteca, Santa Catarina Nuevo León, México

E-Mail: `dagarza@mail.uanl.mx`

The aquifer of the Cañón de La Huasteca conforms himself for a shallow aquifer of gravels, possibly also in fractures of the formation Méndez (shales) and a deep aquifer in calcareous (in fractures and karstic zones). In the present work we have as main objectives: a) the application of the electrical method to obtain the electrical resistivity distributions in the study area, with the purpose of relating with the shallow lithology present. b) the determination of two-dimensional models with base to the electric data measured in the field. On the base of the near surface geology we explore an opportunity area denominated El Cañón de La Escalera, this is a part of the known Cañón de La Huasteca. We use the dipole-dipole array along six profiles perpendicular to the direction of the Cañón La Escalera. The separation among current and potential electrodes was 30 m. The number of potential dipoles n was 5. The inversion of the measured electrical data was made with the use of the commercial program denominated RES2DINV and using quadratic programming. Of the obtained models the next characteristic are highlighted: a) Poor conductor. Generally related to breaches of the Tertiary, to alluvial deposits of the Quaternary one and dry alluvial sediments. b) Good conductor. Related with the bed of streams. The models 2-D obtained with base to the data of apparent resistivity allowed to relate the anomalies with the shallow litohlogy present.

ERP04

Gonçalves, C.M., Oliveira, J.A.S. (DQ - UFMG), Sousa, O.M., Saturnino, J.O. (EBA - UFMG)

Mineral Pigments from Minas Gerais - Brazil. Part II: Applications

E-Mail: cmariag@gmail.com

Natural inorganic pigments have been utilized since ancient times [1]. They are easily found and still widely used for coloring materials. Soil pigments are distinguished on the basis of color as yellow ochres, red earths, green earths, dark yellow or brown siennas and umbers These materials show various desiderable attributes: display a range of colors with pure hue and high tinting strength present in small particle sizes, nonfading andpossibly resistant to acids and alkalis.

In this work, some mineral paints were prepared from selected saprolite samples collected near São Sebastião das Águas Claras (Macacos) - Nova Lima - MG, about 20 km from Belo Horizonte.

The town of Nova Lima is located in the Quadrilátero Ferrífero (QF), central area of the state of Minas Gerais. This place is an important region of Brazil due to its mineral richness, mainly gold, iron and manganese. The most important lithostratigraphic units of the QF are the Archean to Paleoproterozoic granite-gneiss terrains, the Archean greenstone belt sequences (Rio das Velhas Supergroup), the Minas Supergroup, and the post-Minas intrusive rocks [2]. Nova Lima belongs to the Rio das Velhas Supergroup, where the main components are sedimentary and metamorphic rocks (e.g., steatite, schist, mica schist, phyllite, mixed quartzite).

The collection of five colored samples - ochre (MA2), light red (MA13), red (MA16), reddish brown (MA20) and light green (MA27) - were ground in a ball milling for 1 h. The thermal stability was investigated by heating the samples under air atmosphere at 200, 400 and 600 ^{o}C for 1 h. All samples were characterized by X-ray diffraction (XRD) and fluorescence.

The main identified minerals in natura were kaolinite, illite, hematite and goethite. The colors and XRD patterns were conserved under 200 ^{o}C, except for MA20 (its color was changed from reddish brown to orange). At 400 and 600 ^{o}C both colors and mineralogical composition of all samples were altered.

The quality of all pigments was investigated by covering power (CP) and oil absorption (OA) [3]. The results revealed that these materials present essential features for producing paints for ceramics, oil and acrylic painting, among others. Such paints may be used for architectural and handicraft purposes.

References

[1] Hradil, D., Grygar, T., Hradilová, J., Bezdička, P., Applied Clay Science **22** 223 (2003).

[2] Spier, C. A., de Oliveira, S. M. B., Rosière, C. A., Minerallium Deposita **38** 751 (2003).

[3] Book of Standards, **06.02**. American Society of Material Testing (1988).

ERP05

Büchi, A., Pagung, R., Karfunkel, J. (Belo Horizonte, Instituto de Geociências da UFMG, Brazil), Hofmann, M., Hoppe, A. (Darmstadt, Institut für Angewandte Geowissenschaften, TU-Darmstadt, Germany)

Resources for a growing city - sand, clay and gravel extraction north of Belo Horizonte, Brazil

Belo Horizonte, the capital of the state of Minas Gerais (Brazil), is growing rapidly and has been considered by the United Nations one of the cities that will become a megacity with more than ten million inhabitants by the middle of the century. As the analysis of georesources and their economical and ecological viability is essential for a sustainable urban growth, this project aims to evaluate these aspects as support for urban planning in the northern periphery of Belo Horizonte, themain direction of the urban expansion.

As a case study, 6.68 sqkm of the alluvial plain of the Riberão da Mata has been chosen. This area has been subject to sand, clay and gravel extraction during the last decades, and many of the pits have been simply left open after the extraction terminated.

A visual analysis of aerial photos covering nearly half a century shows the land use change in this area. Frequent changes of the riverbed, erosion at its margins, siltation and the augmentation of exposed soil and water bodies due to sand extraction could be observed. These analyses were accompanied by field observations where a special focus has been set on the sedimentological structures visible in sand and clay pits in the central part of the alluvium. Above the channel sediments that provide the sand, quite often four to five meters of overburden in the form of floodplain sediments have to be cleared away.

The peak of the resource extraction was between 1960 and1980, when the city was growing rapidly and environment legislation was less strict. Since the middle of the last century, more than 30% of the area have been subject to extraction of sand and clay (1.5 sqkm in 1977 and only 0,5 sqkm in 1990). The reduced activity in the last twenty years can be mainly assigned to the depletion of easily accessible sand above the water level, land use conflicts and a stricter environmental legislation that protects a buffer zone along rivers. Still, it is one of the few areas close to the city where sand and gravel for construction purposes can be found and extracted.

In some abandoned areas, industrial plants that are e.g. breaking carbonate rocks for gravel substitution have been constructed by now, as the alluvium is one of the few plain construction sites in the area. The gravel extraction has nearly stopped since, as the natural gravel resources are deep and few. When the extraction sites are just left open, the natural recuperation is slow and erosion carries away fertile soil that increases the sediment load of the river. In 1977, 0,4 sqkm of the area could be classified as exposed soil showing signs of erosion. Due to extraction of raw material, the area covered with water has strongly increased, which on the one hand has a positive effect on recreation and fishing possibilities as well as for the bird and amphibian population, but on the other hand reduces the available area of plain building sites.

ERP06

de León, H. (UANL, Linares), WORKING GROUP (Linares, Mexico)

Project: A vanguard Diplome for geoscientists in earth sciences. PEMEX/UANL

The Working group includes: H. de León, C. Pola, R. Chapa, J.A. Ramirez, U. Jenchen, D. Masuch, S. Mendez, J. G. Lopez, F. Medina, J.C. Montalvo, V. Yutsis, F. Velasco, Navarro, I., Chávez, G., A. Oviedo, A. Perez, P. Oseguera, A. García, M. Limon, E. Miranda, A. Guel, R. Barbosa, R. Lopez, M. Maldonado, A. Treviño, V. Beraza, A. Ramos, P. Rodriguez

The main goals of the Department of Earth Sciences (FCT) of the Universidad Autónoma de Nuevo León, arethe creation, preservation and transmission of the scientific and technological culture in benefit of the society. In this sense, it forms and qualifies professionals, scientists and technicians to satisfy the needs for the economic and social development of the state of Nuevo León and Mexico as well.

Petróleos Mexicanos Exploración y Producción (PEP) is a decentralized organism of the Mexican Federal Government. Their main function is to explore and develop, with leading edge technologies, new oil and gas deposits, in order to maximize their economic value to contribute to the sustainable development of Mexico.

The growing world need of hydrocarbons, as well as the fact that they represent the most important Mexico´s export, forces a higher efficiency in the exploration and localization of plays. In this way, PEP requires that its personnel get a higher qualification for these purposes. For this reason, PEP collaborates closely with the FCT for together improve the knowledge and skills in Earth Sciences of selected professionals, studying geologic systems similar to those in the subsurface. The instructors are experienced FCT Professors, PEP Experts and domestic and foreign Advisors. During 4 months of activities, that includes theoretical and practical courses, field training and integration and interpretation of the obtained results, the students obtain a Diploma in Earth Sciences (Diplomado en Goeciencias) with curricular value.

By means of the study of outcrops, the characteristics of the petroleum systems are recognized in different sedimentary and tectonic scenarios. Geologists, Geophysicist, Palaeontologists, Oil Engineers, Mineralogists, Computer Engineers and other Scientists are trained to a better understanding of the geologic models. With this knowledge and with help of modern technologies, is possible the accurate interpretation of the subsurface structures and strata diminishing the risks in the prospection. The graduates acquire very important scientific skills, specially in hydrocarbons exploration. This is the final aim for incoming opportunities in contributing for geological investigations. Undoubtedly the most important tools in getting the corresponding diploma is the effective teaching-learning process during their training.

ERP07

López Escobar, K. (Milagro), Etcheverry, R. (INREMI, La Plata), Botto, L. (CEQUINOR, La Plata), Kaufhold, S. (BGR, Hannover)

Provenance and tectonic of ordovician kaolinte from Buenos Aires province, Argentina.
E-Mail: katthylopez@hotmail.com

The geology and the mineralogy of clays from Barrientos Hills, Buenos Aires Province, has been described and discussed how skills to attain their provenance and tectonic. The inves-tigation is divided in two parts: the first one is dedicated to the study of geological aspects, whereas in the se-cond part it is analyzed and discussed the physico-chemical characterization of the clay materials, very useful to support field observations. The work begins with the location of the geological area, including a brief reference about the general cha-racteristics of Barrientos Hills. Later, a panoramic approach about the regional geology of the Tandilia System is presented. Moreover, showing the out-crops and opencast workings iden-tified was produced. The second part of this investigation tends to establish a mineralogical-physicochemical characterization of the studied claystone which is studied by meansof different techniques. In that way structural and spectroscopic aspects related to the sheet silicate are discussed and analysed with structural and spectros- copy features are discussed attending the following analytical techniques: (1) X-Ray diffraction, (2) FTIR Spectroscopy, (3) Cationic exchange capacity (CEC), (4) X ray fluorescence (for majority elements), (5) scanning electron microscopy (SEM) with dispersive energy accessory for surface chemical analysis (EDAX) as well as different thermal studies in air atmosphere. Moreover iron species behaviour is chemical and essentially analysed in clays and clay minerals using the (6) temperature programmed rediction technique (TPR). Additional studies of (7) stable isotopes ($\delta^{18}O$ and δD) have veen done in clay sa-mples, contributing so to the know-ledge of the processes and formation conditions. All the information in finally used to discuss the provenance of the deposit, suggesting the process steps that led to the studied mineral species and contributing to correlate these claystone deposits with geological units Cambro-Ordovician, Formation Balcarce, reported in the region. The results obtained indicate that claystone derives from a continental margin and was formed in an oceanic environment with low energy. Towards the Ordovician the sedimentary sequence was cut by the intrusion of the basic rocks that caused thermal metasomatic processes in the diabase-claystone contact. This hypothesis allows to define a sedimentary origin for claystone, without a genetical relationship with the diabase.

ERP08

Muñoz, C. (Santiago, Fundación Chile), Kraml, M. (Hannover, BGR), SIERRA NEVADA Working Group (Santiago, Hannover)

Geothermal surface exploration - Examples from Sierra Nevada prospect, Chile

E-Mail: m.kraml@bgr.de

Geothermal surface exploration is based on a broad spectrum of geoscientific investigations. It usually starts with a regional review with prioritizing sites followed by site selection including the application for a concession. A detailed literature survey marks the end of the project identification phase (go/no go decision). Remote sensing, a geologic survey, a hydrologic survey and a geochemical survey are the main components of the reconnaissance phase. At the end of thisphase again a go/no go decision has to be made whether to continue or to stop the project. A detailed geophysical survey with the main aim to locate the reservoir in depth and to determine its size as well as the synthesis of all data resulting in a conceptual model (with suggestion of sites for exploratory drilling) are the important steps for the pre-feasibility study (go/no go decision). A project site in Chile was chosen for geothermal surface exploration by a joint Chilean/German team consisting of Fundación Chile, Geotermia del Pacífico (concession holder) and BGR Hannover. The geothermal prospect site near Curacautín village (38.5°S) is associated with the inactive (dormant) stratovolcano Sierra Nevada (older than last deglaciation), of calc-alkaline composition with an eroded crater of 3 km in diameter. Along the NW slope of the volcano hydrothermal alteration zones appear with partly still active geothermal surface manifestations (e.g. hot spring Termas de Rio Blanco and fumarole field El Toro). In the valleys at the foot of the volcano additional hot springs and thermal water aquifers are located which are partly utilised as spas (i.e. Manzanar, Malalcahuello and newly found hot spring Caromi).

The major crosscutting structural element in the prospect area is the prominent Liquiñe-Ofqui-Fault-Zone (LOFZ). Additional local lineaments were detected by aerial photograph interpretation and byfield work in 2006.

A gas sample of the fumarole El Toro, samples of the available fluids from hot springs and thermal wells as well as samples of alteration zones were taken during the field campaign in February to April 2006. Additionally, a geophysical survey applying resistivity methods (magnetotellurics MT and time-domain-electromagnetics TDEM) was carried out to detect the geothermal reservoir in the subsurface.

Analyses of the fluids were done in the laboratories of Fundación Chile, Santiago, Chile, Thermochem, Inc., Santa Rosa, California, U.S.A. and BGR, Hannover, Germany. An inter-comparison of an identical test sample has demonstrated the quality of the analyses of all involved labs.

Finally a conceptual model of the geothermal system was developed by joint interpretation of the available geoscientific results. Further investigations and analyses of additional samples are suggested to test the validity of the model.

Web page: http://www.bgr.de/GEOTHERM

ERP09

Muñoz, C. (Lima, ExploAndes SRL), Wolf, D. (TU Bergakademie Freiberg)

Thaumasite in a high temperature polymetallic skarn system, Ancovilca project (Central Peru)

The Ancovilca Project is located in the Yauyos Province of the Lima Department, 65 km south of La Oroya town (75°50’44”W, 12°07’46”S), on the right side of the Cañete river. It is interpreted as a large, high temperature, polymetallic intrusion-related skarn system emplaced into the Upper Cretaceous Celendín Formation (limestones interbeded with marls and siltstones) intruded by Miocene granite/granodiorite stocks. An extensive metamorphic halo has been developed at the contact which is made up of marble with intercalationsof skarn (garnet-diopside; garnet-wollastonite-epidote-calcite) and hornfels (diopside-garnet-quartz-felspars) with abundant pyrite. The sulfide mineralization consists of ”mantos” and veins with pyrite, lesser amounts of chalcopyrite, sphalerite, galena. Locally Cu-Ag sulphosalts, molibdenite, stibnite, and bismutinite have been reported.

The thaumasite ($Ca_3Si(CO_3)(SO_4)(OH)_6 * 12H_2O$) occurs as an open space filling (in cavities and/or fractures) within the retrograde skarn mineralogy (garnet-diopside-calcite-chlorite-epidote) associated with anhydrite, gypsum, calcite, pyrite, and probably ettringite. It has fibrous and ascicular habit, and frequently occurs as radial aggregates. It is fragile and behind sun exposure is brittle and pulverulent (probably by water loss). This mineral has been found in all the drill holes (04), drilled by North Compañía Minera S.A. (1999). This is the first report of this mineral in Peru. The amounts of thaumasite and its association with sulfates (gypsum and anhydrite), pyrite, and calcite is remarkable. Due to some external (physical) characteristics that are not typical for the thaumasite, his occurrence has been confirmed by XRD complemented with XRF analysis (Institut für Mineralogie, TU Bergakademie Freiberg, Germany). There is a very good correlation of the H_2O- and CO_2-contents (determined with Thermogravimetric Analysis) and the chemical composition of the Ancovilca samples with that of the theoretical thaumasite.

	Thaumasite (Ancovilca) wt. %& Theoretical composition* wt. %	
SiO_2	10,38	9,65
CaO	27,37	27,02
SO_3	12,92	12,86
H_2O	43,08	43,40
CO_2	6,13	7,07
	99,88	100,00

*calculated for the formula: $Ca_3Si(CO_3)(SO_4)(OH)_6 * 12H_2O$

Furthermore the similitude between the theoretical composition of the thaumasite and the Ancovilca sample shows that the Ancovilca thaumasite is very pure. This is also supported by the lack of XRD reflections different of that of the thaumasite.

In the last years thaumasite has been intensively researched, because it occurs in some concrete materials as a result of the reaction with sulfates or sulfuric acid. The damages produced in this way demanded intense and detailed studies.

The thaumasite occurrences in some similar mineral deposits in Peru, has been probably underestimated. It is possible that this mineral has been misinterpreted as other minerals (gypsum, anhydrite, ettringite), because some common physical properties. The thaumasite presence and its significance in the alteration processes of mineral deposits is investigated.

ERP10

Oliveira, J.A.S. (DQ - UFMG), Gonçalves, C.M. (DQ - UFMG), Sousa, O.M., Saturnino, J.O. (EBA - UFMG)

Mineral Pigments from Minas Gerais - Brazil. Part I: Physical-chemical characterization

E-Mail: juliana@qui.ufmg.br

Natural inorganic pigments have been utilized by mankind since ancient times, which can be extracted directly from the soil and are easily found.

Paints and other decorative finishes made from natural raw-materials are a good replacement for today's conventional paints made from petrochemical derivatives. The manufacturing processes involve minimal pollution, waste and energy.

Preparation of pigments is rather simple. To convert raw material into usable pigment is only a matter of grinding into a very fine powder. Sometimes, if the mineral pigment has been exposed to the air and is oxidized, softened and in a form pure enough, little or no processing is needed. In many cases a pigment can be found ready to use off the ground. Sometimes though, mineral pigments are very hard and must be processed. This is done by grinding the mineral. The material being ground can be left dry or water can be adeed to help keep the fine particles from scattering during processing.

Minas Gerais (MG) State, Brazil, is composed of great geological variety, which results in a large source of different colours that can be seen where the rocks are cut and roads built. Sorrounding Belo Horizonte, the main city, this is mainly associated with the Nova Lima group of rocks, composed of sedimentary and metamorphic rocks.

In order to better understand the pigment composition and application, a research group involved in geoscience, chemistry and Arts have been working in this subject. The present study deals with a group of pigments collected near São Sebastião das Águas Claras (Macacos) - Nova Lima - MG, about 20 km from Belo Horizonte.

Selected saprolite samples from this region presented the colours ochre (MA2), light red (MA13), red (MA16), reddish brown(MA20) and light green (MA27).

The fine granulometry powder compounds were characterized by X-ray diffraction and fluorescence. The main identified minerals were kaolinite, illite, hematite and goethite. Magnetic components were not found. The presence of some aggregates was verified in the compounds analyzed by electron microscopy scanning.

ERP11

Sgarbi, G. N., Karfunkel, J., Pereira, S. D., Pimenta, F. (Belo Horizonte, IGC - UFMG), Peregovich, B. (Belém, NAEA - UFPA)

The Paredão Kimberlite, Western Minas Gerais, Brazil: Field Relations, Facies, Chemical Data and Host Rocks

E-Mail: gncsgarbi@gmail.com

The Paredão Kimberlite of Upper Cretaceous age lies 16 km west of the city the town of Arcos. It forms a circular, geomorphologically lowered area of about 30 ha, in contrast to the sharp scarps of the intruded host-rocks. The latter corresponds to a carbonate sequence (calcarenites, calcilutites and carbonate breccias) of the Neoproterozoic, lower, Bambuí-Group, belonging to the São Francisco Basin. The kimberlite shows a well defined crater facies with poorly-sorted pyroclastic deposits, cemented by a calcium carbonate matrix, tuffs and fine-grade lapillites. Metric-size, angular and rounded "floating" boulders composed mainly of granite and limestones, seldom quartzites, are common. The rounded boulders were related to mutual friction between clasts, as well as corrosion processes, inside the conduct during the ascent of the magma. Clasts and boulders of granite and quartzite are considered as "exotic" to the geology of the studies area, because they do not outcrop. Nevertheless, regionally they are positioned under the carbonate sequence. Due to the composition of the kimberlite, allied with the tropical climatic conditions, the diatreme facies is deeply weathered, forming a green-brown mass of clayed material, covered by soils or volcanoclastic deposits.

The volcaniclastic facies shows 6 m of maximum thickness, and forms elongated bodies of poorly-sorted lapillites, representative of proximal facies of the vent, and distal fine-grade tuffs. Directional fabric is absent in both. They were deposited by pyroclastic flows controlled by gravity, along the declivity of the volcano borders. The tuffs were investigated by optical microscopy and have shown a varied and extensive assembly of organic fragments, not yet identified. The diatreme facies have shown kimberlitic indicator minerals identified by Raman spectroscopy and analyzed by electronic microprobe, showing the following averages:

(a) 19 red-wine, purple and yellow pyrope grains: MgO (12.10 wt%), Cr_2O_5 (0.55 wt%), CaO (4.46 wt%);

(b) Only one green diopside grain: Cr_2O_5 (<0.5 wt%);

(c) 10 Ilmenite grains: $FeO+Fe_2O_3$ (36.56 wt%), Cr_2O_5 (1.52 wt%), MgO (8.16 wt%).

The host-rocks near the crater are oolitic and pelloid limestones, besides reef monomitic breccias, the majority completely chemically modified by the thermal effect of the intrusion. The result was an extensive silicification and withdrawal of the $CaCO_3$ preserving, however, their original appearance, structure and texture.

In the field the contact between the Paredão kimberlite and the host-rocks is, in some localities, difficult to map due to the weathering conditions. The scale of the regional magnetometric maps is too small to delimit the exact contact. This contact has been marked on the geologic map in a 1:10.000 scale with the use of a scintillometer (gamma x-ray), which yield excellent results. The kimberlite as well as their alteration products showed values ranging from twice as high to four times in comparison to those of the host-rocks.

The geology of the area is very exciting and provocative and was not yet described in detail, probably due to the chemical composition of some minerals that indicate little possibility of the Paredão Kimberlite to be economically viable.

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Web page: http://www.igc.ufmg.br

ERP12

Sgarbi, G. N., Sgarbi, P., Karfunkel, J. (Belo Horizonte, IGC - UFMG), Peregovich, B. (Belém, NAEA - UFPA)

The Prospecting for Volcanic Conducts of Upper Cretaceous Age in Western Minas Gerais, Brazil

E-Mail: gncsgarbi@gmail.com

During the Upper Cretaceous, an intense tectonic reactivation took place in the central-eastern plateau of Brazil. This reactivation was associated with an extensive alkaline-ultramafic volcanism. In the state of Minas Gerais vast areas of its western part have been affected by this event. The alkaline rocks occur as lavas, volcaniclastics (pyroclastic, autoclastic and epiclastic rocks), lahar deposits, pipes and plutonic sequences.

The region was submitted during a long time to a tropical, humid climate, and the majority of their geologic products were total or partially masked by weathering effects. However, some methods, focusing field criterias, were successfully utilized to recognize the volcanic conducts, including kimberlitic and kamafugitic bodies:

(i) Aerial-magnetometric data indicating punctual anomalies, combined with high resolution remote sensing images and their processing/interpretation, as well as aerial photographs in a 1:30.000 scale, yield interesting results (when compared with field mapping).

(ii) In the field several isolated conducts show:

(a) smooth, rounded and concave morphologic features, contrasting adjacent areas (host-rocks);

(b) silicified rocks forming a ring which surround the intrusive area;

(c) geobotanic criterias: occurrence of isolated areas showing exuberant vegetation contrasting to the adjacent barren areas and the presence of some vegetal specimens as *Pseudobombax* (paineira), *Myrcine sp.* (pororoca), *Terminalea argentea* (capitão) and *Myracrodroum urundeuva* (aroeira), typical of soils enriched in Mg, K, Ca, Mn, Fe etc.;

(d) pedologic criterias: presence of reddish to red soils enriched in iron or laterite beds/blocks, surrounded by pail/faint shaded, light colored ”white”) soils (from rocks like quartzite, metasiltite, granitoids);

(e) presence of the activities of ants and termites (cupins), which bring samples of rocks and saprolites from about 40 m depth up to the earth surface. The diversity of these prospecting methods is particularly efficient when the host-rocks of the volcanic intrusions are metasiltites or quartzites. On the other hand it is more difficult to identify the target when limestones and some granitoid rocks are the host-rocks, since the cations used in the vegetal diet, are similar.

Utilizing the conventional methods combined with these techniques, more than 20 volcanic intrusions have been discovered in this region, including kimberlites *sensu strictu*.

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Web page: http://www.igc.ufmg.br

ERP13

Perez, D.J., Dodorico, P., Sequeira, N. (Laboratorio de Tectonica Andina, Departamento Geologia, Facultad Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pabellon dos, Ciudad de Buenos Aires, Argentina)

USE OF ASTER IMAGERY TO IDENTIFY MINERALIZATION IN CORDILLERA DE LOS ANDES, CORDILLERA FRONTAL (32 LS), PROVINCIA DE SAN JUAN, ARGENTINA

E-Mail: `daniel@gl.fcen.uba.ar`

INTRODUCTION The objective of the present work is the identification of hydrothermal alteration areas, in a region of Cordillera de Los Andes, using ASTER data, and also to show a methodology for search of mineral resources. The study region is located in the Cordillera of Santa Cruz region (31¡ã45¡¯ LS) San Juan Province, Argentina. The area is located in the Main and Frontal Cordilleras, and it is located in the south end of flat slab segment. The stratigraphic sequence of the region is composed by a Permo-Triassic basement known as Choiyoi Group it is composed of rhyolites and granites. Mesozoic deposits follow, they are represented by the volcaniclastic, pyroclastic and sedimentary rocks of the Rancho de Lata Formation (Triassic-Jurassic); Jurassic marine deposits of the Los Patillos and La Manga Formations (Lias-Dogger), and continental sequences of the Tordillo Formation (Malm). Overlaying the latter sequence, continental sedimentary and volcaniclastic cretaceous sequences of the Diamante and Cristo Redentor Formations are developed. Tertiary volcanic deposits of little development and in those that highlight for the hydrothermal alteration areas of Pach¨®n, Pelambres, La Coipa, Altares, El Yunque and Yeguas Heladas. The structural region presents a thin skinned style, in the Mesozoic sequences; and a thick skinned style, with tectonic inversion, that involves the basement rocks. Digital image processing techniques were used with ASTER data to enhance lithologies and to detect alteration associated with possible mineral deposits. ASTER imagery was combined with field mapping and PIMA field data, into a geographic information system; and was integrated in order to establish the relationship with a structural model of the mineralized bodies.

REMOTE SENSING The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), is a multispectral instrument mounted on the Earth Observing System (EOS), TERRA. ASTER has 14 bands in 3 regions subsystems; three bands on visible and near infrared (VNIR, 0.52-0.86 ¦Ìm), six bands on short-wave infrared (SWIR, 1.60-2.43 ¦Ìm), and five bands on thermal infrared (TIR, 8.125-11.65 ¦Ìm); which have 15, 30, and 90-m spatial resolution, respectively. It has also a stereo mode by the nadir looking band 3N and backward-looking band 3B of VNIR. The ASTER data characteristics were originally selected with the purpose of achieving remote mineralogical identifications and thus it became a power tool to apply in geology. We use the ASTER data image, 21 of January of 2001, and applied the following preprocessing, Crosstalk effect correction, radiance correction, atmospheric correction. Then the following techniques was carry out, color composites, color ratios composites, Spectral Angle Mapper (SAM) classification, and Ninomiya index.

SUMMARY Analysis of ASTER spectral reflectance data provides a basis for geological mapping of the study area and to distinguishing hydrothermal alteration zones, and other different types of rocks. Many different image processing techniques were applied in order to extract only the pertinent in formations. Samples were collected to analyze with a PIMA spectrometer, in order to determinate what ideologies and alteration could be distinguished by spectral reflectance alone. Individual and combinations minerals could be separated in terms of their reflectance. The integrated approach to this study aided the exploration geologists in discovering several new mine prospects, as Carniceria, La Coipa, Yunque and Yeguas Heladas. These deposits were found by using the ASTER imagery to identify areas with characteristics similar to know prospects, as Pachon, Los Pelambre and Altares.

Web page: http://aviris.gl.fcen.uba.ar/

ERP14

Schertl, H.-P., Krebs, M., Maresch, W.V. (Ruhr-Universität Bochum), Draper, G. (Miami, Florida International University)

Jadeitite from Hispaniola: a link between Guatemala and Antigua?

E-Mail: walter.maresch@rub.de

In historical times jade has played an important role as a mystic or ritual stone, as a prestige object, a tool, or a talisman. This is especially true in Eastern Asian cultures, where jade has been highly esteemed even since the Neolithic period about 7000 years ago. Archeological studies show that jade has also been widely used in the Mesoamerican and Caribbean regions (e.g. Bishop et al., 1993, Harlow et al., 2006), although the source of this jade is unclear in many cases. The term ´´jade´´ actually refers to two different types of material. One is a nephrite rock consisting mainly of calcic amphiboles of the tremolite/actinolite solid-solution series, whereas the other is true jadeitite with the sodic pyroxene jadeite as the main constituent.

Very recently, Harlow et al. (2006) described jade artefacts from Antigua, West Indies, and speculated on their provenance. Jadeitite and other HP-LT rocks are now well-known (Harlow et al., 2004) from serpentinite melanges both north and south of the Motagua fault zone in Guatemala, which separates the North American Plate from the Caribbean Plate. Although both melange settings host jadeitite, there are differences both in mineral assemblages and in the $^{40}Ar/^{39}Ar$-ages from phengites. The Antigua jade artefacts reveal affinities with the HP-LT-rocks south of the Motagua fault. They are quartz-bearing, contain phengite, and occasionally also glaucophane and lawsonite (Harlow et al., 2006). However, Harlow et al. (2006) pointed out that serpentinite mélanges related to northern Caribbean subduction-zone complexes are common throughout the Greater Antilles, and that other sources for the Antigua jade are possible. In the present study we provide a first description of a newly discovered source of jadeitites from serpentinite mélanges of the northern Dominican Republic. These rocks should also be considered as potential source material for jade artefacts in the Mesoamerican/Caribbean regions.

The investigated jadeitite is found in northern Hispaniola within a unit called the ´´Rio San Juan Complex´´ (RSJC). The RSJC represents a fossil intra-oceanic subduction zone active between 120 and 55 Ma (Krebs et al., 2007). Here, diapir-like serpentinite mélanges cut Upper Cretaceous to Lower Tertiary HP-LT mafic schists. The mélanges contain blocks and knockers of various metamorphic rock types such as blueschists, eclogites, lawsonite blueschists, jadeitites, cymrite-bearing rocks and orthogneisses. Comprehensive studies of these rocks (e.g. Krebs et al., 2007) reveal distinctive arrays of interrelated pressure-temperature-time paths. The jadeitites form irregular individual masses as well as layers within and closely related to surrounding lawsonite blueschists. The jadeitites are fine-grained, whitish-green, and contain jadeite as the main constituent; the amount of jadeite may exceed 90 vol.%. Phengite, omphacite, epidote, Na-amphibole, plagioclase and quartz occur in minor amounts. Lawsonite, pumpellyite, and stilpnomelane have been observed. Titanite and rutile are accessories. Generally, jadeite forms euhedral to subhedral prismatic crystals; however, anhedral massive intergrowth textures, sometimes also with inclusions of titanite may be found. The homogeneous cores of the crystals reach 98% jadeite end-member composition (the variations observed in one sample investigated are $Jd_{85-97.8}Ag_{0-6.8}Di_{0.6-7.2}Hd_{0.4-2.5}$) and are surrounded by very thin retrograde omphacitic rims with pronounced aegirine- and diopside-components ($Jd_{34.1-69}Ag_{7.6-20.6}Di_{3.7-39.5}Hd_{0.7-6.2}$).

Geochemically, the jadeitite rocks reveal very high amounts of SiO_2 and Na_2O, and low amounts of K_2O. They appear to follow a calcalkaline trend. It is important to note that, in comparison to other blocks in the mélanges, the jadeite-rich rocks appear to have experienced a high degree of metasomatism during their formation.

On the basis of these data, it may be concluded that the RSJC jadeitites are analogous in both mineralogy and fabric to jadeitites described from occurrences south of the Motagua Fault Zone in Guatemela as well to the artefacts from Antigua. The jadeitites from this locality in Hispaniola must therefore also be considered as potential source material for jade in the Mesoamerican/Caribbean region.

Bishop, R.L., Sayre, E.V. and Mishara, J. (1993): Compositional and structural characterization of Maya and Costa Rican jadeitites. In: Precolumbian Jade: New geological and cultural interpretations (F.W. Lange, ed.). University of Utah Press, Salt Lake City, Utah, p. 30-60.

Harlow, G.E., Hemming, S.R., Avé Lallemant, H.G., Sisson, V.B. and Sorensen, S.S. (2004): Two high-pressure-low-temperature serpentine-matrix mélange belts, Motagua fault zone, Guatemala: a record of Aptian and Maastrichtian collisions. Geology 32:17-20.

Harlow, G.E., Murphy, A.R., Hozjan, D.J., De Mille, C.N. and Levinson, A.A. (2006): Pre-Columbian jadeite axes from Antigua, West Indies: description and possible sources. The Canadian Mineralogist, Vol. 44:305-321.

Krebs, M., Maresch, W.V, Schertl, H.-P., Baumann, A., Draper, G., Idleman, B., Münker, C., and E. Trapp. 2007. The dynamics of intra-oceanic subduction zones: A direct comparison between fossil petrological evidence (Rio San Juan Complex, Dominican Republic) and numerical simulation. Lithos, in press.

GG

Geodesy, Geophysics and Geodata

GGP01

Araneda, M. (SEGMI, Santiago de Chile), Pastorino, M.I. (Universidad de Tucumán), Avendaño, M.S. (SEGMI, Santiago de Chile)

GRAVITY IN THE ANDES, ARGENTINA - CHILE 32° - 36° S

This paper presents a correlation of isostatic residual between 32°-36°S with mayor structural features. This presentation is part of the project ”Gravity in the Southern Andes 26°-42°S and correlation with mayor structural features” .This project is mainly developed with the support given by Instituto Panamericano de Historia y Geografía (IPGH), Instituto Geográfico Militar (IGM) and Servicios Geofísicos en Minería e Ingeniería (SEGMI).

The compilation and analysis of the information was made by SEGMI. Part important of the data coming from of the Servicio Nacional de Geología y Minería (SERNAGEOMIN), National Geospatial Intelligence Agency (NGA) of Estados Unidos, Instituto Brasilero de Geofísica y Estadística (IBGE) of Brasil, Empresa Nacional del Petróleo (ENAP), Instituto Geográfico Militar of Argentina, Proyecto gravedad en los Andes del sur y su correlación con rasgos estructurales mayores 35°-38°S and the project of cooperation between SEGMI and the Investigation Cooperative Center 267 (SFB 267) named ”Proceso de Deformación en los Andes” of Germany.

The Bouguer anomaly was calculated with a density of 2.67 gr/cm^3 and the isostatic residual calculated for the Airy-Heiskanen model.

GGP02

Gomez, M.E. (Universidad Nacional de La Plata and CONICET), Bagú, D. (Universidad Nacional de La Plata), Del Cogliano, D., Perdomo, R. (Universidad Nacional de La Plata and CONICET), Mendoza, L. (Universidad Nacional de La Plata)

The Equivalent Source Method as an alternative tool for geoid modelling

E-Mail: dbagu@carina.fcaglp.unlp.edu.ar

During the nineties geodetic networks were established in the Tierra del Fuego and Buenos Aires provinces. In both cases, they are materialized over the bench marks of the national altimetric network. This fact allowed to calculate geoid undulations and to build numerical models to transform ellipsoidal heights into orthometric heights. Particularly, for the case of Tierra del Fuego, besides geometric levelling, the Fagnano Lake was used like a level surface. This job was made in a joint effort with the Dresden University (Technische Universität, Institut für Planetare Geodäsie). The result was a geoid model which differs from EGM96 (Lemoine et al., 1998) and the EIGEN series (Reigber et al., 2005) in approximately 30 cm (standard deviation), and does not fit successfully near the lake. This should be caused by a lack and bad distribution of information combined with global models deficiencies. In the same way, the observed geoid model for Buenos Aires province was compared with the global models previously mentioned. This showed a standard deviation of 15 cm for the EIGEN series and 24 cm with respect to EGM96. In this region (Buenos Aires province) a height transformation model called FCAG98 (Perdomo & Del Cogliano, 1999) was built taking into account about 200 observedgeoid undulations and their differences with EGM96. In the present decade several observation campaigns were carried out (Perdomo et al., 2002; Gomez et al., 2006; Bagú et al., 2006). With these new observations the FCAG98 model was tested and improved. The biggest differences between FCAG98 and new data were found in the north-west of Buenos Aires province and in Sierras de Tandil (a non flat region). In the first case (NW of the province), these differences were clearly due to the lack of data of the FCAG98 model. The inclusion of the new data improved significantly the knowledge of the geoid model behaviour in that region. In the case of the Sierras de Tandil (a mountainous region in the south of the province) it seems clear that there is not enough data, even including the recent campaigns, to solve the short wavelengths satisfactorily. With the goal of solving this problem in this zone, a new study was done combining geometric undulations and gravimetric data by the Equivalent Source (ES) method (Del Cogliano, 2006). As it is well known, this technique consists in the computation of a set of point masses in order to reproduce gravitational field observables, i.e. geoid heights, gravity anomalies and vertical deviations. While in Tandil zone the standard deviation of FCAG98 with respect to test data was about 10 cm, the deviation obtained adding gravity information and using ES to integrate it with the geometric undulations was considerably better (of the order of 3 cm). These results and the possibility to integrate easily different kind of data, makes the ES method an interesting tool to be applied in both regions (Tierra del Fuego and Buenos Aires). Considering the existence of gravity data in both regions, the new objective is to perform the integration of all the information to obtain improved geoid models. In a similar way, it will be very useful to add vertical deviation observations. A recent simulation (Guspí, 2004) has shown that to the level of accuracy of the present vertical deviation results, the use of ES to incorporate them to gravity and geometric undulations should produce excellent results. In this sense, a possible new field of cooperation between German and Argentine groups arises. The new digital zenith cameras (TZK 2D type), recently applied in Germany, has clearly shown the potential to get accurate vertical deviations in short time. It will be very interesting to apply this technique, not only in the regions described in this presentation, but in other projects related to vertical frames in South America.

GGP03

Chen, J., Jegen-Kulcsar, M. (Kiel), Heincke, B. (Trondheim)

Joint inversion and topographic correction of geophysical data

Abstract: Different geophysical data such as gravity, seismic and electromagnetic data often contain complementary information and are sensitive to different features of a subduction zone. Since furthermore inversion of geophysical data of any kind is inherently non-unique, i.e. a variety of earth models mayfit a particular data set equally well, it is difficult to develop a coherent picture of a geological setting from individual inversion results of different data set. The obvious way of developing a more complete picture of subduction zones and reducing the degree of non-uniqueness is the combination of various geophysical data in a joint inversion approach. By inverting different data sets jointly, an earth model is searched, which fits all data sets in question simultaneously. Here we will present a joint inversion scheme of EM, gravity and seismic data together with joint inversion results or data collected on a passive margin. The results are furthermore compared with individual data type inversion. Subduction zones and passive margins are characterized by large changes in topography on a regional as well as local scale. Topography may have a large impact on geophysical data, e.g. on the gravity data dueto the large density contrast between water and rocks, and on EM data due to electrical current distortion. The analysis of the passive margin data showed, that these influences have to be carefully investigated. The first stage we have approached the topography effect on gravity in two ways. (1), Within the model through refined topography modelling. (2) Outside of the model by applying topographic correction to the data. We will present and discuss results for joint inversion with these topographic correction. The second stage dealing with the topographic influence on EM data will be reported next.

GGP04

Del Cogliano, D. (Universidad Nacional de La Plata and CONICET), Dietrich, R., Richter, A. (Technische Universität Dresden, Institut für Planetare Geodäsie), Perdomo, R., Hormaechea, J. L. (Universidad Nacional de La Plata and CONICET), Liebsch, G. (Bundesamt für Kartographie und Geodäsie, Außenstelle Leipzig), Fritsche, M. (Technische Universität Dresden, Institut für Planetare Geodäsie), Gomez, M.E. (Universidad Nacional de La Plata and CONICET), Bagú, D., Mendoza, D. (Universidad Nacional de La Plata)

Regional geoid determination in Tierra del Fuego. The use of Fagnano Lake to improve data distribution.

E-Mail: perdomo@presi.unlp.edu.ar

A regional geoid model for the Argentine portion of the Tierra del Fuego Island was established in previous works on the base of GPS determinations on levelling lines.

This first approach suffers for the lack of data in the remote south-west region of Tierra del Fuego. There are no levelling lines reaching that zone. This fact increases the local interest in getting a geoid model to transform ellipsoidal heights into mean sea level heights.

In order to improve the data distribution in this region, the mean lake level of Fagnano Lake has been studied to use it as a first approximation of the local geoid. This narrow but long lake extends for more than 100 km in the east west direction.

Using a GPS buoy and pressure tide gauges, a method to determine the mean lake surface topography with respect to the ellipsoid has been developed. A specific paper on this topic is also presented in this meeting.

It is shown that the obtained mean lake level is essentially controlled by the regional gravity field. It isimportant to note that even when the use of the lake surface as an equipotential is only an approximation, the inclusion of this information in the local geoid model produces an important benefit due to the improvement on the data distribution.

These results are compared with global models (EGM96, Eigen series) to conclude that none of them fits this region properly. In this sense, new efforts will be made to improve the local research.

For the future, gravity measurements, observed geoid undulations and vertical deviations will be combined using the equivalent sources technique in order to produce a detailed geoid model in areas with sparse information. The equivalent masses are located under the observation stations at a depth related to the sources gravitational effect (the deepest masses correspond to points where the geoid undulations are known). The effect of the equivalent masses has to fit simultaneously, the anomalous potential related to the geoid and its vertical gradient or gravity anomaly.

GGP05

Masuch Oesterreich, D. (Linares, Mexico)

A Comprehensive Seamless Digital Elevation Model for Mexico based on SRTM Data

E-Mail: gis@fct.uanl.mx

The terrain model developed for Mexico is based on the Shuttle Radar Topography Mission Elevation (SRTM) data collected by the Endeavour spacecraft in 2000. For this model the elevation data in DTED Level 1 format were used as distributed by the US Geological Survey. These data have a cell spacing of three arcseconds and are referenced to the WGS84 horizontal datum and to the EGM96 geoid. Elevations are with respect to the reflective surface which may be man-made features, vegetation, or the bare surface of the planet. The DTED data are known in the GIS community as the finished SRTM data. Compared to the research level unfinished data in HGT format they underwent a number of improvements: Water bodies and lakes of more than 600 meters length were depicted, flattened out and set to a constant height. The ocean elevation was set to 0 meters. Islands are represented in the data whenever their axis is longer than 300 meters or their relief is greater than 15 meters. Spikes and wells in the data were detected and voided out. Small voids of less than 16 cells were filled by interpolation.

However, there are areas with varying extensions from a few pixels to several hundred square kilometers in the original USGS dataset. These voids resulted in nodata areas covering occasionally large regions. Within the geographic limits of Mexico covered by this model voids were detected in those parts of the country that exhibit significant changes of relief over short distances, like in the steep canyons of the Sierra Madre Occidental in Northeastern Mexico or the Sierra de Chiapas. The largest nodata area lies in the south of Chihuahua state close to Sinaloa and Sonora states and covers an area of approximately 3000 km2. Due to the size of the nodata area and its almost rectangular shape it was decided to fill the voids with existing elevation data rather than by interpolation. For this purpose the GTOPO30 DEM was used which amplifies the resolution of the model within the affected areas to 1 km2. Finally, in order to create a DEM compatible to the majority of vector data available for Mexico as published by the INEGI (National Institute of Statistics, Geography, and Informatics of Mexico) as well as the data of the Digital Chart of the World, the data set needed to be resampled and projected from arcseconds to decimal degrees. The result is a seamless DEM for Mexico that has exceptional detail especially in the lowlands and in the coastal areas of the country but also preserves a very high level of detail in the mountainous regions and in the Transmexican Volvanic Belt.

At a country wide scale, the DEM is believed to be one of the most detailed digital elevation models available for Mexico. Since it is accurately projected it is perfectly suitable as an integration platform for both terrestrial and maritime geospatial data at a country wide scale, comprising the entire Gulf of Mexico, Sea of Cortez, and parts of the Pacific Ocean. For regional studies, areas are of interest can easily be clipped and converted to any other coordinate system. It also serves as a source of input data to refine morphological models by various interpolation methods.

The model demonstrated its use for a wide range of applications, like integrated management of hydrological basins (watersheds, recharge areas, surface flow systems, geological units, soil and land use, vegetation), geohazard and disaster mitigation, and geological mapping at regional scales.

Projection Parameters of the Seamless 90 Meters Digital Elevation Model for Mexico Cell Size: 0.001 Data Type: Integer Number of Rows: 24239 Number of Values: 5415 Number of Columns: 40192 Attribute Data (bytes): 8

Boundary xmin: -119.266, xmax: -85.772 ymin: 12.996, ymax: 33.195

Coordinate System Description Projection: GEOGRAPHIC Datum: WGS84 Zunits: METERS Units: DECIMAL DEGREES Spheroid: WGS84

Web page: http://www.fct.uanl.mx

GGP06

Masuch Oesterreich, D. (Linares, Mexico)

Availability of Digital Geodata in Mexico

E-Mail: gis@fct.uanl.mx

During the last ten years Mexico has made great efforts in producing and publishing digital geodata at a country wide scale through several government agencies and private enterprises. Three of these entities, two of them governmental and one private, are introduced hereafter.

The principal source of statistical data, maps and georeferenced data is the National Institute for Statistics, Geography, and Informatics (INEGI). Through its network of state offices, INEGI is responsible for data collection, data update and maintenance, and publication of these data at regional and national scales. Geographic information is available in both conventional paper and digital formats. The standard map scales for topographic information are 1:50000 and 1:250000 in UTM coordinates, covering the entire country. Digital data are available for almost 100 0000 covering a great part of the country. Prices are low for the paper maps and moderate to low for digital data. Basic topographic vector data is available for free download at a scale of 1:1,000,000. 30 meter DEMs covering the entire country are also available at no cost at http://www.inegi.gob.mx. INEGI also provides municipal vector data of very high detail, which unfortunately are not made available to the general public. Extensive working experience with INEGI digital data confirmed a generally high quality of both raster and vector data. Occasionally, confusion arises as to the projection parameters of the digital data. Former Mexican geographic data were referenced to the NAD27 datum. Recent maps are exclusively referenced to the ITRF92 datum. Since the difference between these projections in Mexico is roughly 30-35 meters horizontally and 200-205 meters vertically, projection parameters have to be checked and data have to be reprojected, if necessary.

Geological and geophysical data and maps are produced and made available by the Mexican Geological Survey (Servicio Geologico Mexicano, the former Council of Mineral Resources). The standard map scale for paper maps and digital data is 1:250000. Geological and geophysical maps are free to download in pdf format in the cartas section of the productos menu at http://www.coremisgm.gob.mx. Digital geologic information is available as ArcInfo coverages or shapefiles, consistent with the area covered by the respective paper map. Digital data are distributed on CDROM by the state offices and unfortunately must be considered expensive.

The exclusive Mexican distributor of ESRI products is a companycalled SIGSA, located in Mexico City. SIGSA also provides basic topographic data, all sort of digital imagery, and elevation data at various scales and resolutions. Their Project Mexico provides data for the whole country at national, state, and municipal levels at scales as high as 1:5000. Mexicos three major cities (Guadalajara, Monterrey, and Mexico City) are covered at a 1:1000 scale. Information is available at http://www.sigsa.info. Prices for data and consulting services are available only on request and are not necessarily to the cheap side.

Web page: http://www.fct.uanl.mx

GGP07

Mendoza, L., Perdomo, R. (La Plata, Universidad Nacional de La Plata), Hormaechea, J. L. (Rio Grande, Estación Astronómica Río Grande), Del Cogliano, D. (La Plata, Universidad Nacional de La Plata), Dietrich, R., Fritsche, M., Richter, A. (Dresden, Institut für Planetare Geodäsie, TU Dresden)

Determination of recent horizontal crustal displacements at the South America/Scotia

E-Mail: `mendoza@ipg.geo.tu-dresden.de`

The Magallanes-Fagnano fault system is a left-lateral transform system extending more than 600 km and intersecting the Tierra del Fuego Island in the southernmost region of South America. This system accommodates partially the present-day relative movement between the South American and the Scotia tectonics plates. It extends for 300 km, practically in E-W direction, across the island. In this study we present, from repeated GPS observation of geodetic sites located both north and south of the fault system, the results of an homogeneously and rigorous analysis of the complete GPS data set, which covers a temporal lapse of more than 14 years.

We have used a unique global reference frame realization based on GPS for the analysis of all observations. As the main kinematic signal contained in the data an E-W relative velocity of about 6 mm/y was estimated. Furthermore, residual deformation will be discussed in detail.

HZ

Hazard Monitoring and Mitigation

HZ01 – Wed., 11.4., 16:10 - 16:30 · HSK

Climent, A. (San José-Costa Rica)

Strong Motion Monitoring in Central America

E-Mail: `acliment@ice.go.cr`

The Central American region is prone to earthquake phenomena and geological hazards that affect the environment, structures and life. The subduction of the Cocos plate under the Caribbean plate results in a great release of seismic energy, being the cause of the majority of seismicity. Historical reports show that strong earthquakes occur frequently, the most recent events being the El Salvador earthquakes of January 13 and February 13, 2001. In most Central American countries the main cities are located near active faults. Therefore it is necessary to improve the knowledge of seismicity and tectonics in order to obtain improved seismic hazard estimates, and propose actions to mitigate societal effects. The occurrence of strong earthquakes and its record and measurement, by means of seismological instruments, has allowed an improved understanding of the physical and tectonical processes related to these natural events and their effect on civil works. One of these instruments is the accelerograph, whose function is to record the time history of acceleration of the ground motion or the structural response at the specific site where the instrument is installed. Accelerographic records play an important role in the process of seismic design of civil works, since they allow the direct or indirect characterization of the seismic strong ground motion, the estimate of parameters such as peak acceleration, peak velocity, effective acceleration, strong motion duration, Fourier spectra and response spectra. For some of these strong-motion parameters, it is possible to derive predictive equations, often referred to as attenuation equations. Accelerographic records are also useful in seismic safety analysis, assessments of physical vulnerability, and site effects. The ultimate goal is to use this information in the development and improvement of building codes, as well as the development of programs for urban planning, response and mitigation of damage due to strong earthquakes. Since the beginning of strong-motion monitoring in Central America in the 1930s, the operation of the networks in the region has been very irregular with ups and downs in the attention of institutions and governments, as well as in the number of operational stations. Nonetheless, concerted efforts have recently brought the spatial coverage of instrumentation to a highly complete state and empirical knowledge is coming forth to summarize the entire regional seismic character of the area. The strong-motion instruments deployed in the Central American area, at present, include 12 accelerographs in Guatemala, 49 in El Salvador, 18 in Nicaragua, 42 in Costa Rica and 8 in Panama. This amounts to 129 active instruments in the area. The total number of digital accelerographs is 114. In Guatemala, Nicaragua and Panama, a single institution in each country is responsible for the operation of the network. In Costa Rica and El Salvador, the number of owner institutions are two and four, respectively. In general, the instruments are located in the main cities of these countries, which are settled in valleys formed usually by soft and firm soils. Organizations in Costa Rica, Panama, and El Salvador have shown interest in the study of the dynamic behavior of engineered structures such as hydroelectric and geothermal projects, multi-story buildings, and the Panama Canal as a specific case. Unfortunately each country works independently, and this situation is further hampered by a lack of uniformity in concepts of operation, processing and analysis between the different institutions. There is not a common and unified database in the region, and there are different perspectives for operation and future growth in each country basis, but not at a regional scale. One important task in the short term is to establish cooperation agreements among all strong-motion monitoring institutions in order to develop a strong and reliable regional seismic database, which will certainly benefit the production of studies aimed to the mitigation of earthquake risk in Central America.

HZ02 – Wed., 11.4., 16:30 - 16:50 · HSK

Strauch, W., Talavera, E., Tenorio, V., Herrera, V., Morales, A., Acosta, A. (Mnagua, INETER)

Nicaraguan Seismic Network, Status 2007

E-Mail: wilfried.strauch@gf.ineter.gob.ni

The Nicaraguan seismic network is developed and maintained by the Instituto Nicaragüense de Estudios Territoriales (Nicaraguan Geosciences Institute, INETER). The network is an important element of the National information and early warning system on seismic events, volcanic phenomena, tsunamis and landslides.

In the last years the network was greatly upgraded and extended. A number of analog stations were updated with A/D converters, data loggers and digital telemetry using low cost equipment. Most seismic stations are now of digital type. The network counts actually with 15 broad band stations (2 STS-2, 13 Trillium), 50 short period stations, 2 small seismic arrays, and 20 digital accelerographs (Etna). All stations are connected via wireless communication, WAN, LAN or INTERNET to INETER´s Monitoring and Early Warning Center.

Before 2006, the Nicaraguan seismic network was concentrated only in Western Nicaragua, near the Pacific coast where most people live and the seismic activity is considerably higher than in other parts of the country. There was little knowledge about the seismicity in the rest of the country. Low level of infrastructure, lack of communications facilities and difficult access made it nearly impossible to install and maintain telemetric seismic equipment on a permanent base. Thus, an important progress was the extension of the network towards the Central and Atlantic regions of Nicaragua. Using new communications lines provided by the Nicaraguan electric power distribution company and VSAT systems of local institutions INETER succeeded to install 5 seismic broad band stations in this part of Nicaragua.

Many seismic stations are installed in the Nicaraguan volcanic chain for volcano monitoring and eruption warning. Each of the 6 active volcanoes has at least one broad band station and some additional short period stations near the crater area. Volcano Cerro Negro counts now with a dense local network of 10 stations. A similar network is recently under construction at Telica volcano. Many of the not active volcanic complexes have also at least one station installed to detect the possible reawakening of activity.

A small seismic array is installed in Managua for local and regional monitoring and fast processing of strong earthquakes. Another small array at Cerro Negro volcano is used for volcano monitoring. A regional seismic array is in construction near the Caribbean coast of Nicaragua to further improve seismic monitoring for Eastern Nicaragua and the Southwestern Caribbean Sea

Seismic recordings are received continously and in real time via INTERNET from 15 stations in other Central American countries, North and South America and the Caribbean. These data help to process data of strong earthquakes in Nicaragua and Central America, especially necessary for tsunami warning.

Data of several stations are transmitted via INTERNET on line to seismological agencies of the neighboring countries according their specific requirements. The data of the broad band stations are transmitted in real time to a data server of the GEOFON network (GeoForschungsZentrum Potsdam, Germany). From there the data are available via INTERNET for any interested user. Several stations are also transmitted online to Puerto Rico Seismic Network (PRSN) which serves as anode for the emergent tsunami warning system for the Caribbean Sea.

The Monitoring and Early Warning Center at INETER works on a 24x7 base and processes all registered seismic events in near real time. In case of strong seismic events information or warning messages are transmitted automatically by email, and fax a few minutes after the event occurred to more than 70 institutions in Nicaragua and Central America.

Seismic recordings, hypocenter data, epicenter maps and fast information messages are published in near real time on the web site of INETER

INETER publishes monthly and yearly bulletins on the seismic and volcanic activity in Nicaragua.

Web page: http://www.ineter.gob.ni/geofisica/sis/monitor.html

HZ03 – Wed., 11.4., 16:50 - 17:10 · HSK

Gutierrez, V. (Managua, INETER)

Development of a GIS Application for seismic vulnerability and earthquake damage studies in Nicaragua

E-Mail: vladimir.gutierrez@gf.ineter.gob.ni

A GIS based software is presented which permits the estimation of seismic vulnerability and the presentation of results in digital maps for single houses, groups of buildings, parts of settlements or even complete towns.

Nicaragua is a country with a high seismic activity. Thus, seismic vulnerability and risk studies have been carried out, in recent years, by several scientific groups applying different methodologies.

The assessment of seismic vulnerability requires the execution of distinct tasks, e.g. recollection of field data, integration of data from the municipal cadastre, reprocessing or screening to test the reliability of the data, definition of calculation of vulnerability functions, calculation of vulnerability for single objects as houses or buildings, calculation of mean vulnerability for certain areas as barrios or squares. Finally, the results are normally presented on maps.

Observing the work flows of the projects carried out in Nicaragua we observed that the preparation of data and the presentation of the results take much time, mainly because several separate software tools are used for distinct tasks and scientific calculations. Then the results have to be passed to other software used for the graphical presentation of results. It is common, that all the process has to be done repeatedly to observe the influence of different parameters to the final result.

In order to reduce time and effort to be spent with several unspecialized tools and procedures, an integrated software system was created the user of which has not to care about separate software tools for each part of the process. The main advantage of the software is the combination of Geographical Information System (GIS) with the logics that surrounds the specific methodologies of seismic vulnerability index, index of damages and presentation of results. This advantage is accomplished by exploiting the ability of customizing the GIS software (ArcGIS, ESRI) trough plug-in´s of its several software libraries with the specialized functionalities and the logical programming with the requested user requirements.

The new software uses a connection with an external centralized Enterprise Data Base which stores all the input information and calculation results and which is automatically synchronized for the presentation of results using GIS.

When new requirements of typologies for houses are introduced, cadastral data from the municipality is uploaded to the system. This information becomes the base data set of the current project. The cadastral information contains data on the constructive type of the house, dimensions, year of construction, type of walls, roof, number of inhabitants, etc.. These data are then processed to define groups of houses belonging to certain types or classes. For each type a number of houses is selected which will be visited to confirm the correctness of the classification. The other not selected houses get the average value of its type. This process can be run repeatedly to generate distinct results for several sets of input parameters visualizingthe results automatically over a map layout.

The system also allows to present damage scenarios for specific seismic events with given hypocenter and magnitude.

Moreover, there is another and just as important byproduct. The documentation of the software serves as a guide for students working on object oriented software engineering by using unified modeling language (UML) and software logic architecture (3-tier).

This work was carried out at the Geophysical Department of the Instituto Nicaragüense de Estudios Territoriales (INETER) and the Universidad Nacional de Ingenierìa (UNI),

Managua, Nicaragua.

Web page: http://www.ineter.gob.ni/geofisica/sig/index.html

HZ04 – Wed., 11.4., 17:10 - 17:30 · HSK

Funes, G., Gutierrez, D. (COPECO)

Georisk Projects and Studies at COPECO (Honduras) and their impact in disaster management

The Permanent Commission of Contingencies (COPECO) is the Honduran public agency with the mission in disaster management coordinating the response before (stating the procedures to be followed for training and communitarian organization in order to prepare the communities to have the capacity to attend emergencies generated by the presence of natural phenomena), during (with humanitarian assistance in emergency cases, coordination of evacuations and rescue operations) and after catastrophic events. It was founded in 1973 under the name of Permanent Committee for National Emergencies (COPEN) and in 1990 the actually name was given. In the present administration COPECO is working especially in prevention of emergency cases rather than in their response.

For a better national coordination in risk management, the Honduran government is establishing the National Risk Management System (SINAGERH). In this framework all public and private institutions related to risk management are going to have specific tasks in prevention, preparation, response, rehabilitation or reconstruction according to their responsibilities in public administration.

The catastrophic event of hurricane Mitch in 1998, which affected total national territory, pointed out the lack of georisk studies, including evaluation of geohazards and vulnerabilities. Due to such georisk evaluations, most vulnerable and threatened sites in the country can be spotted out and hence the impact can be reduced previously. Since 1998 COPECO cooperated in the following studies:

1) The Mitch Project, United States Geological Survey (USGS), 1998-2001. During this cooperation aerial photography for 40 municipalities and flood hazard investigations in 15 communities of the country were made. Furthermore, an inventory of landslides (triggered by the hurricane Mitch) and a landslide susceptibility study for Tegucigalpa were developed. In addition 35 telemetric precipitation and stream gage stations were installed and a system of floods prognosis for Tegucigalpa was elaborated.

2) Project Master Plan for the cities of Tegucigalpa and Comayagüela, Japanese Government, 2000-2001. Here, flooding and landslides hazards where evaluated and mitigation efforts were identified to reduce the effects.

3) Project Mitigation of Natural Disasters (PMDN), World Bank, 2001-2006. The identification of the natural hazards and mitigation possibilities in 61 Honduran municipalities were focused out. Furthermore, regulations for territorial organization were established for the municipalities, taking into account existing conflicts of landuse and declaredhazard zones. Jointly to these studies, communitarian organizations were trained in emergency response in case of occurring hazards.

4) Project of “Mitigation of Georisks in Central America “, Federal Institute for Geosciences and Natural Resources (BGR, Germany), 2006-2009. Currently this regional project is in execution, cooperating with various institutions in Guatemala, El Salvador, Honduras and Nicaragua. The main object is the establishment of an information system on georisks of common public interest. The evaluation of geohazards and vulnerabilities serves the prevention management of natural disasters. By this project COPECO will, among other things, update and amplify the information generated by anterior projects. Its to COPECOs interest to distribute the generated information to the public, in the strictest sense to the communities. The aim is that the results are respected and received attention by regional planning authorities and in community policy.

The experience obtained from these projects shows, that they have great impact in disaster management. If the communities are involved in all processes of the studies, their awareness to natural hazards will be raised and as a further result, a decrease in human losses and infrastructural damages can be reached.

Web page: http://www.copeco.hn

HZ05 – Thu., 12.4., 10:10 - 10:30 · HSK

Soto, G.J. (San José, Geocientex), Alvarado, G.E. (San José, ICE), Sjöbohm, L. (San José, Consultant)

Volcano-geology and stratigraphy as basis for the mapping of volcanic hazards at Arenal, Costa Rica

E-Mail: katomirodriguez@yahoo.com

Arenal volcano, in northwestern Costa Rica, is in eruption since July 1968 to present. The area has evolved from rural to urban–rural, under a growing tourist industry, where around 12 000 people are exposed to volcanic hazards. In the vicinity, there is one of the most important hydroelectric plants and a vial infrastructure –30 km of roads, 10 bridges– of key importance for all these activities. As a sequel from the eruption of July 1968 to present, Arenal volcano has been the object of a thorough volcanological investigation, which has derived in a precise knowledge of its geological characteristics and its volcanic history through 7 millennia. Its eruptions have varied within a wide spectrum of processes: lava effusions sustained for years, short duration and low volume explosive eruptions, up to highly explosive, violent and destructive plinian eruptions. A reassessment of volcanic hazards at Arenal has been carried out, where the geological and stratigraphical data are the primary tools, because the lack of detailed topographical maps, that can not allow properly performed computational modeling. The following volcanic hazards have been identified: 1. gas discharge, its dispersion by the winds and acid rains; 2. ballistic bombardment of blocks and bombs; 3. fall of pyroclasts carried by the winds; 4. pyroclastic flows and surges; 5. opening of new lateral craters and generations of blasts; 6. blocky lava flows; 7. lahars originated during or after eruptive periods; 8. volcanic rockslides and avalanches, produced by the collapse of segments of the volcano edifice; 9. seiches generated by avalanches or pyroclastic flows entering the neighboring reservoir; 10. volcanic earthquakes up to M 5, generated by the ascent of magma before eruptions. The highest hazard is by pyroclastic flows. A series of thematic maps have been created for each hazard, taking into account the behavior of the volcano through its history. Consequently, two basic scenarios have been established at Arenal, whose volcanic hazard maps result from the combination of thematic maps. The first is a short term scenario shown in Fig.1, resembling the eruption from 1968 to present. It comprises the high hazard zone with 32 sq. km, moderate hazard zone with additional 24 sq. km, and low to moderate hazard zone with 23 sq. km. The long term scenario includesall major events observed at the prehistorical records of Arenal: vulcanian eruptions with blasts, strong strombolian and plinian eruptions. The resulting combined map includes the high hazard and medium hazard zones. This scenario

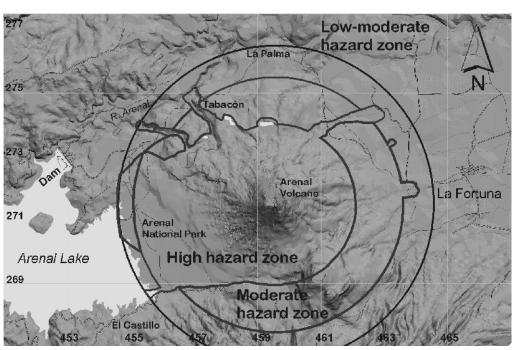

Figure 1: Short term volcanic hazards map of Arenal volcano.

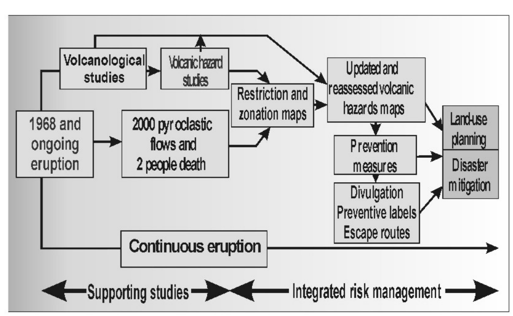

Figure 2: Sequence for the construction of volcanic hazards maps and risk management at Arenal volcano.

implies the cease of the present eruptive cycle, a repose period, and the beginning of a new eruption. Despite the fact that it is not possible to predict when the present eruption will end, it is considered that the next plinian eruption would occur around 2100–2200 C.E. For practical purposes, a lapse longer than 50 years might be considered before the next long term eruption, say vulcanian after 2050 C.E., as an approximation to be considered for the land use planning at Arenal, which should be reassessed every quinquenium, at least. The short term scenario map corroborates the restriction zones for land use established by law in 2001, while the long term scenario corroborates the delimited restriction areas, in order to avoid future developments in those areas, and mitigate the disastrous effects of future major eruptions. This latter map should be used for planning during the next five decades, and therefore to establish the ordered risk management triplet 1.volcanic hazard maps, 2.land use planning, 3.mitigation of volcanic disaster. As part of the risk management shown in Fig.2, other measures already taken include the production and broadcast of informative brochures, preventive labeling of the most hazardous areas, and the identification of escape routes, after recognizing the most vulnerable areas of the vial corridors around the volcano. Volcanic events can produce primary direct or material damage and indirect effects as transportation suspension, and secondary effects like impacts to economy, in the vial corridors and infrastructure surrounding the volcanoes. According to the volcanic hazards map for the short term scenario, the most vulnerable spots are: Guillermina creek, Tabacón river, between the crossroad to the volcano and Aguacaliente river, and Aguacaliente river. They could be damaged, resulting in the obstruction of draining structures, erosion of embankments, melt of pavements, and obstruction or destruction of roads and bridges. Vial structures in the northern side of Arenal, between 3–4.5 km, have a high to moderate risk and very low to moderate in the SW quadrangle.

HZ06 – Thu., 12.4., 10:30 - 10:50 · HSK

Hernández, W. (SNET), Lagos, P. (INSERINSA), de Hasbún, P. (Universidad Centroamericana José Simeón Cañas)

Geomechanical Properties of Volcanic Deposits in the San Salvador Metropolitan area, El Salvador

E-Mail: `whernandez@snet.gob.sv`

General stratigraphy and sampling of the most important pyroclastic deposits and paleosols has been carried out in the San Salvador Metropolitan Area, capital city of El Salvador in order to determine the physical characteristics and susceptibility to landslides or earthquake induced amplification. Deposits from San Salvador volcano, Ilopango Caldera and Plan de La Laguna phreatomagmatic crater are spatially and temporaly intermingled and lie beneath the city. Laboratory tests have been performed to determine the physical and mechanical properties of the most significant paleosols which are considered highly important due to their great incidence on landslides caused by heavy precipitations or large earthquakes. On the other hand, the unaltered pyroclastic deposits lack cementing material which makes it difficult to obtain undisturbed samples. Therefore, in order to determine the bearing capacity of these tephras, we have used the StandardPenetration Test (SPT) to obtain, in an empirical manner, a reference value for this parameter. Finally, isopach maps of the main volcanic air fall from the San Salvador and Ilopango volcanoes are included in the report and show the coverage of these deposits.

HZ07 – Thu., 12.4., 10:50 - 11:10 · HSK

Espinosa, T. (Prof. Esc. Politéc. Nacional - Quito), Vásconez, F. (Quito, Consultant)

Slope Stability Overview along Ecuadorian Pan-American Highway between Quito and Cuenca

Many of Ecuador's hillsides are unstable and vulnerable to landslides. A general evaluation of this problematic along Ecuadorian Pan-American Highway between Quito and Cuenca is presented within the framework of the present work.

The study area is located in the Andean region, with its own character of High Mountain. The largest Ecuador's landslide areas are concentrated in the Andean region.

Some of the issues included are the kinematics of slope and hillside instability processes according its geological settings. The northern part of the study area is covered with deposits of recent volcanism, whose slope and hillside instability processes have its own kinematics characteristics. Especially, it has been analyzed the kinematics of landslides in pyroclastic deposits of the "Cangahua" geologic Formation.

The southern part of the study area is characterized by an ancient volcanism. In comparison with the northern part, the landslide kinematics is substantially different.

The influence of human activities as landslide trigger factor has been special analyzed.

The magnitude of this type of natural disaster is evaluated through the study of the causes and consequences of some historical landslides.

HZP01

Amador, A., Strauch, W., Álvarez, A. (Managua, Nicaragua, INETER)

Recent seismic hazard, vulnerability and risk studies in Managua, Nicaragua

E-Mail: wilfried.strauch@gf.ineter.gob.ni

Managua, Capital of Nicaragua, was hit twice, in the last century, by disastrous local earthquakes. This paper presents an overview of the status of seismic hazard, vulnerability and risk studies for the city, most of which were carried out or supervised by INETER, the Nicaraguan Geosciences Institute. The latest destructive earthquake in the city, in December 1972, killed about 10,000 people and caused a mayor economic and socio-economic drawback for Nicaragua. After this disaster the first seismichazard studies were carried out for Managua, mainly in terms of the probability of hard rock acceleration based on regional seismicity data and the mapping of the location of active seismic faults. The Nicaraguan Building Code and specific local regulations for Managua forbid constructions over active faults. Construction projects are required by the Managua City Administration to present geological studies which proof the absence of geological faulting in the project area. These geological studies are carried out by local private geologists supervised by INETER. Only in 2002-2006, around 400 of such studies were registered by INETER. In the aftermath of the 1972 event the seismic risk of Managua was assumed to be -extreme- by the inhabitants of the city but also by scientific circles, disaster prevention agencies and governmental institutions. The first seismic surface amplification study was carried out within a seismic microzonation project at the end of the 1990ies which demonstrated that the soil in Managua is relatively compact and that surface amplification does not play an important role in the estimation of the seismic hazard for the city. In 2001-2002 a new seismic fault map was elaborated using data from previous studies, and realized new field prospecting in certain areas. GIS technology was used to publish the data in interactive maps on the Web. New seismic hazard maps and earthquake scenarios taking into account surface amplification, topography and seismic faults were elaborated for Managua and surroundings in 2004-2006. A mayor vulnerability and risk study was carried out in 2004-2005. A data base of the Managua city cadastre contains information on type of the house, dimensions, year of construction, type of walls, roof, number of inhabitants, value of the house. These data were used to estimate the seismic vulnerability of around 100,000 single buildings in the town. This study classified the seismic risk of the town as -moderate- what is understandable knowing that in Managua prevail single store buildings with light roofs. Very vulnerable traditional construction types as adobe and taquezal are relatively rare in Managua, mainly due to the 1972 earthquake itself which destroyed most of them in the city. Currently most of the available data on geological faulting, seismic hazard, vulnerability and risk of Managua are stored in a GIS based data bank, together with other information on geological and hydro-meteorological hazards and risks in Nicaragua.

Web page: http://www.ineter.gob.ni/geofisica/sis/dep-sis.html

HZP02

Amador, A., Ugarte, A. (Managua, Nicaragua)

GIS and Seismic Vulnerability in Managua

E-Mail: alvaro.amador@gf.ineter.gob.ni

The last report of a seismic vulnerability and risk, carried out in Managua, Nicaragua(2005), pointed out a lack of cadastral information of buildings. Cadastral data were used to estimate the vulnerability of residences in the metropolitan area. To get better research results the report recommends to complete the cadastre database from Managua. New data collection is necessary to reach this aim.

The Technical University of Nicaragua(UNI) together with the Nicaraguan Geosciences Institute(INETER) carried out in year 2006 a research to know the vulnerability from insuredbuildings. For vulnerability analysis was used the Method of „Vulnerability Index "from Petrini and Benedetti, fitted for Nicaragua from Ugarte and technical personal from the Italian NGO MOVIMONDO. Eleven parameters of the buildings, like in the original version, were research, but with different weights and values. For both vulnerability analysis and graphical representation was used GIS technology. Before was used a software for the analysis and other for the graphical representation.

GPS technology was used to get the geographical position from the researched buildings. The majority from these buildings have data from cadastre of Managua, so that is possible to compare the cadastre data with the data from field work to know the degree of agree both data source to improve the knowledge from cadastre data reliability. New data from circa 100 Buildings of Managua was obtained for the data base of the GIS system from INETER. The research was also an effort to the national professional development in the tools of seismic vulnerability analysis and to an adequate methodology for researches of seismic risk in Nicaragua.

Web page: http://www.ineter.gob.ni

HZP03

Gutierrez, V. (Managua, INETER), Giron, J. (Guatemala, INSIVUMEH), Funes, G. (Tegucigalpa, COPECO), Chavez, G., Strauch, W. (Managua, INETER), Feldhaus, L., Schillinger, S., Schmidt, R. (Hannover, BGR)

Regional GIS on Georisks in Central America

The establishment of a regional Geographic Information System (GIS) on georisks is in process in order to count with a database on geographical information and risk analysis tools. With the aid of this information platform, the institutions are able to work better on prevention of natural disasters, and further on, can respond adequately and quickly to catastrophic events.

Recurrent natural disasters like the El Salvador earthquakes in 2001 or the hurricane Stan in 2005 in northern Central America consistently provoke thousands of deaths and infrastructure destruction. The economic losses and socio-cultural damages complicate regional development. In order to assure sustained means to counteract vulnerabilities and risks related to geohazards a regional initiative is of great importance. Due to natural disaster prevention instruments and better emergency responses many human lives can be saved and the economic losses can be reduced.

Under the patronage of the Coordination Centre for Prevention of Natural Disasters in Central America (CEPREDENAC) the Federal Institute for Geosciences and Natural Resources (BGR, Germany) cooperates with the following Central American partner institutions: the Nicaraguan Institute for Territorial Studies (INETER, Nicaragua, since 2002), the National Service for Territorial Studies (SNET, El Salvador, since 2003), the Permanent Commission of Contingencies (COPECO, Honduras, since 2006) as well as the National Institute for Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH, since 2006) and the National Coordination for Disaster Reduction (CONRED, since 2006) from Guatemala.

The regional project "Mitigation of Georisks in Central America"covers four types of natural disasters: earthquakes, volcanic eruptions, landslides and floods. Scientists and technicians from all partner countries are working together in establishing comparable geological and geophysical analysis methods. Therefore cartography has been digitized and recompiled for the projects study areas and at national scale, seismic sensors register information continuously in various countries, volcanoes are being electronically monitored and water levels in major rivers automatically supervised.

HZP04

Hradecký, P., Stárková, M. (Geological Survey, Prague), Přichystal, A. (Masaryk University, Brno), Baroň, I., Novotný, R., Havlíček, P., Vorel, T. (Czech Geological Survey, Prague), Ševčík, J. (GEKON Ltd., Prague), Kycl, P. (Czech Geological Survey, Prague), Obando, T., Echaverry, M., Strauch, W., Álvarez, A. (INETER, Managua), Kunceová, E. (Czech Geological Survey, Brno)

Geological study of natural hazards, área of Estelí, Nicaragua

E-Mail: `hradecky@cgu.cz`

Since 1997, the Czech Government, Ministry of Environment of Czech Republic supports annual projects of geological mapping within a program of international cooperation with the Republic of Nicaragua. The Czech Geological Survey (CGS) is the implementing agency for these projects, in cooperation with Instituto Nicaragüense de Estudios Territoriales (Nicaraguan Geosciences Institute, INETER). In 2006, geological mapping and a study of susceptibility to natural hazards has been carried out in area of 650 sq. km around the city of Estelí, Northern Nicaragua.

The project included a 2 months field survey in Nicaragua including the compilation of air photos and digital elevation models, and search for older works in Nicaraguan archives. Then, laboratory work, elaboration of GIS, map design and elaboration of the scientific report were carried out at CGS, Czech Republic. The results were presented in December 2006 to local authorities in Estelí and to the scientific community in Managua.

Older reports from the 70ies of the last century, in their majority are not published but only archived, such as Rodezno E.C. (1971) and Garayar (1971). The field survey which produced a wealth of new data was concentrated on multidisciplinary activities such as geological mapping, volcanology, Quaternary cover, structure, geomorphology and mapping and documentation of natural hazards. Minor deposits of construction materials and other economically interesting features were also documented.

Large part of the area is built by a Neogene calc-alkaline volcanic suite, which has been produced by repeated activities of silicic shield stratocones, a category after Cas and Wright (1987). The predominating basaltic and basalt-andesitic lavas and rhyolite ignimbrites thus prove the chemical bimodality of magma. The widespread ignimbrites show depositional and lithological variability. In the lower parts of sequences frequently occur deposits of no-welded, friable ash and pumice flows, homogeneous or diffuse, matrix-supported. Upwards, eutaxitic, welded ignimbrites with characteristic collapsed pumice-obsidiane fragments slowly pass into clast-supported, coarse agglomerate facies. Agglomerate horizons, typical for the area, provided sometimes the source material of subsequent debris flows or lahars. The youngest volcanic products cover some high elevations, being formed by basaltic scoria and lava. This volcanism is probably of Lower Pleistocene in age as a product of renewing the activity on deeper faults.

All the area is strongly affected by tectonic processes. The predominant fault system runs NE-SW, and is responsible for the origin of the Estelí depression where it operated as a sinistral strike-slip. The depression in the eastern part of studied area has been based on a NNE-SSW fault system. The circular structure of Tomabú is a very important structural feature in the Southern part of the area.

Endodynamic factors of geohazards are of insignificant influence, except for occasional weak seismic events and the possibility of subsidence movements in the Tomabú structure. More significant hazard factors are those of exodynamic nature, such as slope instability which can result in landslides, erosion or floods. The hazard in certain areas is determined, to a large extent, by the geological composition, the homogeneity of rocks, their welding, cementation, grade of weathering or by the character of post-volcanic alteration.

The impact of human activity can play a very negative role in this process.

An interesting feature was documented near the town of La Trinidad at the southern limits of the studied area. There a fossile landslide possibly blocked an original river bed and thus caused an important hydrographic change in the area.

HZP05

Ramirez-Ruiz, J.J. (University of Colima)

DEFORMATION MONITORING SYSTEMS DURING THE RECENT ACTIVITY OF THE VOLCAN DE FUEGO DE COLIMA, THE MOST ACTIVE VOLCANO IN MEXICO

E-Mail: `ramirez@cgic.ucol.mx`

The Volcan de Fuego de Colima (19º30’44”N y 103º37’02”W) is an andesitic stratovolcano (3860 masl) that is part of a volcanic complex (Colima Volcanic Complex) located along the western front of the Trans-Mexican Volcanic Belt. It is considered to be one of the most active and dangerous volcanoes in Mexico due to its frequent eruptions. It has had more than 30 explosive eruptions during the past 500 years (Medina-Martinez, 1983, Breton et al., 2002). It is important to rebound the eruptions of 1585, 1606, 1622, 1690,1818, 1869, 1890, 1903 and 1913. Volcan de Colima was one of the 16th Decade Volcanoes selected for special investigation during the last decade of the 20th century by the Commission on Mitigation of Volcanic Disaster of the IAVCEI. Around the Volcan de Colima, a population of approximately more than One Million persons are now living inside a radius of 50 km. The present activity 1997-2006 at Volcan de Fuego de Colima began in November 1997 with a series of seismic swarms and deformation of the summit lava dome. Duringthis period of activity three lava extrusions occurred: November 1998, May 2001 and September 2004. The activity of Volcan de Fuego de Colima is monitored in real time by a seismic network, tilt meter network and video camera network. Additionally gas fumarolessurveys are carried out by the Volcano Observatory of the University of Colima as is observed in the web page www.ucol.mx/volcan. Here it will be present an analysis of the risk and the deformation monitoring systems to vigilant the Volcan de Fuego de Colima.

Web page: http://www.ucol.mx/volcan

HZP06

Strauch, W., Talavera, E., Acosta, N. (Managua, INETER), Sánchez, M., Mejía, E. (Managua, Nicaraguan Red Cross)

Tsunami hazard mapping, warning system and disaster prevention measures in Masachapa/Nicaragua

E-Mail: `wilfried.strauch@gf.ineter.gob.ni`

The steadily increasing population at the Nicaraguan Pacific coast lives under considerable tsunami risk. On September 1, 1992, a magnitude 7.6 earthquake in the subduction zone caused a local tsunami. 45 to 60 minutes after the quake the waves struck the 300 km long coast line with run up heights of up to 10 m. This tsunami caused enormous damage in the infrastructure and killed more than 170 people. At this time, tsunami hazard was unknown in Nicaragua. Not any basic element of a tsunami warning system existed in the country, like a seismic network, a communications network, a warning plan. Nicaragua was not a member state of the Pacific Tsunami Warning System (PTWS).

Due to the 1992 tsunami, the public, government and institutions integrated in disaster prevention programs became aware about the necessity of tsunami disaster prevention measures. Nicaragua became an active member of the PTWS. In the following years the seismic network was developed successfully, a national disaster prevention system was created, technical communications systems became operating.

Nevertheless, the development of the Nicaraguan tsunami warning system was mainly oriented towards technical measures related to monitoring and data communication.

To ample the scope of the development, a one-year pilot project was initiated including multiple topics of tsunami prevention measures and considering the direct participation of the local population. It was decided to run the project in the area of Masachapa, a bigger fisher village with some tourist facilities. The area was heavily affected by the 1992 tsunami.

In the project participated the local municipality and local stakeholders, Ministry of Education, National Police, Nicaraguan Red Cross, Ministry of Health, Ministry of Tourism, Nicaraguan Geosciences Institute (INETER), National System for Disaster Prevention (SINAPRED), Swiss Agency for Development and Cooperation (SDC). The following activities were carried out in 2006/07:

- Development of a tsunami warning plan; - Installation of a seismic station and a sea gauge in Masachapa; - Reception of tsunami warning from INETER via voice communication by radio; - Installation of a siren at each of the 4 population centers of the area; (Activation of sirens possible by manual switch and wireless telemetry) - Development of tsunami hazard maps, 1:5,000 scale; - Investigation of awareness level and information needs for different population groups; - Tsunami awareness measures, brochures, calendars, news paper articles, radio programs, TV spots - Information and education to the population, participative events; - Specific educational measures in the schools; - Installation of tsunami signs, indicating hazardous areas, evacuation routes, safe places; - Integration of local private companies, hotel and restaurant owners; - Evacuation drills.

Many activities were carried out in the Easter week (main holiday season in Nicaragua) of 2006 and 2007 taking advantage of the presence of many tourists and visitors.

Based on the experiences gained in Masachapa it is planned to run similar projects in other areas along the Nicaraguan Pacific coast.

Web page: http://www.ineter.gob.ni/geofisica/proyectos/tsu-masachapa/index.html

HZP07

Castillo, H. (Managua, CARE), Strauch, W., Talavera, W., Morales, A., Herrera, M. (Managua, INETER)

Disaster Prevention and Volcano Monitoring System at Cerro Negro Volcano, Nicaragua

E-Mail: wilfried.strauch@gf.ineter.gob.ni

In 2004-2006, the volcano monitoring system of Cerro Negro volcano, Nicaragua, was considerably improved, a communications system for the case of volcano disaster was installed, the organizational level of the population was improved, and measures for education and information on disaster prevention were taken.

Cerro Negro, the youngest volcano in Nicaragua is, since his birth in 1850, the most active volcano of the country. Indeed, in the 156 years of existence of this volcano 23 eruptions are registered, that means an average of an eruption every 7 years.

The damages caused by the volcanic eruptions of the Cerro Negro volcano, were important for the communities of the municipalities of León, Malpaisillo and Telica. It is considered that a territorial extension of 800 squ.km is under high volcano hazard. 55 small rural communities are located in this area with a population of more than 20,000 people. They present typically high levels of poverty. Thus even moderate economic losses are badly tolerated. Volcanic eruptions of Cerro Negro affect in the agricultural cultivations, cattle rising, flora, fauna. Eruptions may cause temporal losses of large extensions of fertile land because of heavy ash fall. Other problems are loss of livestock, damage to of houses, industrial plants, schools, highways and roads; health problems mainly to children and old people caused by the contamination of the environment.

As many eruptions before, also the latest eruption of Cerro Negro volcano, in 1999, was preceded and accompanied by strong seismic movements. So, the seismic network is seen as the main tool for eruption prediction and early warning.

In 2004, CARE, INETER, Civil Defense and the municipal Mayor's offices of León, Telica and Malpaisillo, started a project with the aim to improve the disaster prevention in the area of Cerro Negro volcano.

The following main results were achieved until January 2006: - 825 community leaders of 55 communities around of the Cerro Negro volcano, 300 teachers of school centers, 15 officials of the municipalities of León, Telica and Malpaisillo, 40 officials of national institutions (INETER and Civil Defense) have improved their knowledge and their response capacity in case volcanic eruptions.

- The seismic monitoring system for the volcano was considerably improved (8 digital seismic stations and one small seismic array). The system works with digital telemetry to INETER´s main offices in Managua. There, a 24x7 duty system monitors the volcanic and seismic activity of Nicaragua and emits warning messages.

- A communication system to the population is working (30 radios installed) which can be used in case of an eruption in the Municipality of León,Telica and Malpaisillo. The system is in routine use for other needs in the communities. Radio operators were trained. - Equipments for 25 rescue brigades exist and training was given

- Evacuation routes were defined and signalized, critical points along the routes were improved through small mitigation works, for an appropriate functioning in case of an emergency.

- School security plans were elaborated

- Hazard maps and scale models of the volcano were elaborated with the communities

- Evacuation drills were carried out

Web page: http://www.ineter.gob.ni/geofisica/proyectos/care/index.h

HZP08

Toulkeridis, T. (CGVG-USFQ, Ecuador), Cando, M. (DINAPA, Ecuador), de la Torre, G. (INOCAR, Ecuador), Cruz, M. (FIGEMPA-ESPE, Ecuador), Vasquez, N. (DNDC, Ecuador)

A new, human decision independent, early alert system for tsunamis at the Ecuadorian coast

In spite of being one of the smallest countries of South America, Ecuador presents all three different types of plate boundaries as well as a hotspot zone at the Galapagos. The future appearance of tsunamis will occur in two most potential forms. The first and most probable way exist as a result of the collision between the eastwards trending oceanic Nazca and the continental Caribbean and South American plates and the subsequent subduction of the oceanic plate along the Nazca trench. Furthermore, due to flank instabilities of one of the huge shield volcanoes of the Galapagos,as recently discovered. Based on these geodynamic settings two different scenarios are possible at the Ecuadorian coast and the Galapagos. The first scenario appears along the subduction zone which allows a reaction time of less than seven minutes before impact in the worst case scenario and up to twenty minutes in the other extreme case, based on the fact that the distance of the fault line area does not extend for more than seventy kilometers. A potential, partial subaerial or submarine collapse of one of the most unstable volcanoes (Roca Redonda, an active volcano, which is situated sixty m above sea level and represents an emergent peak of a submarine shield volcano with a diameter of twenty five kilometers that rises more than three thousand two hundred meters from the seafloor) of the Galapagos impacts with a tsunami major ports of the islands in no later than thirty six minutes and the Ecuadorian mainland coast in some two hours. However, there is little recorded information about tsunamis in Ecuador or its coast, due to the lack of serious research about paleotsunami deposits. Nonetheless, a hand-full of historic tsunamigenic events (1882,1906 (8.8Mw), 1933, 1953, 1958, 1979) is enough to emphasize Ecuador's vulnerability. Therefore, we propose here a new, human-independent, early alert system with the absolute guarantee of functionality. This early alert system will need to respond immediately to any seismic event in the vicinity of Ecuador or any other coastal sites. To localize an earthquake, basically at least three seismographs are necessary. The more seismographs are added, the more precisely localized will be the hypocenter and epicenter. Secondly, those seismographs must to be linked in a system that has the ability to automatically indicate the locality and scale of a seismic event within a few seconds. Any earthquake registering 7.5 Mw or higher on the Richter Scale (this magnitude event is necessary to produce a tsunami) will trigger the automatic transmission of an alert to sirens installed along the shorelines. The transmission of this signal is necessarily independent of human actions and decisions. By generating the alarm signal, people would be short-noticed by sirens and an electronic switch to their celulars to move to a shelter or an assigned place for safety. This system is connected also to places that are attractive for tourism, where large installed screens might display seismographic records in real-time of the current telluric activity. The costs of such an early warning system are obviously extremely low and can be usually financed by local municipalities or even by private investors. This is the first time this form of an early alert system has ever been proposed. Such a system, which is now in Ecuador under construction, may serve as an example to save the life of millions worldwide where similar geodynamic conditions exist.

HZP09

Vásconez, F. (Quito, Consultant)

The Guarumales Landslide in Ecuador

Main point of the present work is the investigation of the "Guarumales" area. Its hillside movements risk the normal operation of the "Paute" hydroelectric plant, that generates about 50% of Ecuador's electricity.

Factors that continuously destabilize the hillsides and that can suddenly cause landslides were acknowledged through the analysis of regional and local geological aspects as well as through the observation of the morphogenetic processes.

A determinant causative element of landslides is the fluvial erosion of the Paute River at the bottom of the hillside. The steep dip toward WSW of the Foliation S1 from metamorphic rocks (green schists facies) commonly constitute the lateral flanks of several landslide units within the area of research. The construction of the "Guarumales" built-up area in the inferior intermediate part; as well as of the "Guarumales-Méndez" road in the upper part; and, a new access route in the lower part of the area of research have aggravated the acceleration of hill movements.

The processing of geodetic measures led to the determination of the superficial movements.

Temperature measurements of groundwater, data processing of tracer injections as well as a new processing of electrical resistivity soundings were carried out in order to determine the preferential directions of the underground water flow.

Critical conditions that trigger an acceleration of the slope movements could be established through dynamical models. Such models facilitated the establishment of risk categories and simplified the elaboration of risk maps.

LI

Life from Fossils to Humans

LI01 – Thu., 12.4., 16:30 - 16:50 · HSF

Leppe, M. (Punta Arenas, Instituto Antártico Chileno)

Upper Triassic South Western Gondwana looked since the Chilean Flora

E-Mail: `mleppe@inach.cl`

The South Western Extratropical Gondwana during the Upper Triassic comprises an important part of the natural history and an example of how the dominant Triassic floral elements face the geographical, geological and climate change. All the Triassic fossiliferous outcrops of Chile belong to the continental and marine margin of Gondwana. The abundance of precipitation, after a continental tilt tothe north, could be a serious conditioner of the dominant presence of the Corystospermaceae, a typical taxon of dryer weather of the area until the Carnian-Norian boundary. The decreasing presence of Corystospermaceae, the appearance of the typical elements of the Jurassic, the dominance of seasonal deciduous forest dominated by the genus Linguifolium, characterizes the Norian-Rhaethian lapse, known as Florian Stage in the argentinian stratigraphy. This work are focused in the Bio-Bío river, central Chile (37º5,95´S-72º53,53´W), where large Triassic outcrops show a great paleofloristic richness. The specific diversity reaches 45 plant megafossil species (imprints) that are characterized for presenting strong botanical and ecological affinities with the southwestern Extratropical Gondwanaland, and specially with the uppermost Upper Triassic formations from Argentina (Florian stage). The taphonomic analysis permit to establish the existence of four types of plant assemblages, that demonstrating the gradual decline of the Corystospermaceae during the Carnian-Rhaetian lapse. The sedimentation type and the associated taxa shows the presence of lacustrine and river sedimentation, and at least one marine depositional event. The question about how the Chilean, Argentinean and West Antarctic floras are related was looked by a panbiogeographic approach. A Parsimony Analysis of Endemicity was elaborated with all the floral diversity of 33 localities, generating a cladogram of 25 of the more significant localities. The results strongly connect south western Chilean floras with the Florian Stage, as Paso Flores, Chihuido and Llantenes Formations in Argentina. The biocronic overlapping of the taxa founded give a Middle Carnian to Upper Norian age (203 to 220 my ago), lapse of time with characteristic extensional events and continental migration, that generating a significant increase in the rainfall and the consequent change in the Triassic assemblages composition.

Web page: http://www.inach.cl

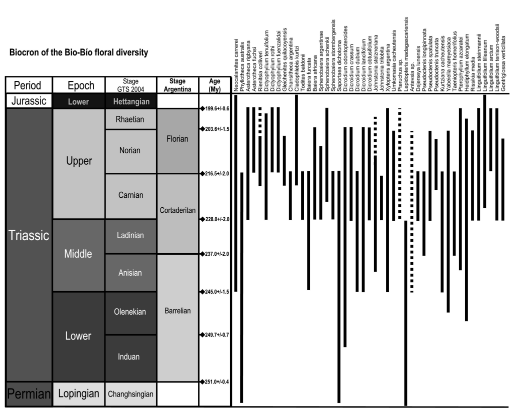

Figure 1: Biocron of the Bio-Bio's floral diversity

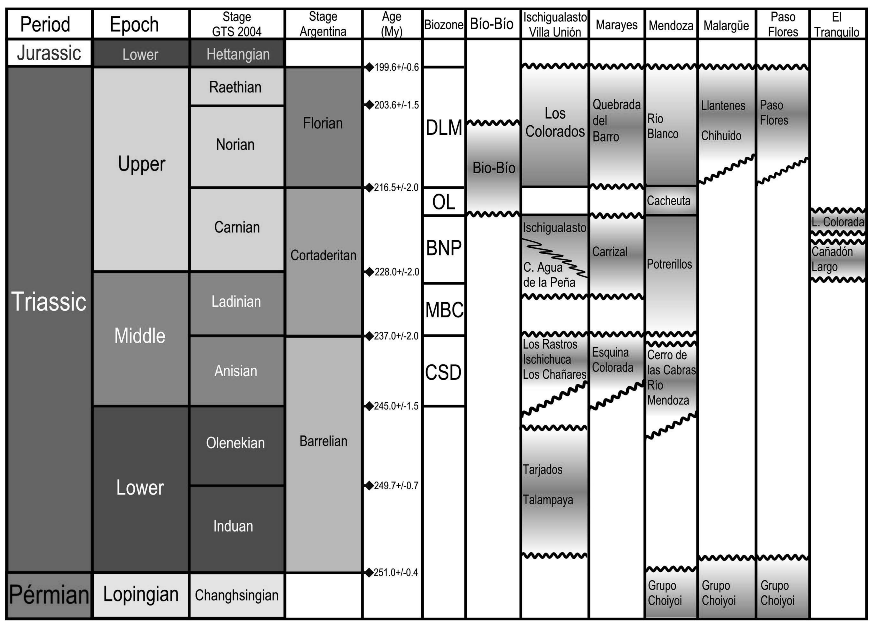

Figure 2: Stratigraphic relation between the main Triassic outcrops of Argentina and Chile.

LI02 – Thu., 12.4., 16:50 - 17:10 · HSF

Brenner, W. (Kiel)

Organic microfossils from Guanabara Bay, Rio de Janeiro, Brazil, distribution patterns and ecological significance

E-Mail: wolframbrenner@hotmail.com

Guanabara Bay, with the cities Rio de Janeiro at the west side and Niterói and São Gonçalo at the east side, is an important economic and tourist centre in southeast Brazil. The bay is one of the most polluted regions in the Brazilian coast, derived from untreated domestic and industrial sewage and waste. Due to the pollution of the Bay, it is an important locality for studying eutrophication and pollution effects on ecosystems.

The distribution of organic microfossils in surface sediment samples of the Guanabara Bay bas been examined from 50 samples. These microfossils include among others dinoflagellate cysts and other algae, microforaminiferal linings, tintinnid loricae and cysts, and copepod eggs. The main factors influencing the distribution of organic microfossils are salinity, which decrease from the entrance of the bay in the south to the north, and pollution/nutrient which is high in the industrial area in the northwest of the bay and low in the environmental protected area in the northeast and in the southern and central part caused by the water exchange with the Atlantic Ocean.

The distribution patterns of the organic microfossils show, that the abundance or presence of some species depends on one or more environmental factors, and some species even differs between industrial and domestic pollution. For example, within the dinoflagellate cysts the peridinioid forms dominate the assemblage in the whole bay except the region with high industrial pollution in the northwest and the costal area between Niterói and São Gonçales, where gonyaulacoid forms dominate. Individual cysts as Scrippsiella trochoidea are common only in the low salinity region in the north of the bay and seem not influenced by pollution, whereas Gyrodinium instriatum is abundant in the southern part and in the northeast, suggesting that this species tolerate different salinities but is restricted by pollution

These findings can improve the interpretation of the fossil record especially for investigation of historical environmental changes and for future prediction of the environment development, especially since some of the dinoflagellates as Alexandrium and Gyrodinium are toxic forms and can provide serious problems for the fisheries and even for human health.

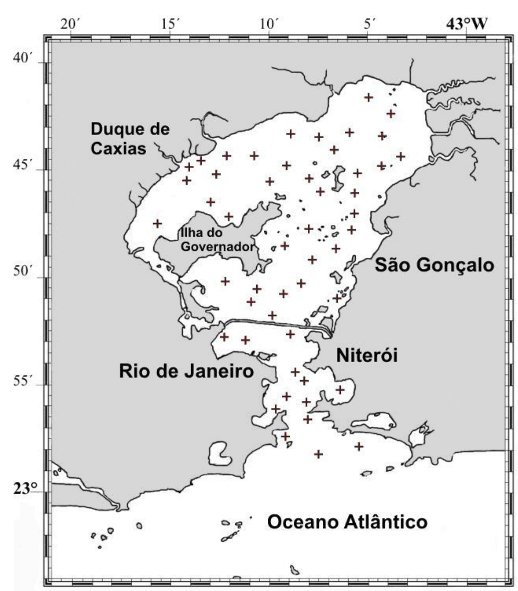

Figure 1: Map of Guanabara Bay with sample distribution

LI03 – Thu., 12.4., 17:10 - 17:30 · HSF

Erdtmann, B.-D. (TU Berlin), Walde, D., do Aperecido Carmo, D. (Universidade de Brasilia)

NEW DATA AND OBSERVATIONS ON EDIACARAN (LATEST PRECAMBRIAN) FOSSILS FROM THE PARAGUAI BELT IN SW BRAZIL

Since the discovery of the presumed Ediacaran fossil Corumbella werneri (Hahn et al. 1982) from the quarry ”Claudio” at Corumbá-Ladario in Mato Grosso do Sul, SW Brazil by Walde in 1982 several new data have emerged about this peculiar apparently first mineral-shelled fossil. Although the biological-functional and systematic relationship of Corumbella werneri still remains unresolved, a tube-like nature and a potential close systematic relation of this organism to coronate scyphozoan cnidarians (and by inference to tetraradially symmetrical conularids) was originally postulated by Hahn, Hahn, Leonardos, Pflug and Walde 1982 and more recently reconfirmed by Babcock, Grunow, Sadowski and Leslie 2005.

Investigation of recently discovered specimens of Corumbella from three localities near Corumbá, however, provide new morphological observations which may significantly affect all previous interpretations of this fossil. Most importantly cross-sectional thin sections have provided evidence that the quite elongate carapaces of Corumbella may not be tuboid in morphology having possessed tetraradiate or circular sagittal cross-sections, but instead, they represent arc-like bilateral structures composed of segmented scales with a dorsal zig-zag median line. This kind of en-echelon dorsal line is also characteristic of several Ediacaran Vendobionta such as Phyllozoon, Dickinsonia and Pteridinium. These forms are interpreted to have lived semi-endobenthically partially immersed into bacterial mats as either symbionts or epibionts of bacterial-microbial mats. So far, hundreds of specimens of Corumbella werneri have been found by the above authors attached to very few bedding planes of thinly laminated carbonaceous mudstones and associated volcanic ashbeds in the upper beds of the Tamengo Formation, Corumbá Group.

The interpretation of Corumbella as flat-lying benthic ”chain-like” organisms is supported by their parallel and usually contiguous alignment on the substrates. Furthermore, their partial disarticulation patterns indicate in-situ burial of an organism which possessed an immobile ”creeping” life-mode along tops of bacterial mats, instead of the formerly presumed ”erect” life habit as tuboid stems of presumed scyphozoans. Hypothetically these multi-scale-segmented ”carapaces” housed a biomass of eukaryotic cell tissues which ”fed” by ingestion of bacteria or nutrients which were ”absorbed” directly through a ventral cell layer attached to the bacterial mat surfaces analogous to the feeding modes proposed for immobile seafloor-dwelling mat-encrusting vendobionts by Seilacher 1992, 1999, Seilacher et al. 2003.

Another glance at latest Ediacaran life is given by a rare occurrence of a ”digestive bacterial cocoon” which was recently recovered by one of the authors (D. Walde) within a tempestitic mud-bed at the quarry ”Claudio” in Corumbá. Within this clearly outlined ”leathery” patch several fragments of partially decayed Corumbella specimens are observed together with an ellipsoid shell including its attached pedicle-like stem of a presumed linguloid brachiopod. On first sight this bluish colored ellipsoid shell was believed to have been the ”missing link” of the ”head” or anterior portion of Corumbella, however, the attached stem portion does not possess the characteristic median line nor distinct segmentation of Corumbella. The apparent lack of any evidence for the presence of both a finite proximal nor distal (apical?) portion in all material assigned to Corumbella makes it difficult to place this fossil into any known Phanerozoic phylum. All attempts to reconstruct this organism (Hahn et al. 1982, Babcock et al. 2005) are completely conjectural with regard to either proximal ”heads” or apical holdfast structures. Therefore, alternative reconstructions may deserve serious consideration. The present authors here propose a reconstruction of Corumbella as a bilaterally symmetric vendobiont covered by arc-like scales, joined en-echalon at a midline, and which were laterally ”openly” immersed into biomat-sealed sediment substrate analoguous to ”biomat encrusters” sensu Seilacher 1999. Taphonomical evidence such as the parallel and contiguous alignment and the usually twisted nature of the elongate chain-like carcasses of Corumbella suggest a benthic ”creeping” life attachment to biomats rather than an erect tube-like life reconstruction as proposed by Hahn et al. 1982 and by Babcock et al. 2005.

On the other hand, another morphological analogy may be discussed at this point for Corumbella werneri, which may indicate a potential relation to brachiopod pedicles as demonstrated by Zhang, Shu, Han and Liu (2006). These authors illustrate and discuss a newly discovered linguloid brachiopod, Xianshanella haikouensis, from the Lower Cambrian (upper Atdabanian) Chengjiang Lagerstätte in Yunnan, SW China, whose pedicles, on first inspection, show great similarity to Corumbella, especially with regard to their ”wrinkled” pseudo-segmentation (ibid. Figs. 1,1, 1-6, 1,8; 3, 4, 3,11 and 3,12). The apparent ”midline” (non in-echelon zig-zag line) within the pedicle of Xianshanella haikouensis, however, is probably the image of an intestinal canal which is visible in many specimens because of the transparent nature of the pedicle integument, as it is characteristic for many soft-bodied Chengjiang fossils.

Regardless of the biological and functional interpretations of Corumbella as a mat-encrusting vendobiont or as apotential brachiopod pedicle, the biostratigraphical implications of the presumed linguloid brachiopod contained in the bacterial ”cocoon” could mean that the upper beds of the Tamengo Formation may be interpreted as either:
a) top Ediacaran, or
b) transitional Ediacaran to Lowermost Cambrian, or
c) Lower Cambrian in age
The present authors favour alternative a) because only a few meters above the horizons containing Corumbella a mass-occurrence of cloudinid ”steinkerns” is observed within the Tamengo Formation. Cloudinids sensu lato, so far, have not yet been found in confirmed Lower Cambrian beds. Moreover, as fossils classically belonging to Phanerozoic phyla (f. ex. Porifera, Arthropoda, etc.) are recently encountered together with Ediacaran biota, the alternative b) could be considered. Cloudinids sensu lato represent probably the first true ”Small Shelly Fossils” and their first appearence may better mark the much disputed Precambrian / Cambrian boundary than any trace fossil such as Treptichnus pedum (Narbonne, Myrow, Landing and Anderson, 1987; Jensen, 2003).

LI04 – Thu., 12.4., 17:30 - 17:50 · HSF

Salazar, C. (Karlsruhe, Universität Karlsruhe)

MAASTRCHTIAN AMMONITES FROM THE QUIRIQUINA FORMATION, CENTRAL CHILE

E-Mail: geosalazar@gmail.com

MAASTRCHTIAN AMMONITES FROM THE QUIRIQUINA FORMATION, CENTRAL CHILE

Christian Salazar-Soto1, Wolfgang Stinnesbeck1 and Luis Arturo Quinzio-Sinn2

1 Institut für Regionale Geologie, Universität Karlsruhe, 76187 Karlsruhe, Germany. 2 Departamento Ciencias de la Tierra, Universidad de Concepción, Casilla 160 C, Concepción, Chile.

ABSTRACT Sediments at the type locality of the Quiriquina Formation at Las Tablas, a bay on the NW coast of Quiriquina Island, VIII Region of Chile, contain abundant and diverse mollusks of Indo-Pacific (Indian, Australian and Antarctica) and southern European affinities. Our review of the ammonite assemblage yielded 24 species referred to 17 genus. Hypophylloceras (Neophylloceras) ramosum, Hypophylloceras (Neophylloceras) hetonaiense,Hypophylloceras (Neophylloceras) inflatum, Phyllopachyceras forbesianum, Anagaudryceras subtilineatum, Anagaudryceras politissimum, Gaudryceras kayei, Zelandites varuna, Pseudophyllites indra, Kitchinites (Kitchinites) darwini darwini, Kossmaticeras (Natalites) erbeni, Grossouvrites gemmatus, Maorites tenuicostatus, Pachydiscus (P.) jacquoti chilensis, Menuites fresvillensis quiriquinae, Diplomoceras cylindraceum, Baculites huenickeni, Eubaculites carinatus and Hoploscaphites constrictus quiriquiniensis have been known previously from the area whereas Phyllopachyceras forbesianum, Anagaudryceras subtilineatum, Gunnarites cf. bhavaniformis and Baculites anceps are new records for the Quiriquina Formation. In addition, Kitchinites sp.1, Kitchinites sp.2, Grossouvrites sp. and P. (Pachydiscus.) sp. appear to be new species recorded here for the first time, as well as new subspecies of Grossouvrites gemmatus and Gaudryceras kayei. The Quiriquina Formation must be considered to be of late Maastrichtian age based on the occurrence of index species Menuites fresvillensis quiriquinae, Pachydiscus (P.) jacquoti chilensis and Hoploscaphites constrictus quiriquiniensis. Towards the top of the Quiriquina formation, ammonoid abundance and diversity declines gradually and not a single individual was found in the uppermost 5 metres of the unit. The extinction of ammonites in central Chile was thus completed prior to the end of the Maastrichtian and must have have been caused by other factors than an asteroid impact at the K/T boundary.

LI05 – Fri., 13.4., 10:10 - 10:30 · HSF

Aceñolaza, G. (Tucumán)

Refinning the chronology of the Seilacherian ´´Cruziana Stratigraphy´´: Additional data from an outstanding outcrop in the Ordovician of Western Gondwana

E-Mail: acecha@webmail.unt.edu.ar

Epicratonic marine sandstones characterize thick sequences on the Lower Paleozoic Gondwanan realm, a facies type that is not good for body fossil preservation. At the same time, clastic rocks, and particularly sandstones, are the best for preserving trace fossils. Even though trace fossils are mostly regarded as poor biostratigraphic indicators, some elements as the ichnogenus Cruziana must be highligthed by their unique paleontological value. Lower Paleozoic Cruziana is mostly regarded as a trilobite crawling exite-produced trace, and due to its striking morphology has provoked many remarkable papers focusing different aspects related to its production, preservation and variability. Trace fossils are valuable elements for characterizing sedimentary environments and a varied spectrum of paleoecological patterns.

Extensive study mostly developed by Professor Dolf Seilacher since the 60´s demonstrated the stratigraphic value of trilobite burrows in the Gondwanan realm. Furthermore, a ”Cruziana stratigraphy” was developed, based on the association of several forms of Cruziana in Lower Paleozoic shallow marine sandstone facies. As a result, Cruziana is used today as a reliable field work tool for correlation of the frequently ”non-fossiliferous” sandstone facies that is typical of Gondwana.

The Cruziana stratigraphical scheme is based on the morphology of traces as primary time markers, for the South American Cambrian - Ordovician successions, the record of C. semiplicata is restricted to the Furongian and Tremadocian, whilst C. furcifera occurs in the Tremadocian and Arenig. Up in the strata, C. rugosa is restricted to the uppermost Tremadocian and Arenig.

Outstanding Cruziana pavements have been recently localized in the Lower Ordovician strata assigned to the Labrado Formation at the Sierra de Zenta, Jujuy Province (northwest Argentina). Traces are mostly referred to the ”rugosa group”, and were found in the upper sector of the section cropping out at Doblozno and Laguna Verde localities.

Carbonate - cemented lenses associated to the trace fossils provided conodonts representative of the Trapezognathus diprion Zone. Trapezognathus diprion (Lindström) has a Baltoscandic provincial affinity and could be referred to the temperate water Baltic Province of the Atlantic Realm. The T. diprion Zone correlates with the uppermost Lower Ordovician Series and to a level that is close to the base ofthe Middle Ordovician Series and its lower stage. In addition, a rich palynological assemblage under study has been recorded along the section, providing additional elements to adjust, for the first time, the Seilacherian ”Cruziana stratigraphy” scheme in South America.

This calibration of Cruziana stratigraphy will lead to improved understanding of biostratigraphic correlations of Ordovician stratigraphic successions of Gondwana, which so often lack standard guide fossils.

LI06 – Fri., 13.4., 10:30 - 10:50 · HSF

Schmincke, H.-U., Rausch, J., Kutterolf, S., Freundt, A. (Kiel)

Acahualinca revisited

Acahualinca revisited

H. -U. Schmincke, J. Rausch, S. Kutterolf, A. Freundt Leibniz Institut für Meereswissenschaften IfM-GEOMAR and SFB 574, Wischhofstr. 1, D-24148 Kiel, Germany

We present further details of a late Holocene footprint surface preserved in two pits in the suburb of Acahualinca (Managua, Nicaragua) and of overlying tephra deposits. The 4 m high walls of the main 14.5 m wide pit expose 6 lithostratigraphic units. Ages given below are discussed in Kutterolf et al. (in rev.). The footprint surface (Unit I) is composed of mostly massive basaltic-andesitic tephra layers, interpreted to represent separate pulses of a basically phreatomagmatic eruption that may have lasted several days tomonths. The tuffs and lapillistones consist of fresh sideromelane and tachylite shards with minor but variable lithoclasts and minor mostly fragmented pl and ol. Unit I tephra is tentatively correlated with the Masaya Triple Layer (2.1 ka BP). An up to 1 m deep major erosional channel oriented NNW unconformably separates Units I and II. Unit II consists of basal 5-10 cm ol-bearing dacitic fallout lapilli overlain by massive fine-grained dacitic hyaloclastite tuff, some layers containing accretionary lapilli and greenschist-facies lithoclasts. The up to c. 40 cm thick Unit II is correlated with the Chiltepe plinian eruption (1.9 ka BP). Unit III is a strongly lithified, up to 50 cm thick massive basalticphreatomagmatic debrite extremely rich in branch molds and excellent leaf impressions, possibly correlative with the Masaya Tuff (c.1.5-1.8 ka BP). Unit IV is a reworked massive to cross-bedded basaltic tuff 15-100 cm thick and rich in brown tuff clasts. An ill-defined light brown mass flow deposit up to 1 m thick (Unit V) is overlain by 1-1.5 m of dominantly reworked chiefly basaltic volcaniclastics topped by soil (Unit VI).

The footprint layer (base of Unit I) is composed of a lower 5-15 cm thick coarse mafic phreatomagmatic vesicle tuff capped by a medium to fine-grained tuff up to 3 cm thick. The surface on which the people walked was muddy, the soft material having been squeezed up on the sides of the tracks and between toes. A group of bipedal footprints up to 5.7 m wide comprises a central group of footprints made by about 6 individuals (e-j), the total number being uncertain because people walked in goose-step fashion. A western band comprises tracks of 3 individuals (b-d) and a single footprint (a) farther out. An eastern side comprises an inner track of deep footprints made by 3 individuals (klm), and further out 3 separate individuals (nop). The total number of people recorded in the footprints is 15-16. The group probably comprised male and female grown ups, teenagers and children based on differences in length of footprints and of strides and depth of footprints. For example, track b (probably young person) shows an average footprint length of 19.4 cm and average stride of 46 cm, track c (possibly grownup male) 23.6 cm and 60.3 cm and track o (possibly grownup female) 22.4 cm and 55 cm. Especially deep footprints are due to 3 causes: 1) Two or more people walking strictly in each others footsteps; 2) differences in weight of individuals (men, woman, children, individuals possibly carrying some load) and 3) local overthickening of the fine-grained muddy ash. The footprint surface was subsequently inundated and smoothed by water probably from nearby Lago Managua. The excellent preservation of the footprints and ubiquitous mudcracks suggest dry season during the eruption. The people walked at a brisk pace based on the tight orientation of the band and the length of the strides. The preservation of the footprint surface is due to rapid covering by phreatomagmatic tephra of the same eruption, probably from active Masaya volcano 10 km to the south. The directions of the main erosional channel in the deposits and the band of footprints are strictly parallel indicating that people walked together in stride straight towards the lakeshore, possibly a site with huts for protection and/or boats for escape.

Kutterolf S, Freundt A, Pérez W, Wehrmann H, Schmincke HU (2007) Temporal succession and magnitudes of highly explosive eruptions in west-central Nicaragua. J Volcanol Geotherm Res (in revision)

LI07 – Fri., 13.4., 10:50 - 11:10 · HSF

Koutsoukos, E. A. M. (Rio de Janeiro, PETROBRAS-CENPES/ Heidelberg, Geologisch-Paläontologisches Institut, Universität Heidelberg)

Phenotypic plasticity and lineages of the planktonic foraminifera (Globigerinina) in the Danian : The low-latitude record from the western northern South Atlantic

E-Mail: ekoutsoukos@gmail.com

Well-preserved foraminiferal assemblages recovered from Cretaceous-Paleogene (K/Pg) boundary sections in the western northern South Atlantic contribute to elucidate the evolutionary events that took place across the boundary transition in the pelagic realm. Highly increased speciation/radiation rates, plastic morphologies and dwarf-sizes (Lilliput effect) are characteristic traits of the early Danian planktonic foraminiferal assemblages. In the aftermath of the Cretaceous-Paleogene (K/Pg) mass-extinction event, when nearly all planktonic foraminifera were extinct, the surviving species (probably only three) started to evolve quickly. Three main dwarf-size planktonic foraminifera lineages are characteristic of the Danian, giving rise to all the subsequent Globigerinida families: (i) the microperforate, non-spinose, Guembelitria-Woodringina-Chiloguembelina (Guembelitriidae) lineage; (ii) the cancellate, spinose, Eoglobigerina-Parasubbotina-Subbotina (Globigerinidae) lineage; and (iii) the cancellate, non-spinose, Praemurica (Globorotaliidae) lineage, the last two evolved from a Hedbergella stock. The nearly coeval main diversification/radiation episodes among these early lineages, which gave rise to a number of other dwarf-size opportunistic forms of highly plastic morphologies with abundant phenotypic variation and intermediates within populations, are evidence of parallel evolutionary trends, and are a remarkable example of macro- and microevolution within the Foraminifera. Common patterns and processes underlie these events, most probably induced by major changes in oceanic water-masses as environmental conditions progressively improved, in the aftermath of the K/Pg boundary event. Theepisodes of maximum radiation appear to be coeval with the progressive recovery of the surface water productivity and the oceanic carbon cycle, coupled with expanded surface-water oligotrophic settings and increased reliance on symbiosis, and the return to background oceanic conditions similar to those observed in the latest Cretaceous.

LI08 – Fri., 13.4., 11:10 - 11:30 · HSF

Ifrim, C. (Staatliches Museum fuer Naturkunde Karlsruhe, Germany), Stinnesbeck, W. (Institut fuer Regionale Geologie, Universitaet Karlsruhe, Germany)

Cenomanian-Turonian high resolution biostratigraphy at Vallecillo in northeastern Mexico and biostratigraphic correlation with the GSSP and Europe

E-Mail: `christina.ifrim@smnk.de`

Small limestone quarries at Vallecillo in the NE Mexican state of Nuevo León are regionally known for the excellent preservation of fossil fishes, but they also contain abundant planktic foraminifers, five species of inoceramids and 12 species of ammonites oflatest Cenomanian to early Turonian age, with both Tethyan and Western Interior Seaway faunal elements present. Ammonite biozones include the late Cenomanian Nigericeras scotti zone, the early Turonian Watinoceras, P. flexuosum, Vascoceras birchbyi and Mammites nodosoides zones. Inoceramids indicate the late Cenomanian Inoceramus pictus and Mytiloides hattini and the early Turonian M. puebloensis and M. kossmati biozones; coeval planktic foraminifers represent the Whiteinella archaeocretacea and the Helvetoglobotruncana helvetica biozones. These faunal characteristics of the Vallecillo fossil assemblage combined with the monotonous marly limestone lithology are favourable attributes for a correlation with the GSSP at Pueblo, Colorado, and the Eastbourne section in southern England. The first appearances (FAs) of the ammonites Watinoceras and Mammites nodosoides are considered approximately isochronous in the three sections, in addition to the FA of the inoceramid Mytiloides puebloensis. These species are thus suited for long-distance correlation. In contrast, the FAs of the ammonites Pseudaspidoceras flexuosum and Fagesia catinus and the foraminifer Helvetoglobotruncana helvetica are clearly diachronous. The range of the inoceramid M. kossmati needs further evaluation.

LIP01

Aceñolaza, F., Aceñolaza, G. (Tucumán)

Ichnology of the Miocene strata in North Patagonia, Chubut and Río Negro coast line (Argentina)

E-Mail: facenola@infovia.com.ar

The Miocene of the Northern Patagonian coast line of Chubut and Rio Negro (Argentina)is characterized by extensively distributed marine sequences developed over a shallow platform covering an area from Viedma to the lower valley of Rio Chubut. Strata was sedimented during the marine transgression associated to the ´´Patagoniense Sea´´ that was contemporary to the ´´Paranense Sea´´ developed mostly in the Mesopotamia and Pampas of northern Argentina.

The marine outcrops are recognized in the SanMatías Gulf/Gran Bajo del Gualicho, Valdés Penninsula and the lower valley of Río Chubut, representing sea level fluctuations occurred in Patagonia during the Late Middle Miocene (Serravallian and Tortonian age).

In all the region, these outcrops display continental intercalations. Marine strata are characterized by abundant fossiliferous levels with marine invertebrates (ej. Ostrea spp., Pecten spp.), with an intense bioturbation with nicely preserved traces represented by the genus Skolithos, Ophiomorpha, Thalassinoides and Rosselia. as the most common forms. At a first sight, there is not a clear separation between the different levels containing the traces, represented by a unique association developed on a shallow tidal - subtidal palaeoenvironment.

The ichnological association provides some clues on the biological diversity of the Miocene sea in the Patagonian coast, and the study of the same will allow a closer comparation with other section along the Argentine coastline.

LIP02

ALVES, L.S.R. (Rio de Janeiro, (FAPERJ/IVP-Bolsista F.P.) Departamento de Estratigrafia e Paleontologia, Universidade do Estado do Rio de Janeiro - UERJ)

THE IRATI FORMATION (UPPER PERMIAN, PARANA BASIN) IN THE SAO PAULO STATE, BRAZIL, AND THE OCCURRENCE OF FOSSIL WOOD

E-Mail: `Laureen.Alves@gmail.com`

The Parana Basin, situated on the western border of South America, is an intracratonic basin filled with Paleozoic strata, Mesozoic sedimentary rocks and basalt lava and Cenozoic deposits. It overlies an area larger than 1.400.000 square km that includes part of territory of Brazil, Eastern Paraguay, Argentinean Mesopotamia and Northern Uruguay. Analyses performed on permineralized paleoxylogical associations that occur within Upper Permian sequences of the Parana Basin show a significant compositional variation as well as excellent anatomic preservation (Alves& Guerra-Sommer, 2005). The occurrence of well-preserved silicified wood logs in the Upper Permian of the Parana Basin, particularly in Irati Formation outcrops of the Sao Paulo State, has allowed for detailed systematic, paleoclimatic and stratigraphic studies to be carried out. A fossil wood is described from the Vitti limestone quarry, an outcrop of the Irati Formation near Rio Claro, Sao Paulo, at km 7.5 of the Rio Claro-Piracicaba highway. The studied specimen was recovered in situ from a carbonate mudstone layer, near the base of the outcrop section, where it was found together with disarticulated vertebrae of mesossaurs. The material studied here was colleted from the north portion of the Parana Basin included in the Carboniferous-Lower Triassic Megasequence defined by Milani et al. (Milani et al., 1998) for the Parana Basin. Several diagnostic features observed in this fossil log permit its attribution to the genus Barakaroxylon, including: presence of a solid medulla with 0.7 cm, a heterocellular medulla, primary endarch xylem, a secondary xylem with distinct growth rings, early wood formed by 100-123 tracheid and late wood narrow formed by 6-15 tracheids, uniseriate bordered pits, uniseriate or partially biseriate medullar rays, with 1- 4 -16 cells high in tangential view, scalariform thickenings in radial walls of tracheids and crossing fields with large an isolated punctuations (Alves, 2006). Detailed analyses of growth rings of this and of other fossil logs recovered from the Irati Formation suggest a climate of 'the Mediterranean' type, characterized by hot and dry summers, and winters with the occurrence of storms and cyclones (Alves et al., 2005).

References:

Alves, L.S.R., 2006. A Fossil Wood from the Irati Formation (Upper Permian), Parana Basin, Sao Paulo State, Brazil. In: Geological Society of America (GSA) Annual Meeting and Exposition, Philadelphia. Geological Society of America Abstracts with Programs, 2006. v. 38. p. 553.

Alves, L.S.R. and Guerra-Sommer, M., 2005. Paleobotany and Paleoclimatology. Part I: Growth Rings in Fossil Woods and Paleoclimates. In: Eduardo A. M. Koutsoukos, Ed., Applied Stratigraphy. Dordrecht: Springer, v. 23, p. 179-202.

Milani, E.J., Faccini, U.F., Scherer, C.M., Araujo, L.M. and Cupertino, J.A., 1998. Sequences and stratigraphic hierarchy of the Parana Basin (Ordovician to Cretaceous) Southern Brazil, Boletim do Instituto de Geociencias da Universidade de Sao Paulo, v. 29, p. 125-173.

LIP03

AZEVEDO–SOARES, H. L. C. (Prefeitura da Cidade do Rio de Janeiro, Secretaria Municipal de Educação)

The Trombetas Group Chitinozoan's of the Amazon Basin - Northern Brazil

E-Mail: hlcuevas@pop.com.br

The Nhamundá, Pitinga and Manacapuru Formations of the Trombetas Group (Amazon Basin) have been studied using palinological methods which helped to accurate their age (Late Rhuddanian throught Early Lochkovian). For this study we have used fifteen boreholes associated with six outcrops. Those formations are easily recognizable throughout the Amazon Basin. The fossileferous deposits of the outcrops have an indicative fauna (Early Wenlock to Early Pridolian) like *Margachitina margaritana, Sphaerochitina densibaculata, Pogonochitina djalmai, P. inormata, Cyathochitina caputoi, Desmochitina densa, Conochitina acuminata* and *C. proboscifera*. But the boreholes samples give us more extended assemblages with *Ancyrochitina fragilis, Ancyrochitina primitiva, Ancyrochitina aff. A. tomentosa, Angochitina echinata, Angochitina ? thadeui, Cingulochitina convexa, Cingulochitina aff. C. ervensis, Cingulochitina serrata, Cyathochitina caputoi, C. campanuaeliformis, Desmochitina densa, Margachitina margaritana, Margachitina* aff. *M. saratensis, Pogonochitina djalmai, P .inormata, Pterochitina perivelata, P. megavelata, Tanuchitina* aff. *T. cylindrica, T. elenitae, Ramochitina illiziensis* and *Vinnalochitina corinnae*. The age of those formations accessed by palinological and biostratigraphical methods could be estimated within Late - Middle Llandovery / Early Wenlock for the Lower Pitinga Formation (and Nhamundá Formation); Ludlow / Pridoli for the Upper Pitinga Formation; and Pridoli /Early Lochkovian for the Manacapuru Formation.

LIP04

Patarroyo, P. (Universidad Nacional de Colombia, Bogotá), Bengtson, P. (Geologisch-Paläontologisches Institut, Universität Heidelberg)

An uppermost Cenomanian–lower Turonian (Cretaceous) ammonite succession northwest of Samacá, Boyacá, Colombia

E-Mail: pcpatarroyog@unal.edu.co

The 160-m-thick Cretaceous sedimentary succession exposed along upper Honda Creek (Quebrada Honda), northwest of Samacá (Boyacá), Colombia, contains abundant ammonites. The lower 18 m of this succession is developed as black shales and quartz sandstones. The shales contain subordinate thin limestone beds and calcareous matter; the sandstones are commonly bioturbated by *Thalassinoides*. Higher up in the succession, the presence of phosphatic fragments and crushed fossils indicates turbulent conditions, possibly caused by a rapid sea-level rise. These deposits are overlain by 90 m of shales, limestones and silicified claystones. The lower 53 m of these deposits (upper Churuvita Formation) represent lowstand systems tract deposits, followed by 90 m of transgressive and highstand systems tract deposits (San Rafael Formation) and 17 m of shales and thin limestone beds (lower Conejo Formation). Above the phosphatic bed at the top of the Churuvita Formation, the succession is dominated by shales with scattered limestones and calcareous concretions containing three-dimensionally preserved ammonites, bivalves and trace fossils. Although *Thalassinoides* occur at the base of one of the beds, the overall interpretation is that of a continuous sea-level rise of a highstand systems tract. The upper part of the succession is characterized by silicified claystones containing crushed ammonites, arthropods and other macrofossils. From the lower part of this unit the ammonites *Neocardioceras*? sp., *Desmoceras* sp. and *Vascoceras* sp. have been collected. The calcareous beds and concretions have yielded *Pseudoneoptychites* sp., *Vascoceras* cf. *venezolanum* Renz, *Wrightoceras munieri* (Collignon), *Mammites* sp., *Kamerunoceras* sp., and *Coilopoceras* sp. From the silicified claystones, *Hoplitoides* sp. has been collected. This assemblage is characteristic of a Tethyan latest Cenomanian to early Turonian succession.

LIP05

Patarroyo, P., Rojas-Briceño, A. (Universidad Nacional de Colombia, Bogotá), Bengtson, P. (Geologisch-Paläontologisches Institut, Universität Heidelberg)

Turonian (Cretaceous) decapod crustaceans from the San Rafael Formation at Pesca, Boyacá, Colombia

E-Mail: pcpatarroyog@unal.edu.co

Feldmann *et al.* (1999) described upper lower Turonian crustaceans from mass mortality surfaces in the San Rafael and La Frontera formations exposed near Samacá (Boyacá) and La Vega (Cundinamarca), respectively. Here we report a new exposure of this taphonomically exceptional occurrence, near the small town of Pesca (Boyacá) in the Eastern Cordillera of Colombia, c. 150 km northeast of Bogotá. The crustaceans are associated with fish remains and ammonites and preserved in siliceous shales of the upper part of the lower Turonian San Rafael Formation, above shales with concretions and calcareous layers of the Churuvita Formation and below shales of the Conejo Formation. Although the crustaceans are flattened their morphological characters are well preserved. Their exquisitely preserved posterior thoracic appendices point to a portunoid affinity, with the anterior thorny margin and the more or less lateral borders being typical features of the Carcineretidae. The characteristic cheliped spines place the specimens in the genus *Ophthalmoplax*, possibly in the species *O. spinosus* Feldmann, Villamil & Kauffman, 1999; however, definite determination must await better preserved carapaces. The ammonites are referred to the genus *Hoplitoides* but lack sufficient diagnostic characters for species identification. It is possible that they belong to *H. lacabagnae* Etayo-Serna, 1979, reported by Feldmann *et al.* (1999) from the type section of the formation.

Reference

Feldmann, R.M., Villamil, T. & Kauffman, E.G. 1999: Decapod and stomatopod crustaceans from mass mortality lagerstatten: Turonian (Cretaceous) of Colombia. *Journal of Paleontology 73(1)*, 91–101.

LIP06

Patarroyo, P. (Universidad Nacional de Colombia, Bogotá), Bengtson, P. (Geologisch-Paläontologisches Institut, Universität Heidelberg)

Ammonite stratigraphy of the lectostratotype of the upper Cenomanian?–lower Turonian (Cretaceous) La Frontera Formation at San Francisco, Cundinamarca, Colombia

E-Mail: pcpatarroyog@unal.edu.co

The Cretaceous La Frontera Formation exposed at San Francisco, c. 40 km northwest of Bogotá (Cundinamarca), comprises 109 m of limestones, mudstones and siliceous claystones. The lower part of the formation is dominated by mudstones with subordinate thin limestone beds and calcareous concretions. The middle part comprises mainly limestones and large calcareous concretions. In the upper part there appear siliceous claystones with pyritic concretions. The La Frontera Formation is underlain by the siliciclastic Pacho Formation and overlain by shales of the Conejo Formation. The formation was originally described on the basis of a section at Albán, southwest of San Francisco; however, this section is poorly exposed and unsuitable for establishing a detailed biostratigraphy. Therefore, the well exposed and fossiliferous San Francisco section has been proposed recently as a lectostratotype. The lower part of this section yields the bivalve *Anomia colombiana* Villamil and the ammonites *Wrightoceras munieri* (Collignon), *Vascoceras* cf. *venezolanum* Renz, *V.* cf. *constrictum* (Renz & Alvarez) and *Benueites* sp. Above these follows a fauna comprising *Kamerunoceras scheibei* (Riedel), *Codazziceras ospinae* (Karsten), *Coilopoceras* sp. and *Hoplitoides* cf. *lagiraldae* Etayo-Serna, with crushed specimens of *Hoplitoides* sp. occurring at the top of the section. The ammonites are all referred to the lower Turonian. No macrofossils have been found below the *Anomia* horizon, so the base of the La Frontera Formation can as yet not be firmly dated, although a late Cenomanian age appears probable.

LIP07

Ifrim, C. (Staatl. Museum fuer Naturkunde Karlsruhe), Stinnesbeck, W. (Universität Karlsruhe), Frey, E. (Staatl. Museum fuer Naturkunde Karlsruhe)

Pseudaspidoceras flexuosum: an ammonite with flexible spines from the early Turonian of NE Mexico

E-Mail: christina.ifrim@smnk.de

At Vallecillo, NE Mexico, platy limestone of latest Cenomainian - early Turonian age contains fossils of exceptional preservation, such as inoceramids, ammonites, fishes and rare marine reptiles. The vertebrates are usually completely preserved to the very detail, with stomach contents, scales and imprints of skin. Ammonites occasionally preserve their aptychi and impressions soft body. Random collection and scientific excavations provided an overview of the fossil assemblage, including quantitative data. Pseudaspidoceras flexuosum turned out to be the most abundant ammonite species with a long stratigraphic range throughout most of the early Turonian. Among the >100 specimens collected, one third of the shells yields long ventrolateral, hollow spines. They occur on more delicately ornamented shells, whereas shells with more stout ornamentation generally lack spines. This suggests the presence of sexual dimorphism.

Spines are exclusively preserved on the living chamber; no spine was found attached to the phragmocone, and grooves for accommodation of the spines of preceding whorls are absent. They show a basal articulation, which may have allowed some mobility. Such spines were hitherto unknown for ammonites. The precise morphology of these spines is currently under study, and their function is not known at present.

LIP08

Ifrim, C., Frey, E. (Staatl. Museum fuer Naturkunde Karlsruhe), Stinnesbeck, W. (Universität Karlsruhe)

Scientific excavation versus random collection in a fossil Lagerstaette: a case study at Vallecillo, NE Mexico

E-Mail: christina.ifrim@smnk.de

Platy limestones (Plattenkalks) often preserve fossils with exceptional details such as soft parts, stomach contents, scales and imprints of skin. The fossil assemblage of such Plattenkalk-Lagerstaetten is usually interpreted by the sum of fossils collected by local quarry workers and stone yard owners, and by excavations of private collectors or scientists. Sometimes fossils obtained from dealers contribute to that interpretation. Mostly, precise finding circumstances of the fossils and their layer of origin are lost.

The platy limestone at Vallecillo is famous for its wealth in excellently preserved fossils, especially fishes, a few marine reptiles and invertebrates like inoceramids and ammonites. The latter allow dating of this latest Cenomanian-early Turonian fossil Lagerstaette. During the last ten years, many fossils were randomly collected by the quarrymen and members of our working group. We additionally excavated defined areas layer by layer for a statistical data collection based on all fossils in their stratigraphic context.

Comparison of both collection types reveals a biased composition of the random collection due to selective collection, with preference on impressive fossils. Despite the lack of stratigraphic data, the enormous surface surveyed provided large, well preserved specimens, valuable for anatomical studies andsystematic determination. This collection type has the advantage to provide a large diversity of taxa such as sharks and marine reptiles.

The statistical data collection allows the monitoring of the stratigraphic distribution of fossils and their absolute abundance in the lithologic column, the ratio between articulated and fragmentaryspecimens and taphonomical aspects, or stratigraphic ranges of single species. However, the diversity in this collection is low compared to the random surface collection due to limited turnover of material. We conclude that both types of collection are necessary for the best possible interpretation of the Vallecillo fossil assemblage.

LIP09

Quintana, F., Paez, M. (Mar del Plata, 'Laboratorio de Paleoecología y Palinología. Universidad Nacional de Mar del Plata'), Corbella, H. (Buenos Aires, 'Museo Argentino de Ciencias Naturales B. Rivadavia'), Fey, M., Haberzettl, T. (Bremen, 'Geomorphology and Polar Research, GEOPOLAR', Universität zu Bremen), Janssen, S. (Köln, 'Seminar für Geographie ud ihre Didaktik', Universität zu Köln), Lücke, A. (Jülich, 'Institute of Chemistry and Dynamics of the Geosphere V: Sedimentary Systems Research Center Jülich'), Maidana, N.I. (Buenos Aires, 'Lab. de Diatomeas Continentales' Universidad de Buenos Aires), Mayr, C. (Jülich, 'Institute of Chemistry and Dynamics of the Geosphere V: Sedimentary Systems Research Center Jülich'), Ohlendorf, C. (Bremen, 'Geomorphology and Polar Research, GEOPOLAR', Universität zu Bremen), Schäbitz, F. (Köln, 'Seminar für Geographie ud ihre Didaktik', Universität zu Köln), Schleser, G.H. (Jülich, 'Institute of Chemistry and Dynamics of the Geosphere V: Sedimentary Systems Research Center Jülich'), Wille, M. (Köln, 'Seminar für Geographie ud ihre Didaktik', Universität zu Köln), Zolitschka, B. (Bremen, 'Geomorphology and Polar Research, GEOPOLAR', Universität zu Bremen)

Pollen analysis of Late Holocene lacustrine sediments from southern Santa Cruz Province, Argentina

Short cores of Laguna Chaltel(CHA, 49°57,65'S - 71°7,67'W) and Laguna Las Vizcachas (VIZ, 50°42,39'S - 71°58,64'W)were chosen for a multiproxy study within the approach of SALSA project that involves sedimentology, stable isotopes and biological indicators as pollen and diatoms. In this work fossil pollen analysis of the cores CHA 04/5 and VIZ 05/6 are presented. Laguna Chaltel is a maar lake with a mean diameter of 2.6 km and a water depth of 41 m, located in thePampa Alta volcanic plateau at 800 m a.s.l. The area is covered by the *Nassauvia glomerulosa* semidesert and surrounded by the *Verbena tridens* shrublands and the *Festuca pallescens* grassland. From the border of this lake, a 104 cm long core (CHA 04/5) was recovered and the pollen analysis was made on a laminated section placed from 69 to 104 cm depth, below an unconformity. According to radiocarbonic dates, this section encompasses from 3520 to 3955 cal. yr. B.P. The fossil pollen assemblages point out that a grass steppe with low cover was present during this period. Furthermore, the high diversity of cushion and dwarf shrubs types as well as the presence of *Ephedra frustillata* type suggest that a semidesert vegetation was present by this time. Extraregional indicators as *Nothofagus dombeyi* type and *Podocarpus* are present with low values. Algae taxa as *Botryococcus* and *Pediastrum* show low percentage except in the lower and the upper part of the record. On the other hand, Laguna Las Vizcachas is a cirque lake of 18,7 m water depth and a maximum distance of 1300 m from north to south and 500 m from west to east. It is located in Las Vizcachas volcanic plateau at 1100 m a.s.l. and surrounded by the *Festuca pallescens* grassland. A short core of 83 cm (VIZ 05/6) was recovered from the center of the lake and seven radiocarbonic dates show that the record covers the last 1537 cal. yr. B.P. The fossil pollen spectra indicate that a grass steppe with cushion and dwarf shrubs developed, since the record is dominated by Poaceae along with other types as *Empetrum*, *Nassauvia*, Asteraceae subf. Asteroideae and *Acaena*. Besides, the presence of *Rumex* after 516 cal. yr. B.P. might be related to an environmental change because of human activity. Extraregional types as *Nothofagus dombeyi* type remains with low values, whereas algae taxa show high percentage through out the whole record. Either Laguna Chaltel or Laguna Las Vizcachas pollen records together with other records placed southward as Laguna Potrok Aike and Laguna Azul suggest that the modern regional vegetation types were present since ca. 2000 years ago. This study will be concluded with the analysis of modern pollen samples collected in both lakes and the comparison of the whole set of proxy data in order to reconstruct the paleoenvironmental history during the Late Holocene of the southern Patagonia.

Contribution to the projects: UNMdP - EXA 275/03, 334/06; SALSA - BMBF 01 LD 0034/0035

LIP10

Rosas, S. (Pontificia Universidad Católica del Peru), Weller, A. (Institut für Geophysik, Clausthal University of Technology), Hartsch, K. (H and G GmbH, Dresden), Matschullat, J., Hartzendorf, D. (Technische Universität Bergakademie Freiberg, Interdisciplinary Environmental Research Centre, Freiberg), Reppchen, G. (HTW, Faculty Surveying / Cartography, Dresden)

Geological Investigations of the Nasca Lines, Peru

This work aims at a better understanding of the structures and processes on the Nasca geoglyph sites compared with areas of undisturbed desert soil to deliver suggestions for conservation options, based on geophysical, geochemical, and mineralogical investigations. The area of the Nasca lines is located in wide flat Holocene alluvial plains. The typical desert soil in the investigation area is a hamada, developed through the aeolic removal of fine-grained yellowish loess material leaving stones that show a dark-coloured crust from oxidation and precipitation processes. The geoglyphs were drawn removing the stones. This abstract presents geophysical results at one test site in the Nasca stone desert and first outcomes from our geochemical and mineralogical work. The objectives were to distinguish the geoglyphs by their composition or physical features and their difference from their surroundings and to evaluate natural preservation processes of the geoglyphs. GEOPHYSICAL SURVEY at the N3 testarea: Magnetic survey: A geomagnetic survey was performed with vertical gradient measurements of the total magnetic field. Additionally, an electrical resistivity imaging was done along the single profiles. A rectangular area with a line distance of 0.5 m was marked. The measurements were made only while walking in northward direction. The resulting magnetic map is shown in Figure 1. The most prominent structure on the map is an east-west trending line. This approximately 3 m wide line belongs to the system of geoglyphs, which was drawn by the Nasca people. This line is visible on the desert floor as a yellow lineament limited in the north and the south by a small wall of dark stones moved away from the line. A magnetic susceptibility meter was used for field measurements at the surface along some profiles. The results show a narrow range of varying values with a slightly higher value level on the lines themselves. The shape of the anomaly can be explained by higher susceptibility values of the soil under the lines. Since the NS trending visible structures are parallel to the outer magnetic field, they become invisible in the magnetic map. A network of structures becomes evident in the magnetic map. These are different from the visible structures on the surface. The more or less linear structures are diagonally aligned to the visible lines. It is not clear, whether the origin of the measured physical anomalies is related to sedimentary or anthropogenic (archaeological) structures. Electrical imaging: The Coastal Desert in southern Peru is among the driest places on Earth. It could be expected that resistivity measurements with a galvanic coupling to the ground were a difficult task in a desert area. The electrical profiles run in S-N direction at x-coordinate 182 m with begin at y = 60 m. The 30 m long profile crossed the wide line at y = 75 m, the dominant structure in the magnetic map, and another smaller line further to the north. A non-commercial 2-D inversion program AC2DSIRT, generated the final model. The electrical image marks a remarkable resis-

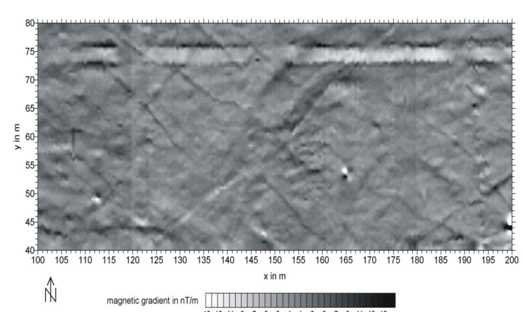

Figure 1: Magnetic gradient map of test site N3

tivity anomaly at the location of the line (y = 75 m), which is centred at a greater depth and does not reach the surface. The narrower line at y = 91 m can be clearly delineated as a surface anomaly. The Nasca people removed the dark stones along the lines disturbing the natural soil protection against evaporation. This became higher along the lines and consequently, the soil beneath them is dryer and the lines should be characterised by higher resistivity values. Since the resistive structure at y = 75 m does not reach the surface, it remains questionable, whether it is related to the line or any geological structure. GEOCHEMICAL SURVEY AND MINERALOGICAL INVESTIGATIONS: The geochemical composition of 260 soil samples was determined. For element mapping by X-Ray Fluorescence Spectroscopy, a handheld and portable ED-XRF spectrometer was used. Another 60 samples were tested in the laboratory with the same instrument but higher counting rates to control accuracy. Further reference measurements were carried out to control precision. The major elements of the sediments represent the typical composition of igneous rocks from the upper continental crust, that have been weathered on the Andes and later deposited on the coastal regions. Some trace elements does not conform with this general correlation. General conclusions: 1) Elevated As median levels in all soil samples, 2) Mo, Se, Hg, and Co were below or close to the detection limit of the XRF, 3) no significant trends of major and trace elements could be detected between localities and pattern types. The element concentrations derive from the geological units in the investigated area: Hydrothermal mineralizations, granitoides of the Coastal Batholite, and volcanic rocks (Complejo Bella Unión). Cu, Au, Ag and subordinated Pb are the main metals in local ore. CONCLUSIONS: Structures of lineaments on the surface become visible, and subsurface structures, hidden in the shallow underground, can be easily detected in geomagnetic gradient surveys. However, not all lineaments are detectable. Structures trending in N-S direction, are not recognised by the magnetic method. The electrical imaging method provides information about depth and extent of different structures of natural or anthropogenic origin. The electrical method yielded good results in the areas of the geoglyphs. Significant structures could be revealed both in vertical and lateral directions. Surface as well as subsurface structures up to 2 m depth were recognised. The geological environment of Nasca is characterised by Andean magmatic rock assembly. Slightly elevated As-values may result from weak vent activities or dissipation of smaller hydrothermal anomalies. No differences occur between the geoglyph features and their hamada environment. Therefore the Nasca people did probably not use either salts or other mineral materials to alter the newly developed surfaces.

LIP11

Solis-Pichardo, G., Schaaf, P., Hernandez, T., Manzanilla, L. (Mexico, Universidad Nacional Autonoma de Mexico), Horn, P. (München, Universität München)

Ancient human migration and Sr isotopes: The Teotihuacan site (Mexico) as an example.

E-Mail: gsolis@geofisica.unam.mx

Asserting provenance of humans is a major issue for archeologists and anthropologists. Strontium isotopes have increasingly proven to be a resourceful tracer tool when comparing isotopic firms between teeth and bone of human skeletal remains along with the soil where burial took place. Sr isotope ratios reflect the geologic substrate, or bedrock, from where an individual obtained food and water, and these ratios are in turn incorporated into the dentition and skeleton during tissue formation. 87Sr/86Sr ratios in tooth enamel point toward the source of diet during youth, providing an indication of place of birth; whereas ratios in dentine and bones come from the food growing in a specific geological region around the time of death. To determine probable mobility of early residents, we studied 20 teeth (enamel) and 20 bone samples recovered from ancient burials at the archeological site of Teotihuacan, central Mexico, the earliest and largest prehispanic urban center in the New World; in addition to local soil and water. Teeth sample preparation before measurement is critical to the results: An orthodontic micro-tool was used to completely isolate the enamel layer from dentine, which was then thoroughly cleaned followed by two leaching steps; thus obtaining up to three fractions (two leachates and residue) for measurement. Bone material, although systematically cleaned, underwent no leaching.

87Sr/86Sr results demonstrated which inhabitants were native (nearly identical 87Sr/86Sr ratios for enamel and bone) of Teotihuacan area and which were immigrants (different 87Sr/86Sr ratios). For instance, 87Sr/86Sr results from a sample with ratios of 0.70477 for bone (which is identical to highland soil), 0.70530 for first leachate, 0.70590 for second leachate, and 0.70668 (mean accuracy +/- 0.00004) for enamel show this individual was born in a different place from where he died. A further step is taken by correlating the obtained data in this study with established geological regions with well-known 87Sr/86Sr signatures; in particular where other archeological sites in Mexico and Central America are found, to possibly asses the original geographic source of the migrant population. However, since some geological provinces (for instance the Oaxaca Complex) show overlapping 87Sr/86Sr values, undertaking oxygen and carbon isotope studies can help us to eliminate ambiguity of origin for certain non-local individuals.

LIP12

Velasco-Segura, J.A. (Facultad de Ciencias de la Tierra, UANL, Linares, México), Frey, E. (Staatliches Museum für Naturkunde, Karlsruhe, Germany), López-Oliva, J.G. (Facultad de Ciencias de la Tierra, UANL, Linares, México), Stinnesbeck, W. (Universität Karlsruhe (TH), Karlsruhe, Germany), González-González, A.H. (Museo del Desierto, Saltillo, México)

Late Jurassic Marine Crocodilians (Thalattosuchia, Metriorhynchidae) of the La Casita Formation in Coahuila and Nuevo León, northeastern México: two case studies.

The Late Jurassic La Casita Formation in northeastern México is famous for its rich vertebrate and invertebrate fossil assemblages. Recently, systematic field work yielded new remains of marine crocodilians, which are referable to Thalattosuchia.

Since the description of Geosaurus vignaudi (FREY et al., 2002) from the Late Jurassic of Puebla state, central-east México, various new specimens of marine crocodilians have been discovered in the northeastern Mexicanstate of Coahuila, especially in the region of Gómez Farias, 60 km south of Saltillo. The material comprises two partial crania of Geosaurus (Metriorhynchidae), of which one was described as Geosaurus saltillense (BUCHY et al., 2006). The second is presented here as a possibly new Geosaurus due to morphological differences with the holotype of G. saltillense. Both specimens come from the Tithonian (Late Jurassic), as indicated by ammonites (Velasco-Segura, 2005; Buchy et al., 2006), and comprise numerous postranial elements as well.

We also present the partial rostrum of a possible Metriorhynchus that was found by W.S. and others during field work at Iturbide in the northeastern Mexican state of Nuevo León, in Late Kimmeridgian sediments of La Casita Formation. This report would be the first evidence for this genus in Mexico.

The new specimens from Mexico fill a palaeogeographic gap for the Late Jurassic Thalattosuchians, which were previously reported only from Europe and South America (FREY et al., 2002). Interestingly, the Mexican Late Jurassic Thalattosuchia are neither referable to the European nor to the South American species and thus hint to geographic isolation of the Gulf of Mexico at least throughout the Late Jurassic.

Buchy, M.C., Stinnesbeck, W., Frey, E., & Gonzalez-Gonzalez, A.H., 2006, A new Tithonian (Upper Jurassic) marine vertebrate concentration Lagerstätte in north-eastern Mexico: 4th Annual Meeting of the European Association of Vertebrate Paleontologists, Budapest, Hungary, p. 17-19.

Buchy, M.C., Vignaud, P., Frey, E., Stinnesbeck, W., & Gonzalez-Gonzalez, A.H., 2006, A new thalattosuchian crocodyliform from the Tithonian (Upper Jurassic) of northeastern Mexico: Comptes-Rendus Paleovol 5 (2006), 785-794.

Frey, E., Buchy, M.C., Stinnesbeck, W., & Lopez-Oliva, J.G., 2002, Geosaurus vignaudi n.sp. (Crocodyloformes: Thalatossuchia), first evidence of metriorhynchid crocodilians in the Late Jurassic (Tithonian) of central-east Mexico (State of Puebla): Canadian journal Of Earth Sciences, v. 39, p. 1467-1483.

Velasco-Segura, J.A., 2005, Analisis litologico y estratigrafico de la Formacion La Caja en la Sierra El Jabali, Saltillo, Coahuila: Tesis de Licenciatura, Facultad de Ciencias de la Tierra, Universidad Autonoma de Nuevo Leon, Mexico 120 pp. (unpublished).

LIP13

Lücke, O.H. (San José, Universidad de Costa Rica), Alvarado, G.E. (San José, Instituto Costarricense de Electricidad, Universidad de Costa Rica)

The dawn of geoarchaeological research in Costa Rica: Heinrich Fischer's XIX century mineralogical understanding of aboriginal sculptures from Costa Rica

E-Mail: oslucke@yahoo.com

The work of Heinrich L. Fischer represents the beginning of an interdisciplinary approach to the understanding of Costa Rican pre-Columbian cultures. Fischer's pioneering work is herein represented and analyzed from a historical and geoscientific point of view. The mineralogical determination of the materials used for the sculptures sheds light on the development and implementation of different crafting techniques which may be associated with different groups within Central American pre-Columbian societies. The mineralogical diversity and composition of the sculptures indicates the use of raw materials which are foreign to the Costa Rican geotectonic context. This particular fact was recognized by Fischer whose interpretation of the origin of such materials was incorrect because of the limited extent of geological studies in Central America atthe time of his research. Fischer's use of non-destructive mineralogical analysis techniques is pioneering in the realm of Costa Rican geoarchaeological research.

SZ1

Subduction Zones: Input, Fore-arc and Seismogenic Zone

SZ101 – Wed., 11.4., 11:10 - 11:30 · HSA

Comte, D. (Dep. de Geofísica, Univ. De Chile, Santiago), Farías, M. (Departamento de Geología, Univ. de Chile, Santiago and LMTG, Université Paul Sabatier, Toulouse), Tassara, A. (Dep. de Geofísica, FCFM, Univ. De Chile, Santiago), Charrier, R. (Dep. de Geología, Univ. de Chile, Santiago)

MAPPING THE SEISMOGENIC INTERPLATE CONTACT

In the Copiapo area, as along almost the entire coast of Chile, subduction involves the fast-moving and young oceanic Nazca plate being underthrust beneath the South American plate. There is strong seismic coupling at the interplate zone, generating the intense seismicity that is characteristic of Chile. The region of this study (27°-28.5°S) is located near the transition between subduction that dips eastward with an angle of about 30º and a subhorizontal subduction geometry. This change is well correlated with the end of a Quaternary volcanic chain, which is absent as far south as latitude 33°S (Cahill and Isacks, 1992). Kirby et al. (1996) explored indetail the genetic relationships between arc volcanoes and Wadati-Benioff zones, and their conceptual model highlights the fundamental role of temperature and free aqueous fluids in promoting reaction rates and the dual effects of such liberated fluids in facilitating both seismogenic intraslab faulting. In the Copiapo region, two historical events Mw > 8.0 have been reported: 1819 (Mw=8.3) and the 1922 (Mw=8.5) earthquakes, both produced destructive tsunamis. Moreover, Copiapo region has also experienced seismic swarms, like the one observed during July and August 1973, corresponding to an increase of earthquakes with magnitudes between 5.0 and 6.0 andapparently not associated with any large earthquake. On April 2006, another seismic swarm occurred in front of the Copiapo-Chile region, alarming the population who expected a large earthquake.

During the austral spring of 1998, a dense inland and off-shore seismic network was installed in order to obtain an overall view of the seismic activity occurring between the trench and the western Cordillera and to examine the southern part of the 1922 rupture area. Details of the seafloor morphology in the Copiapo area suggest that seamounts are being subducting in this region. Additional considerations would also help to support that hypothesis: seamount subduction could result in locally increased normal stress of the subduction interface (Scholtz and Small, 1997) and Comte et al. (2002) obtained a tensional regime for the events located above the interplate contact. Both, the 1973 and the 2006 swarms, were located in the region where the trace of the subducting seamount can be observed with the bathymetry. This is also well correlated with surface neotectonic results showing an extensional regime in this region (Lavenu et al., 1999; Marquardt and Lavenu, 1999). Therefore, the seismicity observed can be interpreted as the response of the overriding plate to the heterogeneities associated with the subducting seamounts.

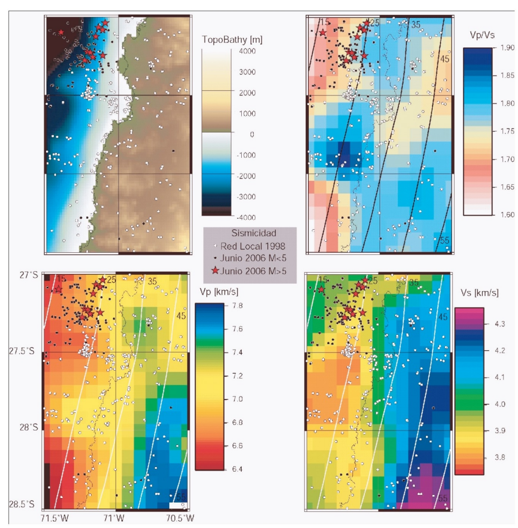

Figure 1: Vp, Vs and Vp/Vs ratio obtained from the microearthquake recorded by an inland and off-shore seismic network. The observed variations are well correlated with the site of the 1973 and 2006 seismic swarms, and with the southern end of the rupture of previous large earthquake in this region.

According to Scholtz and Small (1997), the presence of such heterogeneities does not necessarily lead to significant variations in the seismic coupling of the Copiapo region, because it would depend on the size of the subducted seamounts; they could be related to small earthquakes which rupture isolated unstable patches during the interseismic period.

Considering that:
- with the 1998 experiment we were able to have a 3D body-wave velocity structure - we have a well defined geometry of the Wadati-Benioff zone; therefore, we could visualize the body-wave velocity structure along the interplate contact (Figure 1).

It is interesting to note that the location of the seismic swarms are well correlated with small Vp, Vs, Vp/Vs and gravity anomalies. But, it is more interesting to note that the highest anomalies observed in the region are well correlated with the southern rupture end of the previous large earthquakes (1796, 1922).

Finally, it is good to mention that the area that participated in the 1922 large earthquake and did not break with the 1983 earthquake, is an important seismic gap, where the Weibull and the Poisson distribution suggest that there is a probability greater than 80% of having soon an earthquake with a minimum magnitude equivalent with the 1983 one.

SZ102 – Wed., 11.4., 11:30 - 11:50 · HSA

Krawczyk, C.M. (Potsdam, GFZ), Wigger, P. (Berlin, Free University), Brasse, H. (Berlin, Free University), Haberland, C. (Potsdam, University), Echtler, H., Ritter, O. (Potsdam, GFZ), Alasonati, P. (Kiel, University), Bataille, K. (Concepcion, Universidad), TIPTEQ Research Group

Depth-graded properties in the seismogenic zone at the South-Central Chilean margin from geophysical observations

E-Mail: `lotte@gfz-potsdam.de`

The understanding of structural and petrophysical properties of seismogenic coupling zones is one of the major goals in subduction zone research. Seismogenic zones are governed by seismological activity, regionally and temporally diverse, and at their down-dip end mega-thrust earthquakes initiate. In Chile, the project TIPTEQ (from The Incoming Plate to mega-Thrust EarthQuake processes) concentrated between 2005 and 2007 different onshore geophysical experiment components between 37°-39° S. The surveys were designed to (1) yield a structural image, (2) reveal the vertical crustal zonation and map active faults, (3) determine the conductivity structure, and (4) result in a 3-D asperity mapping. This should give finally a high-resolution image of the seismogenic coupling zone in the area of the 1960 Chile earthquake hypocentre. A controlled source seismic experiment at 38° S provides the structural characteristics and an image of the present state of the plate interface ruptured during the 1960 earthquake. Close to the coast the subducting oceanic crust is clearly visible and can be traced further inland down to about 50 km depth with variable reflectivity. A strongly structured forearc and accretionary wedge are identified. Between depths of 5 to 25 km several bright reflectivity spots can be seen in the upper plate, which may suggest fluid traps in the accretionary wedge. Strong reflective bands up to 3 km thick characterise the upper and middle crust of the overriding plate. These slightly upwardly convex, reflective structures are interpreted as representing the Permo-Triassic accretionary wedge above the subducting Nazca Plate. Two high-velocity bodies in the upper crust are found on either side of the Lanalhue fault zone, suggesting uplift of mantle material. However, they are presumably of different origin. A major structural element at the plate boundary lies between 18 and 50 km depth. It is interpreted as a subduction channel that is transporting sedimentary material from west to east below the overriding South American plate. Local seismicity and teleseismic data, gathered with a temporary seismological network, show that most of the crustal seismicity is concentratedin clusters. Close to the coast line activity is concentrated in the subduction channel, and further inland at the Lanalhue fault zone. Evaluation of both offshore and onshore MT data reveals uniformly deflected induction vectors over the entire forearc (and even arc) between 38°S and 41°S. These are only interpretable by assuming a deeply fractured crust - in the view of modeling this is treated with a macro-ansiotropic approach. This anisotropy persists for the whole continental crust until the trench. The oceanic crust is characterised by relatively low resistivities, indicative for sea-water penetrating perhaps into upper mantle depths. Finally, a combined seismological-magnetotelluric monitoring E-W profile was installed as a set of three stations, extending from the Atlantic Ocean to the Volcanic Arc. The overall goal is to detect transient events which are related to the subduction system. Synchronous recordings of seismic broadband data (periods up to hours) will allow us to examine a wide spectrum of earthquake styles with the recently acquired new data sets. Thus, the Chilean subduction system at c. 38° S is characterised by a seismically active subduction channel at depth, and a recently more inactive part of the old Permo-Triassic accretionary wedge above. The onshore structural image and coastal uplift suggest that basal accretion of parts of this material controls the seismic architecture and growth of the

south Chilean crust. Large, long-living fault zones may have been used repeatedly, with varying kinematics through time. Furthermore, high-velocity bodies at shallow depth suggest together with strong reflective bands that these reflectors could represent old shear zones along which continental mantle material may have been transported to upper crustal levels. The suggestion that the rheology of the forearc exerts an important control on where extensive rupture and great earthquakes can occur will be further examined based also on gravity data. An optimised filtering of the gravity anomalies along the continental margin also shows that coseismic slips associated with the 1960 Chile earthquake correlate with fore-arc gravity lows centered on sedimentary basins.

SZ103 – Wed., 11.4., 11:50 - 12:10 · HSA

Stipp, M. (Universität Freiburg), Behrmann, J.H. (IFM-GEOMAR Kiel)

Subducted crust and sediments - a source for intermediate depth earthquakes?

E-Mail: `Michael.Stipp@geologie.uni-freiburg.de`

Nucleation of subduction thrust earthquakes is often attributed to dehydration embrittlement of ultramafic rocks. Deep seismic imaging indicates that in addition to downgoing mantle lithosphere and oceanic crust, continental slivers and marine sediments are transported deep into the earth mantle. Also, remnants of deeply subducted crust and sediments are ubiquitous in exhumed ancient subduction complexes, e.g. in the Alps or other orogens. P/T-estimates hint at confining pressures of at least 3-4 GPa, suggesting subduction depths of 100 km or more. Global calculation of sediment budgets shows that only about 30% of the sediment income in deep sea trenches is stored in accretionary prisms, whereas as much as 70% is subducted to greater depth and in most cases does not return to the surface. These materials are preferentially distributed along the plate boundary between the downgoing and the overriding plates in active subduction zones.

Continental crust and marine sediments, and their metamorphic equivalents are much weaker than basalts or mantle peridotite. So why should deformation partition into the much stronger mafic and ultramafic rocks whenboundary layers of weak rock are sandwiched between the two convergent plates? We advance the hypothesis that plate boundary deformation is preferentially localized in this boundary layer, and that strain-hardening may control switches from aseismic creep to brittle, or seismic deformation. Experimental data show that quartz, the mineral controlling bulk rheological behaviour of a widerange of crustal rocks and metasediments, can suffer dramatic strain-hardening by small parameter changes, e.g. strain rate increase due to more localized deformation or dehydration at high confining pressures. This in turn forms asperities for earthquakes nucleating near the deep end of the seismogenic zone. The lower seismicity downdip from the seismogenic zone is thought to indicate

widespread aseismic creep in the boundary layer, but at greater depth (70-100 km), comparable effects are also likely to occur in the eclogitized downgoing oceanic slab, accounting for the observed increased seismic activity there. We conclude that strain hardening and rupturing in downgoing sediments and crust is an important additonal mechanism for subduction earthquake nucleation.

SZ104 – Wed., 11.4., 12:10 - 12:30 · HSA

Ivandic, M. (Kiel, SFB 574, University of Kiel), Grevemeyer, I., Berhorst, A., Flueh, E. (Kiel, Leibniz Institut fuer Meereswissenschaften, IFM-GEOMAR), McIntosh, K. (Austin, Institute for Geophysics, University of Texas at Austin)

Structure and hydration of the subducting plate offshore Nicaragua

E-Mail: mivandic@ifm-geomar.de

A seismic wide-angle and refraction experiment was conducted offshore of Nicaragua in the Middle American Trench to investigate the impact of bending related normal faulting on the seismic properties of the oceanic lithosphere prior to subduction. Based on reflectivity pattern of multi-channel seismic reflection (MCS) data it has been suggested that bending-related faulting facilitates hydration and serpentinization of the incoming oceanic plate. Seismic wide-angle and refraction data were collected along a transect which extends from the outer rise region not yet affected by subduction into the trench northwest of the Nicoya Penninsula, where multibeam bathymetric data show prominent normal faults on the seaward trench slope. Coincident MCS data indicates that the thickness of the incoming oceanic crust is remarkably uniform. A tomographic joint inversion of seismic refraction and wide-angle reflection data yields anomalously low seismic P-wave velocities in the crust and uppermost mantle seaward of the trench axis. Crustal velocities are reduced by 0.2-0.5 km/s compared to normal mature oceanic crust. Seismic velocities of the uppermost mantle are 7.6-7.8 km/s and hence 5-7% lower than the typical velocity of mantle peridotite. These systematic changes in P-wave velocity from the outer rise towards the trench axis indicate an evolutionary process in the subducting slab consistent with percolation of seawater through the faulted and fractured lithosphere and serpentinization of mantle peridotites. If hydration is indeed affecting the seismic properties of the mantle, serpentinization reaches 12-17%.

Web page: http://www.sfb574.uni-kiel.de

SZ105 – Wed., 11.4., 12:30 - 12:50 · HSA

Bürk, D. (SFB 574, CAU Kiel), Götze, H.-J. (SFB 574, CAU Kiel), Klaucke, I. (IFM-GEOMAR, Kiel)

Geoacoustic investigations of cold vents and sedimentary processes at the active continental margin offshore Nicaragua

The presentation highlights the results of an investigation of cold vents in the forearc region of the active continental margin offshore Nicaragua with a set of geoacoustic methods. The methods include multibeam bathymetry with associated amplitude measurements and high-resolution, 75 kHz deep-towed sidescan sonar with corresponding 2–10 kHz chirp subbottom profiler. Ground truthing is available from camera system surveys and coring on several of the structures.

In first order the venting sites can be classified in mound structures and intensity anomalies. Mounds have a topographic expression on the seafloor and are hence detectable in the multibeam bathymetry, whereas intensity anomalies are only imaged in the sidescan sonar data. Both are characterized by increased backscatter intensities which are mainly related to increased seafloor roughness or hardgrounds like authigenic carbonates. A strong influence of the topography to the sidescan sonar signal is excluded as a detailed analysis with a new processing algorithm showed.

The mound structures itself can be classified based on their morphology, backscatter signal and fluid venting activity into three main types:
(1) Mid-sized and dome-shaped mounds with diameters around 700-1000 m and heights of 50-100 m show bright backscatter due to authigenic carbonates with some fluid venting activity and associated vent fauna. (2) Small mounds with very little topographic expression have diameters around 500 m and show irregular outlines. Authigenic carbonates are sometimes covered with sediments, there are no signs of erosion. A wide range of vent biota indicates stronger fluid venting activity. (3) Very large and steep mounds have diameters exceeding 1000 m and heights up to 150–200 m. Authigenic carbonates are widespread on the top plateau areas. Subbottom profiles show no sediment coverage. Vent fauna is rare indicating little to none fluid venting activity. The calculated ratio of mound volume and mound base area is a characteristic number for each mound, and is a measure of how much a mound is exposed above the seafloor surface with respect to its base area.

The nature of the venting structures was previously unknown. They were termed mud mounds, mud volcanoes or mud diapirs. From the geoacoustic investigations it can now be ruled out that they are mud volcanoes. Mud flows or other deposits of eruptive processes are not detected. However, signs of upward moving sediments in the shallow subsurface exist and can be interpreted as diapiric processes. In which depth the sediment mobilization is originating is unknown. It is speculated that the sediments are mobilized by the dissociation of gas hydrates in the shallow subsurface. The hydrates in turn are decomposed by upward travelling warmer fluids from larger depths. But the shaping of the mounds is strongly driven by erosional processes which are active on the slope, like it is shown very clearly where canyons incise deep into the slope. As the mounds consist not only of mud but also to a considerable amount of authigenic carbonates, it is suggested to use the neutral term *mound*.

SZ106 – Wed., 11.4., 16:10 - 16:30 · HSA

Diaz-Naveas, J. (Valparaiso, Chile), Lykke-Andersen, H. (Department of Earth Sciences, University of Aarhus, Denmark), Greinert, J. (Institute of Geological and Nuclear Sciences, New Zealand)

Preliminary seismic and bathymetric results of VG06 cruise off Central Chile

E-Mail: `jdiaz@ucv.cl`

The second Chilean FONDEF project on gas hydrates (2006-2009) deals with the exploration of the most promising submarine hydrate reservoirs off Central Chile and of a technical and an economical feasibility study of their exploitation.

The first cruise of this project was carried out between 34°and 37°S, and between the 200m and 3000m isobaths, from February 3 until 22, 2006, on board Chilean Navy research vessel Vidal Gormaz. The University of Aarhus provided a 96 channel 600m long streamer with a 4 sleeve-gun array with a total volume of 160 cubic inches for carrying seismic reflection lines. 58 seismic lines were shot covering an overall length of about 2,350km. IfM-GEOMAR provided an ELAC 1050 multibeam echosounder with a maximum swath of 153°and 126 beams and a frequency of 50kHz. The overall area covered with multibeam bathymetry was $5,900km^2$.

Bathymetry reveals a complex structure with ridges, basins, blocky units and submarine canyons. Seismic lines show both complex structural and stratigraphical units. The selected region for semidetailed studies shows a very dense BSR distribution. However, the nature of BSRs differ from line to line. Lines close to 36°S show the most conspicous BSR. There is a tendency for BSRs to “dissapear” when entering non tilted sedimentary basins. Other regions show enhanced reflectivity below the BSR and possible bright spots. Some BSRs appear to reach the seafloor. Line VG02-17-2 shows two mud volcanoes-like features. Also, along this line, which is parallel to the margin, the BSR is more evident than across margin BSRs. Lines VG06-61 and VG06-62 show little mound-like structures with underlying diminished reflectivity. A submarine canyon shows erosion just above the BSR along line VG06-65.

Finally an enigmatic 200Hz reflectivity appears consistently on 4 lines in the water column at a depth of 1500m. This, and stratigraphy of the water column allows to get a valuable byproduct from seismic reflection lines, seismic oceanography, as it has been shown already by other researchers.

SZ107 – Wed., 11.4., 16:30 - 16:50 · HSA

Weinrebe, W. (Kiel, IFM-GEOMAR), Ranero, C. (Barcelona, CMIMA), Diaz-Naveas, J. (Valparaiso), Meteor shipboard scientific party (Kiel)

Morphology of the Central Chilean Continental Margin between 33°S and 37°S: transition from subduction erosion to subduction accretion

E-Mail: `wweinrebe@ifm-geomar.de`

Along much of southern Chile, the trench is filled with about 2-2.5 km thick turbidites, supplied from the erosion of the Andes. Elongated anticline ridges at the front of the continental slope indicate that sediment accretion is prevalent in this area. The gentle topography of the trench gradually deepens from south to north, causing along-trench northward sediment transport. A continuousmeandering channel that distributes turbidites can be followed along the trench from about 41°S until about 33°S. Here, the Juan Fernández Ridge on the ocean plate enters the subduction zone and changes margin tectonics dramatically. The ridge forms a barrier inhibiting transport of sediments further to the north. The ridge topographic separates a flooded trench to the south from a sediment starved segment to the north, and marks the abrupt boundary between tectonic erosion and sediment accretion. The area just south of this boundary between 33°S and 37°S was recently mapped by a high-resolution multibeam survey with German RV METEOR. The morphology of the surveyed area shows an irregular slope toe facing the trench, surprisingly, the turbidite-flooded trench is not faced by a well-developed system of accretionary ridges. Generally, the morphology of the continental slope displays three different regions: The lower slope typically displays a rugged terrain, including collapse structures, whereas the middle slope is characterized by a series of smooth terraces probably representing mid-slope basins. The transition from the lower to the middle slope occurs across a roughly margin-parallel 150-km-long distinct lineament of alternating narrow highs and troughs. These structures indicate local uplift and subsidence along the same lineament, suggesting strike-slip deformation along a fairly continuos array of faults. Their sharp relief and the transition from a rugged to a smooth morphology across them suggest that faulting is currently active. Across a moderate change in slope dip, the middle slope grades into the upper slope, which displays a smooth morphology and gentle dips. The entire slope structure is cut by several large canyons that zigzag from near the coast to the trench. The canyons head is typically located at the mouth of the largest rivers in the area and possibly transport most of the sediment reaching the trench.

Web page: http://www.sfb574.uni-kiel.de/php/goto/Meteor67-1

SZ108 – Wed., 11.4., 16:50 - 17:10 · HSA

Herms, P. *(Kiel, University and SFB 574), John, T. (Oslo, University and SFB 574), Schenk, V. (Kiel, University and SFB 574), Bakker, R.J. (Leoben, University)*

Metamorphic fluids in the subduction zone eclogites of the Raspas Complex, Ecuador

E-Mail: ph@min.uni-kiel.de

The Raspas Complex is one of the rare occurrences of high-pressure rocks in the Andes and can be interpreted as a late Jurassic to early Cretaceous metamorphic ophiolite complex. The Raspas Complex consists of eclogite-facies metaperidotites of the El Toro formation and of eclogites, garnet- amphibolites, blueschists and garnet-chloritoid mica schist of the Raspas formation. Associated with the Raspas complex are other units of MORB-type affinities representing together an oceanic lithosphere which is separated from two different continentally derived units by tectonic contacts in the south and in the north. P-T and age determinations of the high-pressure metamorphic rocks of the Raspas Complex indicate a subduction of the oceanic lithosphere to a depth of about 70 km at about 132 Ma (Gabriele et al. 2003, Eur. J. Min. 15: 977-989; K-Ar data on phengite by Feininger 1980, J. Petrol. 21:107-140). To get a better understanding of the role of the fluid phases in subduction settings, the knowledge of the composition and fluid/rock ratio of high pressure fluids is a prerequisite. Fluid inclusions are preserved relics of the fluid present at different stages during the subduction cycle and thus the only direct evidence for the original palaeofluids. Geochemically different protoliths can be assigned to the eclogites: MORB, OIB and metasomatized eclogites which are cut by zoisite veins representing former fluid pathways. In all the geochemically different eclogite types, primary fluid inclusions could be investigated in omphacite, zoisite, garnet and quartz. Preliminary results from microthermometry and Raman spectroscopy on primary fluid inclusions in the eclogite-facies minerals yield a rather homogeneous low salinity-fluid composition in the system H2O-NaCl-CH4. A consistent volume fraction of the vapour bubble in all primary inclusions in the eclogite-facies minerals indicate homogeneous entrapment. The majority of fluid inclusions also contain tiny solids and most of them have been identified as calcite by Raman spectroscopy. In a mm- thin eclogite-facies zoisite vein, beside the previously mentioned inclusion type, a second type of fluid inclusion coexists which contains CH4 with some traces of ethane and graphite. Broad zoisite veins partly with interstitial albite, however, must have formed later at decreasing pressures. The vein zoisites have similar homogeneous fluid inclusion composition in the system H2O-NaCl-CH4 like the eclogite-facies minerals, indicating homogeneous fluid composition during the eclogite-facies stage and during subsequent exhumation. Such homogeneous aqueous fluid composition can be best explained by aqueous fluid infiltration from an external source where dehydration of (OH)-bearing minerals takes place. Deserpentinization of the underlying oceanic mantle could be a realistic source for the liberated H2O and CH4 of the infiltrating fluid. This model gets supported by the fact that the serpentinized peridotites from Ecuador, geochemically defined as depleted MORB-mantle peridotites, have been subducted as well, reaching eclogite-facies conditions. A comparison with eclogite-facies fluid composition from other complexes shows that low-salinity aqueous fluids with methane are rather the exception. Only in the Dabie-Sulu terrane of eastern China (Fu et al. 2003, J. Metam. Geol. 21: 561-578) also CH4-rich fluid inclusions of pre- to syn-peak metamorphic origin have been identified. Fu et al. (2003) related the formation of methane to the serpentinization of peridotites prior to or during subduction.

SZ109 – Wed., 11.4., 17:10 - 17:30 · HSA

Dinc Akdogan, A.N., Arroyo, I. (Kiel, SFB 574, University of Kiel), Koulakov, I. (Russia, Institute of Geology, SB RAS), Thorwart, M., Rabbel, W., Flueh, E. (Kiel, SFB 574, University of Kiel)

A combined tomographic inversion of two independent amphibious networks in Costa Rica

E-Mail: nilay@geophysik.uni-kiel.de

The subduction zone structure and related processes have been investigated with local earthquake tomography in Central Costa Rica. Two data sets of 3044 high quality events from two independent adjacent amphibious networks, JACO and QUEPOS were combined for a simultenous inversion of hypocenter locations, 3-D P-wave velocities and Vp/Vs ratios. The problem of lack of the resolution at the intersection of the two networks was solved by a spatial overlap of the data, which is supposed to provide an improved interpolation. The synthetic tests confirm the reliability of the solutions and indicate that the study area is well constrained down to 60 km depth. Depending on the results, the seismicity of the Wadati-Benioff zone decreases from northwest to south east Costa Rica. Plate interface seismicity extends from 12-20 km below sea level and interplate seismicity begins downdip of the plate interface which correlates with the intersection of the slab and the continental Moho which corresponds to 35-40 km depth. Crustal earthquakes occur at the edges of the low velocity zones.

SZ110 – Thu., 12.4., 10:10 - 10:30 · HSD

Perdomo, R. (Universidad Nacional de La Plata and CONICET)

Twenty years of continuous cooperation between La Plata and German Scientists

E-Mail: `perdomo@presi.unlp.edu.ar`

The history of La Plata Observatory (now the Faculty of Astronomy and Geophysics of La Plata National University) is very rich concerning the participation of German scientists in the development of the main research lines. However, they were personal contributions.

On the contrary, in the last twenty years, a new way of cooperation took its place, with strong emphasis in GPS applications to earth sciences.

The visit of Prof. Lelgemann, from Berlin Technical University in 1986 followed by Dr. Klotz in 1987 started an important program of cooperation with the main purpose of studying the plate motion along the Andes. The so called SAGA project, South America Geodynamic Activities, was started in those days with the monumentation and first measurements, and continued up to now with several campaigns. The main results will be discussed in a specific paper, but three by-products of these activities should be pointed out:

1. The installation and continuous operation of two GPS permanent stations: lpgs (La Plata) which is the oldest permanent GPS in Argentina, and riog (Rio Grande, Tierra del Fuego) which is the southest of the continental IGS stations. 2. The use of the GFZ (GeoForschungsZentrum, Potsdam) receivers to measure the first GPS geodetic network in Tierra del Fuego (1993). This network became the first GPS frame of Argentina. Besides the usual applications of this network, as time passed, new measurements allowed our group to determine the movements between Scotia plate and SAM plate in that portion of the boundary. Those results drove us to establish a strong cooperation with Dresden University that will be described later on. 3. The lpgs station, and two SAGA points located in Buenos Aires province, allowed us to measure and compensate a quite accurate network for this province (the most important of the country) and to relate it to ITRF96. As most of the points were chosen to coincide with existing pillars of the national levelling network, a local geoid model was estimated and the improvement of this model has been one of the most important lines of our recent work.

La Plata Observatory became a well known place for the installation and permanent operation of different equipment, always in cooperation with GFZ, a PRARE station was installed in La Plata and worked there for more than one year, and recently (August 2006) the only Galileo sensor in the region has also been installed and has been operating in La Plata since then.

Besides, as mentioned above, we have a more recent but strong cooperation with Dresden University (Technische Universität, Institut für Planetare Geodäsie) in Tierra del Fuego plate kinematics and local geoid modelling. The main objectives are still in progress, to study in detail the region of the fault, to vinculate the GPS measurements with the levelling lines, to get a geoid model, and to test it using the surface of the Fagnano Lake. Also we will have specific presentations for these lines of research. However, a remarkable unexpected result must be emphasized: up to his moment, two PhD Thesis are being developed using the results of these measurements, one is devoted to the reprocessing the historical campaigns since 1993 up to now (by and Argentine colleague) and the other, to the study of the lake surface (by a German colleague).

Extraordinary achievements in short time which combines basic scientific research, applied results (which are being used for surveyors working in the region), and two PhD thesis, one from each side!!

A very interesting experiment should also be mentioned, it was a squat determination in La Plata River in cooperation with the Oldenburg Fachhochschule. La Plata River is very flat and usually the big ships touch the sand of the bottom when approaching Buenos Aires port. The knowledge of the squatting for each big ship will surely benefit the operation in the port.

For the future, besides the continuation of IPG (TU Dresden) and GFZ fruitful cooperation, a probable project between Brazil, Argentina and Germany (Hanover University) in the frame of SIRGAS will add other concrete results to the list shown above. We hope the next twenty years will be as least as good as the past.

SZ111 – Thu., 12.4., 10:30 - 10:50 · HSD

Protti, M., González, V. (Observatorio Vulcanológico y Sismológico de Costa Rica), Schwartz, S. (University of California, Santa Cruz), Dixon, T. (University of Miami), Kato, T. (Tokyo University), Kaneda, Y. (IFREE-JAMSTEC)

Seismic and Geodetic Monitoring of the Nicoya, Costa Rica, Seismic Gap

The Nicoya segment of the Middle America Trench has been recognized as a mature seismic gap with potential to generate an Mw>7.5 earthquake in the near future (it ruptured with large earthquakes in 1853, 1900 and 1950). Low level of background seismicity and fast crustal deformation of the forearc are indicatives of strong coupling along the plate interface.

With the goal of documenting the evolution of loading and stress release along this seismic gap, an international effort involving several institutions from Costa Rica, the United States and Japan is being carried out for over a decade in the region. This effort involves the installation of temporary and permanent seismic and geodetic networks. The seismic monitoring has provided valuable information on the geometry and characteristics of the plate interface and the geodetic networks have helped quantify the extend and degree of coupling. A continuously recording, three-station GPS network on the Nicoya Peninsula, Costa Rica, recorded what we believe is the first slow slip event observed along the plate interface of the Costa Rica subduction zone. Collaborative international efforts are focused on expanding these seismic and geodetic networks to provide improved resolution of future creep events and enhanced understanding of the mechanical behavior of the Nicoya subduction segment of the Middle American Trench.

SZ112 – Thu., 12.4., 10:50 - 11:10 · HSD

Victor, P., Sobiesiak, M., Nielsen, S.N., Oncken, O. (GFZ Potsdam)

Discrepancies between long-term and short-term surface deformation signals in the forearc of N-Chile

The mechanism of permanent strain accumulation across the forearc of N-Chile is an open question. Strong coupling along the seismogenic interface leads to elastic loading of the forearc crust that is subsequently released by large subduction earthquakes. The observed mismatch between coseismic strain release and interseismic strain accumulation from GPS campaign measurements in the area points to convergence vector parallel shortening as the residual horizontal deformation signal. However mapping of active faults and surface ruptures in the area reveals only convergence vector parallel extension in the long-term record. Likewise the long-term uplift signal calculated from marine terraces and paleostrandlines in the Antofagasta area is not in accordance with the short-term vertical displacement data modelled from GPS measurements. Furthermore the forearc between 18°S and 25°S displays a strong segmentation in terms of active surface deformation not recorded by short term observations. In this study we investigate the influence of spatial variations in seismogenic behaviour of the plate interface on forearc segmentation and deformation accumulation. Discrepancies between long-term and short-term deformation signals seem to be most pronounced in the area of a segment boundary for large subduction zone earthquakes located at the latitude of Mejillones Peninsula. On the basis of field mapping of active deformation we propose that the subduction process and surface deformation are intimately linked together. The northern part of Mejillones Peninsula records a continuous uplift signal over various incrementsin the late Pleistocene and the strain accumulation pattern along active faults is homogeneous. This homogeneous surface deformation pattern is well in accordance with a relatively weak interface that acted as a barrier for rupture propagation of the 1995 Antofagasta earthquake (Mw=8,0) to the north. In contrast asperities mapped on the interface south of the segment boundary correspond to heterogeneities that aided in accelerating the initial rupture to the south and are reflected in heterogeneous surface deformation pattern. In this area the mismatch between long-term and short-term surface deformation signals is especially pronounced. This is where we focus our InSAR observations to study triggering mechanisms for surface ruptures and get additional short-term datasets for vertical surface motion.

SZ1P01

Alasonati, P., Alasonati Tašárová, Z., Götze, H.-J., Hackney, R. (Kiel, Germany, Institute of Geosciences, Christian-Albrechts University), Meyer, U. (Hannover, Germany, Associates section Airborne geophysics, Federal Institute for Geosciences and Natural Resources (BGR)), Schmidt, S. (Kiel, Germany, Institute of Geosciences, Christian-Albrechts University), TIPTEQ Research Group (Potsdam, Germany, GeoForschungsZentrum Potsdam)

Locating basin-centered asperities along the Chilean margin between 36° and 44°S based on gravity anomalies

Recent studies that suggest a global correlation between negative residual trench-parallel gravity anomalies and high seismic moment release (e.g. Song & Simons, 2003; Wellset al., 2003) have important implications for the state of plate coupling in south-central Chile.
The northern part of this region (36-39°S) is associated with positive fore-arc gravity anomalies, which implies low coupling in this part of the margin. Further south (39-44°S), optimised filtering of the gravity anomalies confirms that coseismic slip associated with the 1960 Mw 9.5 Valdivia earthquake correlates with fore-arc gravity lows centered on sedimentary basins.
An existing 3D density model for the region between 36° and 42°S (Tašárová, 2004) has been extended southward to 44°S using constraints from newly measured seismicity (Lange, pers. comm., 2006) and gravity anomalies from improved satellite models (Förste et al., 2006). This density model helps constrain the degree of plate coupling in this region and the causes behind its variation.

SZ1P02

Scherwath, M., Contreras-Reyes, E., Grevemeyer, I., Flueh, E., Weinrebe, W., TIPTEQ Research Group (Kiel)

Upper lithospheric structure of the subduction zone in Southern Chile - comparison of differently aged incoming plate

Seismic imaging of the crust and upper mantle of the subduction zone system was conducted during the RV Sonne cruise SO181 around the Chile Triple Junction, in particular in the area of the 1960 Great Chile megathrust earthquake (Mw=9.5). As part of the TIPTEQ project (from The Incoming Plate to megaThrust EarthQuake processes), funded by the German Ministry for Education and Research (BMBF) and the German Research Foundation (DFG), three data transects compare subduction zone structures of differently aged incoming Nazca plate (between 3 and 14.5 Ma at the trench) and its influence on the overlying South American plate. The oceanic lithosphere entering the subduction thrust is around 5 km thick on all lines. The trench basin along the deformation front consists of an almost homogeneous sedimentary cover of about 2 km thickness from the Chile Ridge in the south to the Juan Fernandez Rise in the north, indicating an efficient sedimentary transport system to the north in the direction of a deepening seafloor. Seismic velocities in the oceanic lithosphere are lowaround the spreading centres and increase with plate cooling. However, a localized velocity decrease at the outer rise on the older transect exists, which is interpreted as lithospheric hydration effects associated with plate bending (see also Contreras-Reyes et al., this conference) and relatively deep outer rise seismicity. The dip of the subducting slabat the imaged first tenth of kilometres into the subduction zone are shallow, around 4 to 7 degrees, steepening marginally with age. Finally, the overriding continental plate appears to be strongly deformed within about 80 km of the deformation front as indicated by strongly lowered seismic velocities in this region. This effect is seen along much of the Chile margin and seems independent of the age, i.e. thermal structure of the incoming plate. Thus, the plate geometry appears rather age-independent, playing only a minor role on the seismogenic zone. This could explain why the 1960 great Chile earthquake ruptured over the entire 800-1000 km length despite encountering thermally strongly varying structures.

SZ1P03

Thorwart, M., Dzierma, Y., Dinc Akdogan, A.N., Rabbel, W., Flueh, E. (Kiel, SFB 574, University of Kiel), Gossler, J. (Kiel, IFM-Geomar), Taylor, W., Alvarado, G.E. (Costa Rica, ICE)

Receiver function and non-volcanic tremor studies in Costa Rica

E-Mail: `nilay@geophysik.uni-kiel.de`

As part of the collaborative research center SFB 574, the Central America subduction zone is being investigated by a seismological research subproject conducted by Costa Rican and German partners. The general goal of SFB 574 is to study the origin and influence of volatiles and fluids in subduction zones. The seismological subproject constitutes the structural and seismotectonical framework of these investigations. Under this framework, several seismological network installations had already been accomplished. In addition to the short period amphibious network TOMO, two other experiments are being performed in Costa Rica: a transect comprising 18 broadband stations in the Talamanca region and array of 6 borehole stations at the Nicoya Peninsula. The steepness of the subducting slab is one of the main ambiguities in southern Costa Rica where the Cocos Ridge subducts beneath Costa Rica and seismicity in the Wadati-Benioff zone is decreases. For this reason receiver function analysis is being performed for imaging the subducting slab and the Moho. Vp/Vs ratios which can be obtained as well from this analyses, will give some indications for the amount of fluid contents in the mantle wedge. The aim of the borehole experiment is to observe non-volcanic tremors in Costa Rica. There are some indications of silent slip events in the area of the installation which are correlated with non-volcanic tremors. Previous works in Japan and Cascadia mentions that non-volcanic tremors are related to fluid flow at the plate boundary.

SZ1P04

Dinc Akdogan, A.N., Thorwart, M. (Kiel, SFB 574, University of Kiel), Koulakov, I. (Russia, Institute of Geology, SB RAS), Arroyo, I., Rabbel, W., Flueh, E. (Kiel, SFB 574, University of Kiel)

Subduction zone structure and related processes beneath central Costa Rica

E-Mail: nilay@geophysik.uni-kiel.de

The subduction zone structure and related processes are interpreted using a 3-D velocity model and seismicity of central Costa Rica obtained by the means of local earthquake tomography. There are three prominent features that can be clearly identified from the velocity model and the earthquake distributions: 1) A 4-10 percent high velocity perturbation down to 60 km depth related to the Cocos Plate subducting under Costa Rica. The earthquakes of intermediate depth are mostly located in the uppermost part of the slab and are supposed to be caused by dehydration embrittlement associated with metamorphic phase tranformations. 2) A 10-20 percent velocity decrease reaching down to 20 km depth, along the trench which can be correlated with high deformation caused by the bending of the incoming plate and possibly the occurance of serpentinization. 3) Negative velocity perturbations under the volcanic arc which can be caused by high content of upwelling fluid and magma, confirming the fluid release from the slab. These interpretations are supported by petrological modelling based on the correlation between the seismic wave velocity, H2O content and metamorphic phase transformations. It provides a better insight into the origin of seismicity of the seismogenic zone, which is supposed to be generated by interactions of thermal, mechanical, hydrological and compositional processes in the subduction factory.

SZ1P05

Dinc Akdogan, A.N., Thorwart, M., Dzierma, Y., Rabbel, W., Flueh, E. (Kiel, SFB 574, University of Kiel), Gossler, J. (Kiel, IFM-Geomar), Taylor, W., Alvarado, G.E. (Costa Rica, ICE)

Seismicity of Southern Nicaragua and Northern Costa Rica : A Combined Offshore and Onshore Study

E-Mail: nilay@geophysik.uni-kiel.de

As part of the collaborative research center SFB 574, the Central America subduction zone is being investigated by a seismological research subproject conducted by Costa Rican and German partners. The general goal of SFB 574 is to study the origin and influence of volatiles and fluids in subduction zones. The seismological subproject constitutes the structural and seismotectonical framework of these investigations. Under this framework, several seismological network installations had already been accomplished. The amphibious network TOMO was operated from November 2005 to May 2006 encompassing the Isthmus of Nicaragua and northern part of Nicoya Peninsula, Costa Rica. The network comprises 19 ocean bottom seismometers provided by IFM-GEOMAR, Kiel and 35 land stations provided by GFZ, Potsdam and Red Sismologico Nationale (RSN), Costa Rica. Approximately 2000 earthquakes were recorded during the observation period. These events are located using a previously defined 1D model for this region. We observe two prominent features: 1) The intermediate and deep events, giving a preliminary idea of the geometry and the dip angle of the slab. In comparison to central Costa Rica, the dip angle is steeper. 2) Clusters of events in the region of continental slope which are related to the faults. These faults can be possible pathways for fluid flow. Fluid flow may generate earthquake clusters. For further insights into the composition and physical state of the lithosphere and the dynamics of the subduction zone, focal mechanism solutions and local earthquake tomography is going to be performed in the continuation of this work.

SZ1P06

Hackney, R. (University of Kiel), Khazaradze, G. (University of Barcelona), Alasonati Tašárová, Z. (University of Kiel)

A 3D gravity model as a constraint on improved elastic-dislocation modeling of GPS data in south-central Chile

E-Mail: rhackney@geophysik.uni-kiel.de

Subduction zone gravity anomalies might indicate the degree of plate interface coupling and reflect the extent of rupture during great earthquakes (Song & Simons, 2003; Wells et al., 2003). In south-central Chile (36–42°S), at the northern end of the rupture zone of the 1960 Mw 9.5 Valdivia earthquake, there is a prominent change in fore-arc gravity anomalies (Figure 1). North of 39°S, fore-arc anomalies are positive, while south of this latitude, negative residual anomalies dominate. This difference suggests that north of 39°S the plate interface is less coupled and less likely to be a part of extensive plate rupture. South of 39°S, the interface should be more highly coupled and susceptible to rupture.

This interpretation is consistent with: 1) the rupture that occurred during the Valdivia earthquake, 2) observed fore-arc seismicity and 3) a north-to-south increase in the width of the locked zone inferred from modelling of GPS data (Khazaradze & Klotz, 2003). The Valdivia earthquake initiated near 39°S, but rupture propagated southward away from the region of positive anomalies. Where anomalies are positive, seismicity is high, indicating ongoing strain release. In contrast, earthquakes are scarce where anomalies are negative (i.e. in the area where the plate interface ruptured in 1960), indicating that strain is again building after re-locking of the plate interface following the Valdivia earthquake.

A three-dimensional gravity model of this region (Tašárová, 2004), partly constrained by seismic results, suggests that the observed differences in gravity anomalies reflect differences in slab depth beneath the fore-arc (Hackney et al., 2006). The positive anomalies can largely be explained by a slab that north of 39°S is about 5 km shallower than tothe south. This, in turn, suggests that slab geometry contributes to the inferred variations in plate coupling in this region.

In the previous elastic dislocation model of this region (AEDM, Khazaradze & Klotz, 2003), fault geometry was poorly constrained. Therefore, we used the geometry inferred from the 3D gravity model in a more detailed elastic dislocation model. Figure 1 shows the results of the old and new dislocation modelling. Whilst there is room for further work, the fit between observed and calculated velocities at coastal sites, where the inter-seismic signal is greatest, is significantly improved. The geometry of the seismogenic zone inferred from the new dislocation model is different from that in the original AEDM in that the width of both the locked and transition zones is reduced. In the new model, the base of the locked zone extends to about 38 km depth (cf. ∼42 km in the AEDM), while the transition zone extends to a depth of ∼50 km (cf. ∼60 km in the AEDM). A further reduction in the width of the seismogenic zone is likely to further improve the fit between observed and calculated velocities.

It is our hope that this modelling will help to better constrain along-strike variations in the coupling properties of the thrust interface and allow further examination of the correlations between these properties and gravity anomalies.

References

Hackney R et al. (2006), Frontiers in Earth Sciences, 1, Springer-Verlag, 355–375.

Khazaradze G & Klotz J (2003), J. Geophys. Res., 108, 2289, doi:10.1029/2002JB001879.

Song TA & Simons M (2003), Science, 301, 630–633.

Tašárová Z (2004), PhD, Freie Universität Berlin, http://www.diss.fu-berlin.de/2005/2019/indexe.html, 168pp.

Wells RE et al. (2003), J. Geophys. Res., 108, 2507, doi:2510.1029/2002JB002072.

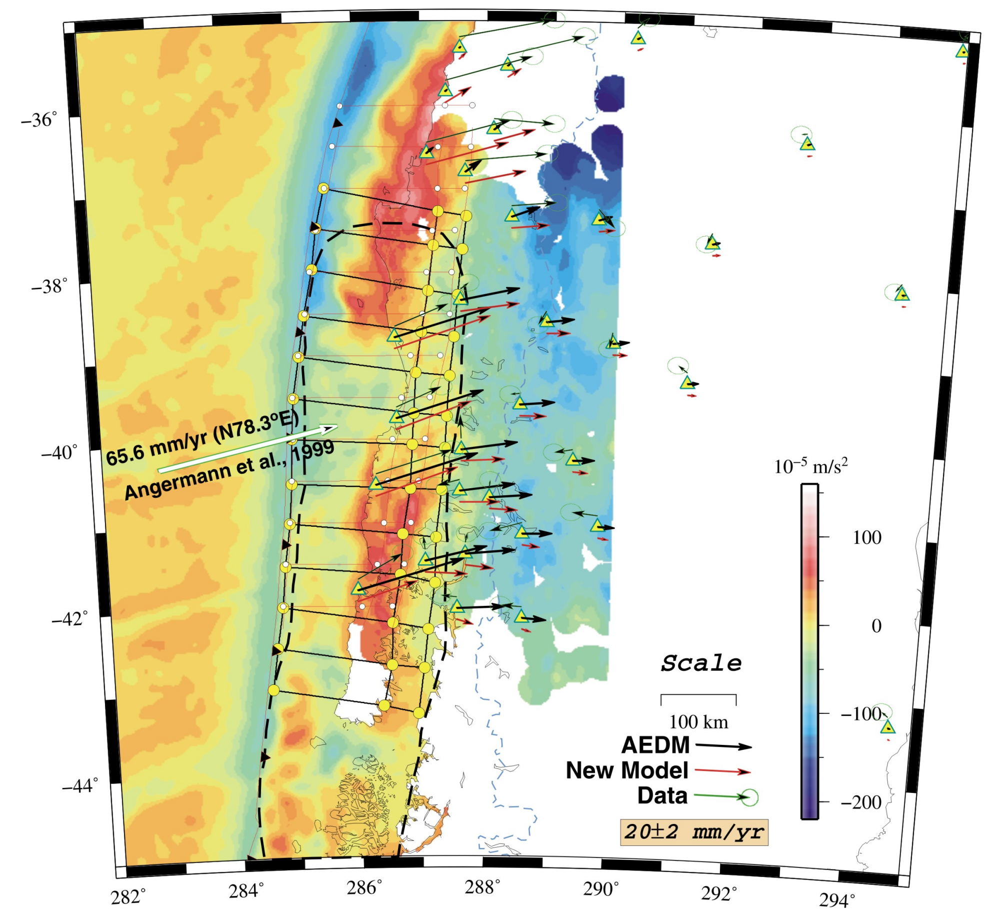

Figure 1: Gravity anomalies (free-air offshore, Bouguer onshore) and GPS velocities in south-central Chile. The velocities predicted by the old AEDM (black) and the new (red) models are compared to the SAGA 94–96 observations (green with ellipses). The outline of the locked and transition zones is also plotted.

SZ1P07

Hammerich, T. (Kiel, Sonderforschungsbereich, Christian-Albrechts-Universität zu Kiel), Garbe-Schönberg, D. (Kiel, Institut für Geowissenschaften, Christian-Albrechts-Universität zu Kiel), Liebetrau, V. (Kiel, IFM-GEOMAR)

Central American forearc seep carbonates: First results from Meteor 66 drill cores

During cruise M66-3 of RV Meteor offshore pacific Nicaragua/Costa Rica continuous authigenic carbonate cores (seep carbonates) were drilled. A total length of 835cm carbonate core from 9 drilling locations were achieved. Highlight is a 317cm long core from the top of Jaco Scarp, a large-scale escarpment caused by subducting seamounds. The detailed petrographic investigation of thin sections show a high small-scale variety in petrographic and lithological units. The carbonate cores can be divided into three main mineralogic sub-units: a) carbonate cores consisting of aragonite only, b) carbonate cores consisting of Mg-calcite only, and c) cores consisting of Mg-calcite clasts with aragonite matrix. The lithologic units are sediments with incorporated seep biology (clams, serpulid tubeworms, foraminifera & gastropods) and extended aragonite cements in voids and channels. Microbial carbonates with clotted microfabrics represent the early carbonate precipitates followed by fibrous botryoidal cements as the late precipitates. A striking phenomenon is that thebotryoidal cements are pendulously, they mostly grow top down decreasing in size in the same direction. Under UV-bluelight fluorescence microscopy the clotted carbonates show a high luminescence resulting from the strong incorporation of residual organic matter. In contrast the botryoidal cements show low luminescence with distinct luminescent lines. These lines represent times of stagnation to stagnancy in carbonate precipitation and reflect the growth history of the cements. Preliminary geochemical investigations using electron microprobe show that the distinct luminescent lines not only represent changes in the incorporation of organic matter, they also represent variations in the geochemical content e.g. for strontium. Sub-samples from the carbonate cements were taken for high precision U/Th dating, stable isotopes and XRD analysis. Additional investigations with electron microprobe, micro-XRD & LA-ICPMS will be used to provide a detailed chronology of the seep carbonates and to reconstruct the history of fluids in the Central American Forearc.

SZ1P08

Harders, R., Brückmann, W. (Kiel, SFB 574, University of Kiel), Feeser, V. (Kiel, Institut für Geowissenschaften), Kutterolf, S., Hensen, C. (Kiel, SFB 574, University of Kiel), Mörz, T. (Bremen, MARUM)

Ash Layers: The Controlling Factor On Translational Sliding Offshore Central America?

The erosive convergent margin of Central America is dominated by a fast subduction (8,5 mm/year) of a rough Pacific Plate. Offshore Costa Rica the morphology of the oceanic plate is characterized by the thick Cocos Ridge and its northwestern adjacent seamount province. Offshore Nicaragua fewer and smaller seamounts, but bend faults dominate the plate morphology. In both areas subduction of a rough relief results in erosion of the frontal prism, local slope uplift and subduction erosion at the base of the upper plate which oversteepen the continental slope, leading to slope failures.

Our investigations focus on translational slides offshore Nicaragua with less seamount subduction influence than offshore Costa Rica. Three translational slides of different scales were investigated by gravity coring during M66 expedition in autumn 2005. On board sediment property investigations from two out of three slide locations revealed ash layers situated on top of older and over consolidated clayey sections, beneath much younger and less dense clay sections. This jump to higher densities below an ash layer led to the assumption, that the over consolidated material represents the basement of a slide event. As these ash layers also showed low shear strengths and high porosities, they were interpreted as the failure planes and the weak layers respectively. The recovered cores showed, that numerous 1 mm - 5 cm thick ash layers are intercalated with sharp boundaries to marine clays in average of every 90 cm. These ashes differ in two ways from the pelagic clays. Firstly they consist of silt and sand, causing much higher intrinsic permeabilities compared with the pelagic clays. Secondly they are made of disc shaped glass shards which cause higher consolidation rates. This is proved by our first laboratory shear box tests, where ash matter compacted with much higher values than spherical grain shaped reference material. Both factors together could cause a peak pore pressure if ashes compacted rapidly, for instance in a seismic event. Peek pore pressures would effectively reduce the shear strength between the ash particles and facilitate translational failure.

To test this hypothesis and to analyse the relation between pore water pressures and shear strengths under drained conditions, we will modify a shear box, to simultaneously measure pore water pressure and shear strength. We will present field observations from cruise M66 as well as first results from laboratory deformation experiments, supporting our model.

SZ1P09

Heberer, B. (Universitaet Freiburg), Behrmann, J.H. (IFM-Geomar, Kiel), Rahn, M. (HSK, Villigen)

Can apatite fission track ages from modern trench sands reflect the dynamics of the upper plate? Preliminary results from the Southern Chile Trench

E-Mail: `bianca.heberer@sbg.ac.at`

Detrital apatites from Southern Chile trench sediments between 46°and 30°S were dated by fission track means. We address the question, whether the lateral age segmentation of the ocean floor and hence its variable mechanical behavior and thermal structure is reflected by a variation of the latitudinal denudation pattern of the overriding South American plate and its sedimentary input into the trench. Age differences in the lower plate oceanic crust are due to the angle of the spreading ridge with the subduction zone and the offset of the ridge by several transform faults. Crustal ages increase from zero at the southernmost limit of the study area to more than 40 Ma in the North.

Modern sand samples from trench and trench fans were collected by gravity coring, the latter being preferentially targeted. Within these fans the material is derived from a limited onshore drainage system and has not undergone mixing processes as intense as found within the trench.

Preliminary results show an increase in age from the Chile Triple Junction (CTJ) northwards. Apatites from lower Pleistocene samples from ODP Leg 141 in the vicinity of the triple junction show a distinct 9 Ma peak. This population is in line with the late Miocene peak detected in an earlier study, and can tentatively be ascribed to the collision of the first segment of the Chile rise in the Golfo de Peñas region resulting in a focused pulse of local forearc uplift. Ages further N (Chacao Fan and Tolten Fan) repeatedly show a late Miocene peak, but due to a high volcaniclastic input into the trench the youngest peak age is only poorly constrained.

At the Biobío Fan (36.5°S) an inferior 9 Ma signal is still present, but is accompanied by two, more prominent Cretaceous populations, which are thought to be derived from the Coastal Cordillera. The northernmost sample off the coast of the drainage area of Rio Limari (30.5°S) yields exclusively Cretaceous ages. At this latitude, there is no present-day volcanic activity in the hinterland. Input of volcaniclastic material from areas further S, transported in the axial channel of the Southern Chile Trench, is blocked bythe Juan Fernandez ridge at approximately 33°S.

In addition to further ages from the trench, first data from the littoral are shown and compared with the data from the trench and with published onland fission track ages. This data set will be used to test the generally made assumption of zero transport time of eroded material. Only identical ages within all three settings would support this widely used concept.

SZ1P10

Karaca, D., Hensen, C., Wallmann, K. (Kiel, IFM-GEOMAR)

Estimates of methane fluxes and authigenic carbonate formation at mud volcanoes off Costa Rica, a numerical model approach

E-Mail: dkaraca@ifm-geomar.de

The forearc of the active convergent margin off Costa Rica is characterized by active fluid venting related to mud diapirism and volcanism. A significant portion of bicarbonate generated through anaerobic oxidation of ascending methane (AOM) precipitates as authigenic carbonates in the near surface sediments.

The purpose of our study is a thorough investigation of the major parameters controlling authigenic carbonate formation, such as the fluid composition and advection rate. These efforts will help to further our understanding of turnover rates at mud volcanoes at the erosive margin off Costa Rica and examine the use of authigenic carbonates as archives for fluid flow. Preliminary studies focus on the variability of venting activity along the slope and aim at the derivation of local methane budgets.

Using a numerical reactive-transport model, we simulate carbonate precipitation and the effect of fluid flow rates on methane discharge at two mud volcano sites offshore southern Costa Rica characterized by the occurrence of bacterial mats. At the Mound 11 location 98%($\sim$10 000 μmol cm^{-2} a^{-1}) of the methane is released into the overlying bottom waters due to exceptionally high advection rates of about 200 cm/year, which corresponds to a very low efficiency of AOM of only 2%($\sim$170 μmol cm^{-2} a^{-1}). In comparison, moderatefluid flow rates of 15 cm/year at the nearby Mound 12 location lead to reduced methane output (74%) from the sediment. The lower methane turnover by AOM at Mound 11 causes a reduced alkalinity production and hence, a lower degree of authigenic carbonate formation.

SZ1P11

Kuhn, P., Littke, R. (RWTH Aachen University Institute of Geology and Geochemistry of Petroleum and Coal), Echtler, H., Krawczyk, C.M. (GeoForschungsZentrum Potsdam), Rojas, L. (ENAP/Sipetrol, Santiago, Chile)

Cenozoic Evolution of the Arauco Forearc Basin, South-central Chile - a Thermal Modelling Study based on Coalification of Organic Matter

E-Mail: kuhn@lek.rwth-aachen.de

The Arauco Basin and Peninsula (36°46' to 38°30' S) are part of the coastal fore-arc domain of the Chilean active margin and records Eocene to early Pliocene extension and subsidence followed by ongoing uplift and contraction since the late Pliocene. This uplifted block of continental shelf is the biggest, in extension ($\sim$2250 km^2) and westward coastline displacement ($\sim$30 km), of the entire Pacific margin of the southern hemisphere. The shelf in the Arauco area records temporal and spatial discontinuous marine and continental fore-arc basin formation since Late Cretaceous, developed on top of a crystalline Permo-Triassic basement. Alternating episodes of uplift/erosion and subsidence/sedimentation are evident from the geological record and paleogeographic reconstructions, possibly controlled by the alternating cycles of accretion/erosion described for the frontal wedge. Maximum sediment thickness is $\sim$3000 m, but varies dramatically along and across strike, showing temporal discontinuous transgressive-regressive cycles of marine to continental facies. The study of the thermal evolution of theses sequences is targeted to a better quantitative understanding of the related subduction processes in a highly dynamic setting.

The development of the study area is generally agreed to have occurred in four different phases of sedimentation. The oldest sedimentary unit in the forearc basin was deposited during Late Cretaceous times (Santonian - Maastrichtian) in an extensional phase (Wenzel 1972). Thicknesses range from 300 to 1300 m. The second unit is dated to be of Eocene to early Oligocene age. These rocks were deposited during a time of active tectonicsubsidence. The coal-bearing formations Trihueco and Curanilahue are included in this unit. After an erosional event, sediments of Miocene age were deposited as the third sequence. The transition is marked by an angular unconformity (Kuhn 2006). The Pliocene is the forth and uppermost unit deposited locally in subsiding areas coexisting with areas of uplift and deformation. All clastic sediments of the Arauco basin are to some degree influenced and displaced by normal faults. The main direction of the faulting inherited from older structures strikes NE and divides the basin into numerous smaller blocks tilted mainly to the west.

This consensus is not given for the precise timing and even opposing ideas are published on the degree of inversion and the connected maximum erosion taking place during the Miocene (Alvarez 2006, Melnick and Echtler 2006).

The answer to this can probably be given by a thermal model which is the aim of the ongoing research. The study presented here is based on 75 rock samples taken from numerous positions across the Arauco peninsula. 50 samples are from 10 different onshore wells that were drilled into the coal-bearing basin by ENAP (Empresa Nacional del Petróleo, Chile) between 1968 and 1973. These were supplemented by samples from two coal mines (CARVILE, Lebu and Enarcar, Trongol/Curanilahue). Furthermore, samples from surface outcrops were collected across the Arauco peninsula during a field mapping campaign in spring 2006. Vitrinite reflectance is measured on the prepared samples and can be correlated with the maximum temperature the analysed material was exposed to during its burial (Barker 1993). Furthermore the total organic carbon (TOC) and composition of organic matter (Rock Eval Pyrolysis) is determined.

Already analysed coal samples from Eocene units (sampled in the coal mines and in outcrops) show alterations which indicate subsurface palaeo-temperatures of up to 120°C. These are believed to be related to a deep burial and subsequent inversion (> 1.5 km). High subsidence rates may be explained with tectonic erosion enhancing basin formation along the active margin. This setting results however in a low heat flow to the bottom of the basin leading to a low temperature gradient with depth in the basin fill. To better constrain the thermal history of the basin and thus the related subduction setting in the tectonic context, 1D models of the wells are currently build and correlated with the regional data sets.

References

Alvarez, P., Radic, J.P. and Rojas L. 2006: Evolucion Tectonosedimentaria de la cuenca de antearco Arauco Itata, Chile Central. 11. Congreso Geológico Chileno, Antofagasta, Chile

Barker, C. and Pawlewicz, M. 1993: Calculation of Vitrinite Reflectance from Thermal Histories and Peak Temperatures. A comparison of methods; In: ACS Symposium Series (1994), 570 Vitrinite Reflectance as a Maturity Parameter. American Chemical Society, Washington, DC, 216-229

Kuhn, P. 2006: Geology of the Coastal Area of Lebu - Arauco Basin, Chile. Diploma Mapping Thesis, RWTH Aachen University, Germany

Melnick, D. and Echtler, H. 2006: Inversion of forearc basins in south-central Chile caused by rapid glacial age trench fill. Geology; v. 34; no. 9; 709-712

Wenzel, O. 1972: Geología y reserves del yacimiento carbonífero der Lebu. Empresa Nacional del Carbon S.A., Chile

SZ1P12

Lahrmann, B., Götze, H.-J., Schmidt, S. (CAU Kiel)

3D density modelling of the southern parts of the central american subduction zone

E-Mail: birger@geophysik.uni-kiel.de

Crustal structures along the southern part of the central american subduction zone have been investigated for many years. Especially the oceanic crust and the margin wedge were objects of intensive research and are therefore well defined. Actual seismological work in central and northern Costa Rica provides new information for the deeper underground. Gravity data from the region has been gathered from various institutions and the analysis of the gravity field with the curvature method, Euler deconvolution and other methods show anomaly sources. By combining these data a 3D density model has been developed within the framework of German Collaborative Research Center 574 Volatiles and Fluids in Subduction Zones: Climate Feedback and Trigger Mechanisms for Natural Disasters. Open questions like the location of the border between the Chortis block in the north and the Chorotega block in the south, their different crustal structure and effects of serpentinization could be modelled but with the restriction that due to the lack of gravity data and the lack of additional constraining data the modelling in some parts of the study area is non unique.

Web page: http://www.sfb574.uni-kiel.de

SZ1P13

Mahatsente, R. (University of Kiel), Ranalli, G. (Carleton University), Macera, P., Gasperini, D. (University of Pisa), Götze, H.-J. (University of Kiel)

Slab-Plume interaction: consequences for slab-break off

E-Mail: rezene@geophysik.uni-kiel.de

Abstract

The interaction of slab with a plume has an implication on the occurrence of subduction related volcanism in collision tectonics regime. The softening effects of an impinging plume on a subducting slab have been studied using lithospheric strength analysis and favourable conditions for slab detachment are identified. The total lithospheric strengths are estimated based on thermal models of a slab assumed to be in contact with a hot plume. The initial temperature of the plume head is 1900 K and assumed to be hotter than the surrounding mantle by 300 K.

The simulation of the softening effects of the plume started when the tip of the slab reached a depth of 525 km. At this stage, the continental crust has subducted to a depth of 240 km. The temperature distributions in the slab including the plume are computed using the equation of conservation of energy. The heat transfer equation is solved using a Finite Difference code Shemat.

The lithospheric strength has been estimated for cold and hot geothermic conditions of a subducting slab. The time evolution of the total lithospheric strength of a cold slab indicates that the slab most likely detaches within the first 10 Ma since the arrival of the plume. Whereas in the case of hot conditions of the slab, slab-break off is more likely to occur at any time since the arrival of the plume. Apart from the cold geothermic condition of the slab, the relatively higher negative buoyancy, compared to the total lithospheric strength, plays a major roll in softening the lithosphere.

SZ1P14

Willner, A.P. (Universität Stuttgart, Institut für Mineralogie und Kristallchemie, Ruhr-Universität Bochum, Institut für Geologie, Mineralogie und Geophysik), Gerdes, A. (Universität Frankfurt, Institut für Geowissenschaften), Massonne, H.-J. (Universität Stuttgart, Institut für Mineralogie und Kristallchemie)

Growth of the South American convergent margin during Late Paleozoic times: a study of U/Pb ages of detrital zircons in fossil accretionary prisms at latitudes around 33°S

E-Mail: h-j.massonne@mineralogie.uni-stuttgart.de

Growth of the South American continent along its Pacific margin at 28°-40°S in Paleozoic times involves (1) the deposition of vast masses of greywackes and their deformation during the Early Paleozoic Pampean and Famatinian orogenies in NW-Argentina, (2) the Ordovician collision with the exotic microplate Cuyania exposed in the Argentine Precordillera, (3) the possible Devonian collision of the hypothetical terrane Chilenia, and (4) the deposition of mainly greywackes on this microplate and to the W of it as well as the accretion of these sediments to the continental margin and partial incorporation into magmatic arcs during Late Paleozoic times. In order to elucidate especially (3) and (4) we have sampled low grade metagreywackes from the late Paleozoic accretionary prism within the Chilean Coastal Cordillera between 31°S and 35°S as well as metasediments from a collisional accretionary prism (Guarguaráz Complex) at the western suture of the Cuyania Terrane (Argentine Precordillera). The samples from the former locality were taken from higher levels of the frontal as well as from the structurally underlying basal accretionary wedge. After separation, zircons were inspected for shape and internal structure by cathodoluminescence imagery. Subsequently, we applied SHRIMP and MC-LA-ICP-MS to determine U-Pb ages of homogeneous growth domains of zircon. The detrital zircons are expected to represent the entire history of the Paleozoic growth of South America at the chosen latitudes.

Zircons, originally of igneous and metamorphic origin, in the high pressure Guarguaráz Complex display a broad age cluster at 0.98-1.44 Ga (maximum at 1.10 Ga, submaximum at 1.34 Ga) similar to the zircon age variation in the sediments of the Argentine Precordillera (Gleason et al. 2007). This suggests that only sediments from the Cuyania Terrane were subducted within its western suture zone.

The age pattern of the zircons in all investigated metagreywackes from the Late Paleozoic accretionary prism shows a mixed provenance, i.e. from the Cuyania Terrane as well as from the Argentine basement to the east of it. Ages of 0.40-0.58 Ga are typical for the variation of magmatic and metamorphic zircons grown during the Pampean and Famatinian orogenies in the Lower Paleozoic mobile belt of NW-Argentina. Dominance of the maxima at 0.45 and 0.52 Ma varies regionally. This proves that there was no erosional barrier during Late Paleozoic times preventing a major input of zircons from the east of the Precordillera. Ages of 0.60-0.98 Ga are minor, but omnipresent. They can be interpreted as a mixture of the youngest detrital zircon ages from the Precordillera (Gleason et al. 2007) and from the Brasiliano orogen to the east of the Argentine basement. The latter occurs as youngest age cluster in the age pattern of detrital zircons from the Lower Paleozoic basement in Argentina (Schwartz & Gromet 2004). A second major age cluster of igneous and metamorphic zircons at 1.01-1.39 Ga (maximum at 1.10 Ga) matches the distribution in the Precordillera, but must also be influenced by recycled detrital zircons from metagreywackes in NW-Argentina, where also a maximum around 1.10 Ga prevails (Gleason et al. 2007). Minor age cluster are at 1.50-1.72 Ga, 1.91-2.48 Ga, 2.62-2.79 Ga and 2.94-3.20 Ga. The latter is as yet unknown in the sediments of the Precordillera or in the metasediments of the NW-Argentine basement, from which the detrital zircons might be recycled.

These Archean zircons represent the so far oldest minerals dated in Chile.

Only in metagreywackes at 31°S magmatic zircons representing the youngest age cluster at 0.30-0.39 Ga were observed. No significant age difference between the youngest ages of this cluster was noted comparing samples from the upper frontal and the lower basal accretionary wedge. These youngest ages presumably overlap with the age of high pressure metamorphism showing that they were eroded and resedimented into the trench just before subduction to maximum depth in the accretion prism at normal rates. The 0.30-0.39 Ga cluster proves the existence of a magmatic arc at this latitude but a lack of a magmatic arc at 35°S at this time. The Paleozoic arc, exposed with intrusions at 250-300 Ma, formed there later.

References

Gleason, J.D., Finney, S.C., Peralta, S.H., Gehrels, G.E. and Marsaglia, K.M. (2007) Sedimentology 54, 107-136.

Schwartz, J.J. and Gromet, L.P. (2004) Precambrian Research 129, 1-21.

SZ1P15

Mavromatis, V., Comas, L., Schmidt, M. (Kiel, Department of Geosciences, University of Kiel), Hensen, C., Liebetrau, V., Wallmann, K. (Kiel, IFM-GEOMAR)

Precipitation of artificial Mg-Calcite compared to authigenic carbonate formed at mud mounds (Costa Rica/Nicaragua Fore Arc)

More than 100 mud mounds have been identified in the Costa Rica/Nicaragua forearc area at water depths between 1000 and 2000 m. A striking feature of these mounds is a coverage by consolidated carbonaceous sediment. These carbonates are cemented and are often consist of Mg-Calcite, with varying $MgCO_3$ content. Their geochemical and mineralogical composition varies and can reflect near surface diagenesis or deep fluid signatures.

Formation of carbonates under laboratory T-controlled conditions with similar mineralogical and geochemical characteristics compared to natural samples should give essential information about deep fluid-sources, formation temperatures, diagenesis and the temporal variations under which the natural carbonate concretions have been formed.

Mg-Calcite crystals have been precipitated from oversaturated Ca^{2+} and Mg^{2+} solutions in the temperature range of 20 – 80 °C. X-ray diffraction pattern of the artificial calcites is similar to a variety of natural samples. In the artificial calcite, the Mg content varies between 2 and 4 % for low Mg-calcites and 5 to 18 % for high Mg-calcites. The crystal structure and the particle size of the synthesized material, as also the presence of amorphous phases in the samples, have been examined with scanning electron microscopy and infrared spectroscopy. Temperature-related oxygen isotope fractionation were determined by IR-MS. Fluid and mineral partition coefficients were determined by ICP-OES/MS. A natural mud mound system in Costa Rica fore arc (Mound 12) is described and authigenic carbonate formation is interpreted including new laboratory results.

SZ1P16

Roeser, G. (Universitaet Freiburg), Heberer, B. (Universität Freiburg), Behrmann, J.H. (IFM-Geomar, Kiel), Rahn, M. (HSK, Villigen-HSK), Kopf, A. (RCOM Bremen)

Sedimentology, petrography and provenance of modern Southern Chile Trench sediments (36° - 47°S)

E-Mail: georg.roeser@geologie.uni-freiburg.de

Sedimentology, petrography and the provenance of sediments from the Southern Chile Trench (36°S - 47°S) that are about to be subducted into the seismogenic zone beneath the South American Plate, were investigated in an integrated approach combining description of a large collection of gravity cores, quantitative X-ray petrography, modal analysis and fission track age analysis on detrital apatite. The sedimentary environments studied were trench hemipelagics, trench fan deposits, and more distal hemipelagics sedimented on the Nazca Plate N of the Chile Triple Junction (CTJ). The trench is fed by terrigenous turbidity currents from multiple point sources via submarine canyons, extending from the shelf break across the slope, and building submarine fans at the bottom. The turbidites are interlayered with clay- and silt-sized hemipelagics. Within the trench, sediment is transported northwards along a slightly inclined axial channel. The regional depth gradient in the trench floor is caused by the northward age increase of the Nazca Plate.

Both, grain-size and core physical properties reveal distinct latitude-dependent trends. In the trench and the trench fans, contents of clay-sized particles increase towards N with a coeval decrease of the medium and coarse silt fraction due to a combination of several factors, such as the northward directed sediment transport, changes in hinterland lithologies, and different erosion patterns as well as greater water depths in the N. Bulk density of the hemipelagic section reveals a slight but consistent increase towards the S. This relates to higher sediment input, morphologically expressed by a completely buried trench, and goes along with an increase in average turbidite thickness.

Modal analyses of turbidites show a southward increase in sediment maturity. While volcanic lithics represent the most dominant fraction within samples from 36°to 43°S, quartz, and metamorphic and magmatic lithics prevail near the CTJ (at 46.5°S). This reflects the source lithologies, especially the absence of present-day volcanic activity in the hinterland between 47°and 49°S, and is also mirrored in the southward decreasing magnetic susceptibility found in the gravity core material. Further N, active volcanoes in the Main Cordillera partly cause singularities in the provenance signal due to an overwhelming contribution of highly erodible volcanics. Neither were major intrasite variations of detrital modes detected nor variations between trench and trench fans, the latter being ascribed to intense source mixing within the trench.

SZ1P17

Salazar, P. (UCN Antofagasta and Freie Universität Berlin), Kummerow, J., Wigger, P. (Freie Universität Berlin), Asch, G. (GeoForschungsZentrum Potsdam), Moser, D. (Freie Universität Berlin)

Analysis of Microseismicity in the West Fissure Zone, Northern Chile

E-Mail: `pablo@geophysik.fu-berlin.de`

Introduction

The West Fissure fault system (WF) is one of the principal structural features in Northern Chile. The WF pertains to a fault system located in the Precordillera with a predominant N-S orientation and with associated strike-slip movements. The total length of the fault system is more than 1000 km (Camus, 2003).

In spite of its geological/tectonic importance, however, very poor evidence of its seismic activity is known. Present studies focus on the intermediate-depth seismicity associated with the subduction of the Nazca Plate beneath the South American Plate (e.g., the Tarapacá earthquake on 13 June, 2005 [Peyrat et al., 2006]).

Seismic Network

In order to monitor seismicity at a segment of the WF, we have installed a temporary seismic network in November 2005. It will continue recording throughout the year 2007. The network is located at ~ 21°S and covers an area of about 50x50km. This area was traversed by the geophysical ANCORP transect [ANCORP Working Group, 2003] (see Fig. 1). The seismic network consists of 12 3-component instruments, which record continuously at a sample rate of 200 Hz.

Data and Data Analysis

We observe upper crustal microseismicity, which can partly be associated with the WF. The local magnitudes, Ml, of the earthquakes range between -1 and 2. Among the detected events we found an earthquake swarm consisting of 120 events, that occurred between March 31, and April 28, 2006. These events exhibit very high waveform similarity. Accurate location shows that they cluster in a narrow zone (<1km width) at ~ 10km depth. It may be speculated, that the swarm was triggered by a magnitude Mb=5.3 event, that occurred south of Pica at 58km depth on March 27, 2006 (about 40km west of the swarm locations). We also determined focal mechanisms for some events based on polarity of P and S wave arrivals and amplitude ratios (SV/P, SH/P and SV/SH) [Snoke, 2003]. Preliminary results show that the mechanisms are strike-slip and consistent with WF fault motion postulated from geological studies.

References

ANCORP Working Group (2003): Seismic imaging of an active continental margin and plateau in the central Andes (Andean Continental Research Project 1996 (ANCORP '96)), J. Geophys. Res., 108 (B7), doi:10.1029/2002JB001771.

Camus 2003. Geologia de los sistemas porfidicos de los Andes de Chile. Servicio Nacional de Geologia y Mineria, 267pp. Santiago, Chile.

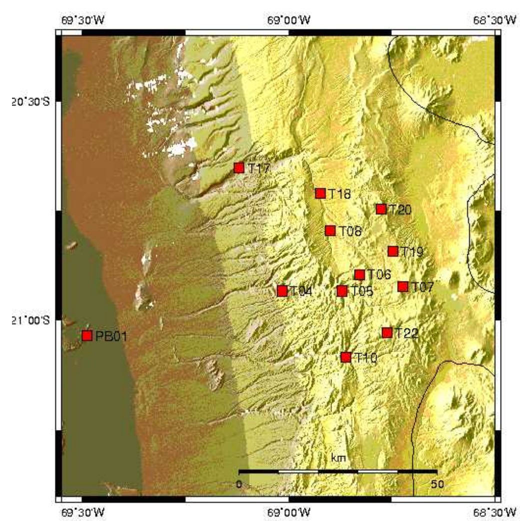

Figure 1: Location map of the seismic monitoring system

Peyrat S., J. Campos, J. B. Chabalier, A. Perez, S. Bonvalot, M.-P. Bouin, D. Legrand, A. Nercessian, O. Charade, G. Patau, E. Clévédé, E. Kausel, P. Bernard and J.-P. Vilotte (2006). Tarapacá intermediate-depth earthquake (Mw 7.7, 2005, northern Chile): A slab-pull event with horizontal fault plane constrained from seismologic and geodetic observations. Geophysical Research Letters, 33, L22308.

Snoke, J. A. (2003). FOCMEC: FOcal MEChanism determinations, International Handbook of Earthquake and Engineering Seismology (W. H. K. Lee, H. Kanamori, P. C. Jennings, and C. Kisslinger, Eds.), Academic Press, San Diego, Chapter 85.12.

Web page: http://www.userpage.fu-berlin.de/ seis

SZ1P18

Schwarzer, A., Gursky, H.-J. (TU Clausthal)

Ophiolite breccias of the Nicoya Complex, NW Costa Rica - an overview

The geologic basement of southern Central America is composed of Jurassic to Early Tertiary ophiolitic units, traditionally assembled as the Nicoya Complex. It includes different magmatic and sedimentary rocks from various plate tectonic settings. Gabbros, massive and pillow basalts are dominant and associated with heterogeneous sedimentary rocks, such as variable clastics, radiolarian cherts and limestones of mostly deep marine origin. Volcaniclastic breccias make up approximately 10 percent of the Nicoya Complex. In contrast to the magmatic and fine-grained sedimentary rocks, the ophiolite breccias have not yet been investigated in detail.

We are currently studying these breccias focusing on outcrops along the Pacific coastline of Costa Rica (Nicoya Peninsula, Herradura and Quepos areas). Breccias occur as generally irregular lenticular bodies, from few meters to tens of meters in thickness, intercalated within volcanic units and at the top of the ophiolite suite underlying the sedimentary cover sequences. Several structurally and compositionally different breccia types are present: - coarse-grained massive monomictic basalt breccias, mostly pillow and pillow- block breccias, - coarse-grained, massive oligomictic basalt breccias including sedimentary clasts, as results of reworking and redeposition processes, - fine-grained stratified basalt breccias grading locally into volcarenites, partly intercalated with coarse-grained breccia beds and exceptionally with pillow basalt units, - and in places: variable oligomictic breccias composed of basalt, limestone and/or siliceous components, coarse-grained gabbro brechas including mega-brechas, and fine-grained radiolarite breccia.

Basalt-dominated breccias are by far dominant, however the remarkably wide range of breccia types indicates variable reworking and sedimentary processes and points to a relatively large number of different oceanic sedimentary environments controlled by specific volcanic, structural and/or plate tectonic settings. The coarse-grained massive monomictic basalt breccias mostly result from pillow basalt fragmentation, as frequently observed on modern ocean floors (e.g. oceanic ridges), due to autoclastic fragmentation or rock fall and accumulation as talus breccias along the rims of pillow flow units or minor fault scarps. Local subangular grain shapes and ill-defined bedding may indicate incipient fan development including debris-flow deposition. The presence of radiolarite clasts indicates that high-relief areas existed where, due to tectonic uplift, older stratigraphic units including radiolarite formations were exposed to erosion. The fine-grained basalt breccias and volcarenites are mostly high-concentrated turbidites; places and modes of their relatively good sorting are unclear. The non-basaltic and mixed breccias formed at major fault scarps where deeper crustal units were exposed and in uplifted and strongly eroded ophiolite terrains, the latter especially at the top of the ophiolite units, before the onset of the deposition of the sedimentary cover sequences.

As a perspective, the ophiolite breccias of the Nicoya Complex may help to reconstruct environments, controlled by volcanic and tectonic activities, that are diagnostic for specific deep-sea plate-tectonic settings such as ridges, plateaus, basal island-arcs and sea-mounts.

SZ1P19

van der Straaten, F. (SFB 574, CAU Kiel), Schenk, V. (CAU Kiel), John, T. (University of Oslo), Gao, J. (Chin. Acad. of Science, Beijing)

Fluid infiltration during the retrograde eclogite to blueschist transformation under HP/LT conditions (Tian Shan, China).

Fluids and volatiles in subduction zones are in interaction with the oceanic crust, the mantle and the related volcanism. Depart from the main pathway from the downgoing slab into the mantle wedge and through the subduction related volcanism up to the atmosphere, some paths are differing: Some fluids migrate into the partially hydrated and serpentinized mantle wedge above the slab, the so-called subduction channel. These fluids may flow upwards, against the movement of the down going slab. Partially rehydrated eclogites and blueschists are possible tracer for the nature and origin of the rehydrating fluids. During the prograde metamorphism the eclogites lose their volatiles by dehydration reactions and emit them as fluids into the mantle wedge. If eclogites reach a dry state they are able to give information about the retrogradly incorporated fluids. This is especially true, if the eclogites become transformed to blueschists which indicates rehydration under cool conditions within the subduction channel.

Eclogites of the Tian Shan orogenic belt (China) were analyzed petrologically and geochemically. Lenses of eclogitic relics in a blueschist matrix show a chemistry of ocean island basalt and are interpreted as the protoliths of the surrounding blueschists. Omphacite and garnet represent the minerals stable under eclogite facies conditions. In addition, omphacite is found as inclusions in retrograde glaucophane, phengite and carbonate. This indicates a retrogressive overprint under blueschist facies conditions. Late-stage epidote includes omphacite, amphibole and rutile. The latest recognized reaction is the partial replacement of rutile by titanite.

With increasing distance from the eclogite, two sequent zones could be distinguished: 1) a glaucophane-blueschist and 2) a phengite-ankerite-blueschist. All two zones differ from the eclogite precursor mainly in their contents of large ion lithophile elements (LILE). Mass balance calculations in comparison with the phase relations of the different zones were made. During the subsequent formation of the glaucophane-blueschist (stage 1) and the ankerite-phengite-blueschist (stage 2) replacing the eclogite, HFSE behaved immobile, while REE, P, Sr and Pb were lost and LILE, K and CO2 were gained. The loss of REE is attributed to the breakdown of apatite, epidote and garnet due to retrogressive metamorphic reactions. Infiltrating fluids could have been released from subducting dehydrating pelagic sediments. Those fluids could be rich in mobile LIL elements (Rb, Cs, Ba and K). The observed chemical changes leads to the assumption that the subduction channel fluids changes the petropyhsical properties of the rocks as well as the rheology and property of the subduction channel, the most likely exhumation path for subducted rocks.

Web page: http://www.min.uni-kiel.de/petrographie/schenk/index.html

SZ1P20

Voelker, D., Grevemeyer, I. (Kiel, Leibniz-Institut für Meereswissenschaften an der Universität Kiel , IFM-GEOMAR), He, J., Wang, K. (Sidney, Pacific Geoscience Centre, Geological Survey of Canada), Heesemann, M. (Bremen, Universität Bremen)

Temperature Field and Seismicity of the Southern Chile Subduction Zone at 38°S and 43°S

The thermal regime of the Chilean subduction zone has been calculated along two profiles perpendicular to the coast at 38°15'S and 43°S. The profiles extend from the coast, enclose the seismogenic coupling zone and include the mantle wedge tip. The northern profile (starting off Arauco Peninsula) is in line with a number of geophysical profiles of the TIPTEQ project, the seismological network ISSA 2000 as well as on- and offshore seismic experiments of the SPOC 2001 project and crosses the hypocenter of the May 1960 (Mw=9.5) mega thrust earthquake. The southern profile (starting off Isla de Chiloe) corresponds to the TIPTEQ South experiment (TIPTEQ corridor 2) which conducted sea floor heat flow measurements, wide angle seismic reflection experiments and a regional seismological network.

The temperature fields and heat flow curves were obtained using a 2D Finite Element Code of He and Wang which accounts for conductive heat transport, frictional heating at the decollement, heat transport by mantle wedge flow and radiogenic heat production. The first-order parameters which govern the temperature field and distinguish both profiles are the slab and margin geometry and the thermal structure ofthe incoming Nazca Plate, which basically is a function of its age (off Chiloe 15My, off Arauco 30My).

Most of the model's boundary conditions such as material properties and rheologies and the distribution of radiogenic heat sources had to be derived indirectly. Parameter studies of the most probable ranges of parameter sets are discussed.

The temperature distribution along the plate interface has fundamental implications for the stress pattern and spatial as well as temporal distribution, magnitude and type of earthquakes observed. The down dip limit of thrust earthquakes is generally considered to be a function of the temperature at the plate interface. On the other hand mineral phase transitions within the down going slab, which are triggered by changing PT conditions are made responsiblefor earthquake activity at intermediate depth (>30 km). As those phase transition reactions are partly exothermic, they contribute to the heat balance as heat sources which further complicates matters. We try to offer some first results on the role of phase transitions in this respect and discuss our results against the most recent seismological network observations provided by the TIPTEQ group.

SZ1P21

Gross, K., Buske, S., Shapiro, S., Wigger, P. (Berlin, Freie Universität), TIPTEQ Research Group (Germany)

Seismic Imaging of the Subduction Zone in Southern Central Chile

E-Mail: `wigger@geophysik.fu-berlin.de`

With a quarter of the worldwide seismic energy in the last century having been released in the Chilean region alone, the Andean subduction zone is a natural laboratory for seismogenic studies. The overarching purpose of project TIPTEQ (from The Incoming Plate to mega-Thrust EarthQuake processes), which comprises 13 sub-projects, is to investigate processes active at all scales in the seismogenic coupling zone which hosted the rupture plane of the 1960 Valdivia earthquake (Mw = 9.5) in south central Chile. The controlled-source seismology survey described here aims at imaging and identifying the structural and petrophysical properties within the seismogenic coupling zone at 38.2° S.

The application of Kirchhoff prestack depth migration as well as two advanced imaging techniques (Fresnel Volume Migration and Refection Image Spectroscopy) reveal the subducted Nazca plate with varying reflectivity. Below the coast the plate interface occurs at 25 km depth as the sharp lower boundary of a 2-5 km thick, highly reflective region, which we interpret as a subduction channel. Theplate interface can be traced down to depths of 50-60 km below the Central Valley. We observe strong reflectivity at the plate interface and in the continental mantle wedge further down-dip than the seismogenic coupling zone. The sections show a segmented forearc crust in theoverriding South American plate. Major features in the accretionary wedge, such as the Lanalhue fault zone, can be identified. At the eastern end of the profile a bright west-dipping reflector lies perpendicular to the plate interface and may be linked to the volcanic arc.

Web page: http://www.userpage.fu-berlin.de/ seis

SZ1P22

Worzewski, T., Jegen-Kulcsar, M. (IFM-GEOMAR, Kiel), Franke, A. (TU Bergakademie Freiberg)

Marine MT Experiment on Subduction Zones

The water content and its distribution play an important role in the subduction process. The amount of water carried into the subduction zone and its distribution are not well constrained by existing data and are subject of vigorous current research.

The electrical conductivity is a key parameter, which is most sensitive to the presence of fluids in the host rock and may change over orders of magnitude depending on water content, presence of partial melt and connectivity. Electromagnetic experiments, measuring the resistivity distribution, are therefore a method of choice for water and partial melt targets.

At IFM-GEOMAR and University of Kiel we are building up a marine EM group and are constructing marine MT Stations as well as a Controlled Source EM instrument, which will be used 2007 in Central America to conduct an onshore-offshore marine MT experiment together with the Free University of Berlin.

In this poster we present numerical modelling studies aimed to determine the resolution and sensitivity of the MT response to fluids in the crust and subducting slab.

SZ2

Subduction Zones: Volcanism & Magmatism

SZ201 – Thu., 12.4., 11:40 - 12:00 · HSK

Arévalo, C. (SERNAGEOMIN, Santiago), Grocott, J. (Midland Valley Exploration Ld., Glasgow), Cruden, A. (University of Toronto)

The construction of the Andean magmatic arc batholith, local and regional perspectives, northern Chile (25° to 29° S)

In the Coastal and western Main Cordillera of northern Chile (25° S to 29º S), margin-parallel suites of Triassic to Palaeocene plutonic complexes young systematically from west to east in a ca. 700 km-long segment of the Andean magmatic arc batholith.

To the local scale, the shape and emplacement mechanisms of compositionally layered Triassic to Cretaceous plutonic complexes have been evaluated in detail in the Coastal Cordillera of Vallenar near 28ºS (Welkner et al, 2006). Exceptional exposure of pluton roofs and floors, and steeply-dipping sides lead us to infer that: (1) creation of space for these intrusions required deformation of the host rocks and was achieved by an interaction between vertical pluton growth and reactivation of normal fault systems; (2) pluton shape was controlled by subsidence of the pluton floor during fault reactivation in which equal amounts of floor subsidence of the fault footwall and hangingwall led to symmetrical intrusions, and differential subsidence caused plutons to grow asymmetrically; and (3) floor depression was prevalent over roof uplift.

To higher scale, the eastward migration of the locus of magmatism, well knownin the Andes (Zentilli, 1974), is also documented here by ca. 200 K-Ar, Ar-Ar & U-Pb ages and a migration rate of 500m/Myr from Triassic to Cretaceous is recorded. Precise geochronology on layers of each individual plutonic complex revealed that the duration of this ”in situ” magma evacuation process was ”stable” for 3-5 Myr and then the emplacement locus ”jumped” to the east. Thislandward migration of the magmatic arc within a setting of retreating subduction boundary during the Mesozoic is a first order paradigm of the Andean geodynamics. We argue that emplacement of magmas in the upper crust must be tied to processes in the continental lithosphere and the asthenosphere wedge not to the to retreating subducting plate.

REFERENCES

Zentilli, M.,1974, Geological evolution and metallogenic relationships in the Andes of Northern Chile between 26° and 29°: Unpublished Ph.D. thesis, Kingston, Ontario, Queen’s University, 394 p.

Welkner, D.; Arévalo, C.; Godoy, E. 2006. Geología de la Carta Freirina-El Morado, Región de Atacama. Servicio Nacional de Geología y Minería, Carta Geológica de Chile, Serie Geología Básica, No. 100, 51 p.

SZ202 – Thu., 12.4., 12:00 - 12:20 · HSK

Breitkreuz, Ch., Löbel, C. (TU Bergakademie Freiberg), Wilke, H.-G. (Departamento de Ciencias Geológicas, Universidad Católica del Norte, Antofagasta, Chile), Renno, A. (Institut für Mineralogie, TU Bergakademie Freiberg)

Volcanological and petrological study of Pliocene ash deposits in the Coastal Cordillera between 22°and 24°S in northern Chile - Preliminary Results

Field work on Pliocene ash deposits have been carried out at 11 localities in the vicinity of Antofagasta, to the north of Salar de Navidad, and to the east of Tocopilla. 10 localities expose ash layers with maximum thickness of 1 meter intercalated into alluvial deposits, with almost horizontally (alluvial fan) or inclined bedding (talus). In the Cuenca del Tiburón (Mejillones Peninsula) an ash layer is intercalated into shallow marine Pliocene deposits.

Distinction between primary deposits (pyroclastic fallout and/or eolian) and local alluvial re-working was carried out by evaluation of the geometry of ash deposit in the field (observations of base and top, channels eroded into the top etc.) and of the amount of non-volcanic composite grains. Most of the ash deposits in the alluvial environment display a massive internal texture. One alluvial and, in particular, the marine locality show internal bedding and syndepositional deformation.

XRD measurements on 10 samples revealed semi quantitative composition including glass (41 to 85 %), plagioclase (2 to 26 %), biotite (< 5 %) and hornblende (< 7 %) as the assumed primary magmatic components. Only two samples contain pyroxene (< 2 %). Some samples contain quartz (< 7 %) which is attributed to non-volcanic compound grains entrained during local reworking. At some localities, the ash layers experienced considerable lithification caused mainly by authigenic growth of halite (up to 40%) and gypsum (< 6%) under hyperarid climatic conditions. Furthermore, authigenic overprint led to the formation of brownish cm-sized domains in two places.

Sieving of disintegrated samples yielded mean grain size between 40 and 125 μm and sorting of approx. 1.5. Glass shards show two types: i) white elongate finely fibrous grains and ii) transparent grains with roundish vesicles and thick bubble walls. Preliminary microprobe examination revealed glass with 74 to 80 % SiO2, as well as plagioclase, k-feldspar, biotite, hornblende and pyroxene.

4 K/Ar ages on biotite separated from ash deposits of the Coastal Cordillera (21°04' to 23°43'S) range between 3 and 6 Ma (González et al. 2003, J. South Amer. Earth Sci., 16: 321 - 342; and Naranjo 1987 therein). From the marine locality a Pliocene fauna is known. Ar/Ar dating of crystals and glass separated from our samples is planned for 2007.

Combining the presented methods we aim at a comprehensive volcanological and petrological characterization of the ash beds. The data will be used to find out whether the sampled ash beds were formed in the course of one or more eruptive events. A long-term objective of the project is the reconstruction of transport of the large ash volume (several km^3), which apparently originated from a major Pliocene dacitic eruption in the High Andes, against the prevailing surface wind direction.

SZ203 – Thu., 12.4., 12:20 - 12:40 · HSK

Pérez, W. (SFB 574, Escuela Centroamericana de Geología, Universidad de Costa Rica), Freundt, A., Kutterolf, S. (SFB 574, IFM-GEOMAR)

Reconstruction of the 2,000 year old basaltic Plinian event from Masaya Caldera Complex (Nicaragua): the Masaya Triple Layer and La Concepción Tephra

E-Mail: wperez@ifm-geomar.de

The Masaya Caldera Complex has been the site of several highly explosive basaltic eruptions over the last ∼6,000 years and one of the biggest events was an eruption ca. 2000 years ago which formed the widespread deposits of the Masaya Triple Layer (MTL) to the NW of the caldera and the newly recognized La Concepción Tephra (LCT) to the S.

These two deposits were previously treated separately since they exhibit a different internal architecture and distribution, even though both deposits resemble each other both consisting of well-sorted lapilli layers intercalated with tuffs. The LCT and MTL also have the same stratigraphic position between the San Antonio Tephra and the Masaya Tuff and their chemical composition is also identical and different from other Masaya Complex tephra, evidencing a very close genetic relationship between them.

A marker bed allowed us to construct a plausible correlation between the MTL and LCT, after analyzing carefully the most proximal exposures sequence of both units at the S and NW, as well as the thickness distribution and the maximum juvenile and pre-existent clast distribution. We were able to distinguish 10 main subunits at the deposit designated with numbers from I to X, alternating magmatic and phreatomagmatic episodes. They had bulk volumes between 0.02 and 0.22 km^3 for a whole LCT-MTL deposit volume of 0.86 km^3. Two cores drilled offshore Nicaragua during the Meteor cruise M54/2 were chemically correlated with these deposits. Considering these distal deposits new calculations yielded a total volume of 3.3 km^3, which implies 1.5 km^3 of erupted basaltic magma.

The magmatic eruptions ranged from Plinian to subplinian in character, with estimated eruptive column heights between 21 to 24 km which were affected by variable wind speeds from <2 m/s to 20 m/s which changed during the curse of the eruption. The mass discharge rates were also calculated between 106 to 108 kg/s, suggesting the eruptions lasted couple hours to a few days. In a general way it can be summarized that La Concepción Tephra and the Masaya Triple Layer deposits are the product of a spasmodic eruptive period which alternated Plinian to subplinian events with phreatomagmatic explosions.

SZ204 – Thu., 12.4., 12:40 - 13:00 · HSK

Schmincke, H.-U. (Kiel)

A prehistoric (c. 1 ka BP) large-volume (>1 km3 DRE) hydroclastic basaltic-andesitic eruption sourced in Nejapa maar (Managua, Nicaragua)

A prehistoric (c. 1 ka BP) large-volume (>1 km3 DRE) hydroclastic basaltic-andesitic eruption sourced in Nejapa maar (Managua, Nicaragua)

J. Rausch, H. -U. Schmincke Leibniz Institut für Meereswissenschaften IfM-GEOMAR and SFB 574 , Wischhofstr. 1, D-24148 Kiel, Germany. e-mail: hschmincke@ifm-geomar.de

Nejapa Maar (c. 120 m depth, 1.5 km diameter), the largest of 3 prominent maars along the Holocene Miraflores-Nejapa alignment in Nicaragua, is interpreted by us as the source of a major hydroclastic basaltic-andesitic eruption (Nejapa Formation NF) for which we present preliminary data. The NF is more than 1m thick as much as 5 km from source beyond which the deposits are eroded. We estimate the total magma volume erupted (DRE) of NF as more than 1 km3. Juvenile clasts, dominantly slightly vesicular and irregularly shaped grains, probably make up over 80 percent by volume of the NF. This, the paucity of fine-grained tuffs and the dominant plane parallel bedding all suggest fragmentation by interaction of a vesiculating magma with water, eruption in moderately high eruption columns and dominant deposition as fallout. Lateral surge transport is evident in silt-fine ash-sized tephra beds. Lithic blocks of basaltic lava up to 4 m in diameter are restricted to a proximal facies east of Nejapa maar. The NF is separated by a regional paleosol developed on well-dated basaltic Masaya Tuff (1.8 ka BP) that overlies dacitic Chiltepe pumice (1.9 ka BP) (Kutterolf et al. in revision). Widespread pottery found by us below the deposit west of Nejapa maar documents the existence of an indigenous population. This population is probably correlative with Cultura Usulután widespread in Central America and with an age between 2.7 ka BP and 1.7 ka BP (R Garcia pers. comm.). Charcoal below NF is presently being dated (AMS Leibniz Labor Kiel) with a suspected age between 1 and 1.5 ka BP, in any case significantly younger than MT. The powerful Nejapa eruption apparently terminated this culture in the area with no evidence for recolonization for several hundred years. Pottery above the NF is related to the indigenous Ometepe population dated previously between c. 1350 and 1550 AD (R Garcia pers. comm.). The Ometepe people disappeared with the Spanish invasion. Since the NF deposits extend through large areas of westernmost Managua, a recurrence of an eruption of this magnitude in this part of the Nejapa-Miraflores alignment would destroy densely populated suburbs of the capital of Nicaragua. The NF together with the MT thus significantly increases the recurrence rate of large potentially disastrous eruptions during the past c. 1.5 ka in central Nicaragua.

Kutterolf S, Freundt A, Pérez W, Wehrmann H, Schmincke HU (2007) Temporal succession and magnitudes of highly explosive eruptions in west-central Nicaragua. J Volcanol Geotherm Res (in revision)

SZ205 – Thu., 12.4., 16:30 - 16:50 · HSK

Navarro, P. (Lima, Instituto Geologico Minero y Metalurgico), Rivera, M., Monge, R. (Lima)

Anatomy of the synorogenic Cenozoic volcanic rocks of northern Peru

E-Mail: pnavarro@ingemmet.gob.pe

Cenozoic volcanic deposits present in Western Cordillera of northern Peru had been mapped like one unit called Calipuy Group. This unit overlies unconformably carbonated and clastic sequences from Cretaceous.

Volcanic rocks of Cenozoic constitute three major zones called Santiago de Chuco (7°30, 8°30S), Cajamarca (6°,7°30S) and Huancabamba (4°,6°S), all them emplaced between Eocene and upper Miocene. This paper shows geological cartography, geochemistry and regional structural setting results carried out in Santiago de Chuco zone, that has an surface of 6000 km2.

Eruptive activity was strenght, explosive and effusive, and it built thirteen stratovolcanoes, two collapse caldera and lava dome. Magmatic activity generated felsic, holocristalin intrusive rocks and andesitic, dacitic and rhyolitic subvolcanic bodies of 0.1 to 10 km diameter. All of them are cutting Cretaceous sequences and Eocene and Miocene volcanic rocks, they were emplaced along faults, fold axes and strata plains, with principally N 140°trend.

Ar40/Ar39 radiometric ages from lava, pyroclastic and subvolcanic rocks stablish four eruptive stages happened between 40 and 16 My. These stages belong to Eocene, early Oligocene, upper Oligocene-early Miocene and early Miocene. The elder volcanic rocks are located in west, whereas the youngest in east, suggesting a migration of magmatic arc.

Volcanic rocks show a mineralogycharacterized by plagioclase phenocrysts, pyroxenes (clino and ortopyroxene), olivine, amphibol, Fe-Ti oxides, biotite, quartz, K-spar and secondary or alteration minerals. Mineralogy is similar in almost volcanic centers.

Petrological evidences suggest magmas from eruptions had been subjected to fractionated crystallization, magmatic mixing and crustal contamination during its ascent and deposition. Fractionated crystallization explains progressive evolution of mineralogical composition from basaltic andesites to rhyolites. Magmatic mixing is suggested for the presence of unbalanced mineralogical phases like zonation plagioclases, xenocrysts and unstabled minerals.

Geochemistry of volcanic rocks show a similar variation from basaltic andesites to rhyolites, with much andesite, owing to calcoalcaline suite, K-medium to high. Trace elements, included REE, confirm magma origin from partial fusion of asthenospheric mantle wedge during Nazca plate subduction process.

Duringthe Eocene to Miocene time it happens the deformation and the uplift of Western Cordillera with important shortening and development of synorogenic continental basins to the east. The studied volcanism is located in similar Eocene and Miocene time in continuous way and migrated from west to east, so that a relation time-space exists between deformation, uplift and magmatism. Additionally this magmatic activity caused major ore-mine emplacement of Au-ephitermal and Cu(Au) porphyry systems.

Web page: http://www.ingemmet.gob.pe

SZ206 – Thu., 12.4., 16:50 - 17:10 · HSK

Pulgarin, B. (INGEOMINAS, OVS de Popayan, Colombia), Macias, J. L. (UNAM, Instituto de Geofisica, Mexico City)

Late Pleistocene Massive Deposits Associated to the Southern Flank Collapse of the Nevado del Huila Volcanic Complex (Colombia)

E-Mail: bpulgarin@ingeominas.gov.co

Nevado del Huila Volcanic Complex (5,364 masl) is located in the SW part of Colombia. During late Pleistocene the volcano's southern flank collapsed generating a debris avalanche that moved southwards for about 14 km up to the Paez river, forming a natural dam. The deposit morphology varies from proximal to distal areas in hummocks, lobes, and flat terraces. It has an average thickness of 150m, covers an area of 36 km^2 and therefore has a minimum volume of 5.4 km^3 (H / L = 0.17). The damming of the Paez river, formed a temporary lake that reached an estimated volume of less than 0.5 km^3 prior to breakout out. Failure of the dam produced a debris flow that flowed for at least 67 km reaching a maximum velocity of 26 m/s. The deposit formed a terrace up to 100 m thick, covering an area of 82 km^2 with a minimum volume of 4 km^3. Both deposits consists of andesite lavas and less than 3% basement rocks (granite, quartz–diorite, schist, quartzite, gneiss) most blocks display jigsaw–fit structures (macroscopically and microscopically), and the matrix contains the same type of clay minerals (montmorillonite, kaolinite) indicating their genetic relationship. In case of the occurrence of a similar type of event more than 400,000 inhabitants could be in extreme risk along the Paez basin.

SZ207 – Thu., 12.4., 17:10 - 17:30 · HSK

Wegner, W., Wörner, G. (Abt. Geochemie, Goettingen, Germany), Harmon, R.S. (Army Research Office, Research Triangle Park, USA), Simon, K. (Abt. Geochemie, Goettingen, Germany), Singer, B., Hora, J. (Depart of Geology and Geophysics, Madison, USA)

Geochemical fingerprints in igneous rocks from Chagres Igneous Complex, Central Panama and Western Panama: Evolution of a maturing arc system

The closure of the Central American Land Bridge is characterized by a continuous evolution of magmatism in this region from 90 Ma to present. Out of 415 rock samples 183 samples were analyzed for major and trace elements along the Cordilliera de Panama (Fig.1) to document this evolution and to put it into a tectonic framework. The region of the Chagres Igneous Complex (CHICO) was of special interest due to the unusually complete lithological inventory of a suboceanic island arc volcanic complex. The oceanic basement of the Caribbean Large Igneous Province (CLIP) was formed in Late Cretatous (90-70 Ma) by the Galapagos plume (Hoernle et al. 2002). These CLIP rocks show three distinct groups in trace element patterns (Fig. 2): a) CLIP oceanic basement displaying flat patterns b) CLIP terranes with ocean island basalt (OIB) signatures c) rare CLIP rocks with arc signature CHICO (45 to 66 Ma, Ar-Ar mineral ages) belongs to the series of Late Cretaceous to Early Tertiary mafic igneous complexes that characterize the Central America from northern Costa Rica to the Colombian Andes. Rocks are tholeiitic, mobile elements (Cs, Ba, Rb, K, Sr) are highly variable. Immobile trace elements such as Nb, Ta, middle and heavy REE show patterns suggesting an arc origin that formed from subduction below a CLIP oceanic plateau. These early arc rocks (Fig. 2d) comprise most of the basement of the Cordilliera de Panama and indicate that the mantle wedge at 66 Ma is different i.e. more depleted than the Galapagos mantle. Miocene (20-5 Ma) andesites (Fig. 2e), which are located in centers along the Cordilliera de Panama display a progressive enrichment from tholeiitic to medium-K arc magmatism. Fluid enrichment patterns with typical Ta and Nb depletions are characteristic for these rocks. However, Ta and Nb abundances increase with time. This implies a more enriched mantle wedge and argues against a continuous depletion by earlier melting events. Therefore fresh input of mantle material is necessary by corner flow and enhanced mobility of the mantle wedge. In accordance with previous findings, his type of arc magmatism stops at around 5 Ma. Adakite volcanism (younger than 2 Ma) represents the youngest magmatism in Panama. These adakites (see Rausch and Wörner, this meeting) are characterized by enrichment in compatible elements and depletion in the heavy rare earth elements (REE, Fig. 2f).

Refrences: Abratis M, Woerner G (2001) Ridge collision, slab-window formation, and the flux of Pacific asthenosphere into the Caribbean realm. Geology (Boulder). 29; 2, Pages 127-130. Hoernle K, van den Bogaard P, Werner R, Lissinna B, Hauff F, Alvarado G, Garbe Schoenberg D (2002) Missing history (16-71 Ma) of the Galapagos hotspot; implications for the tectonic and biological evolution of the Americas. Geology (Boulder). 30; 9, Pages 795-798.

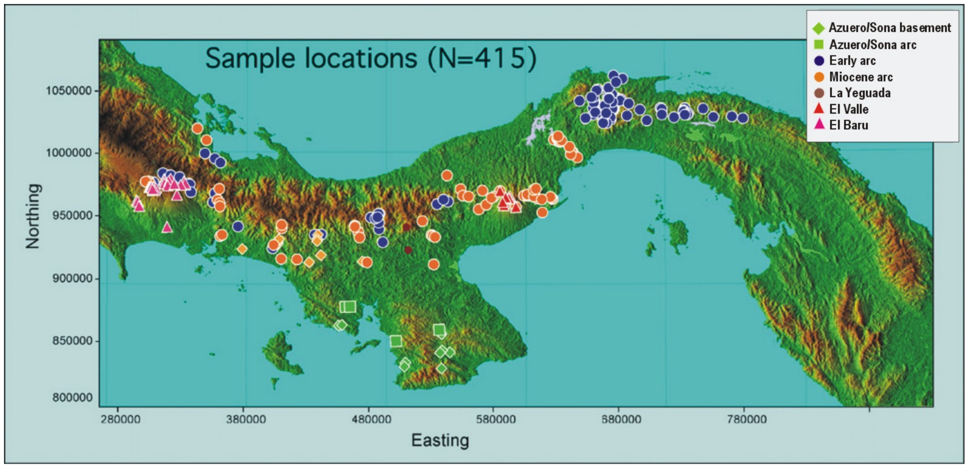

Figure 1: Fig. 1: Sample location map

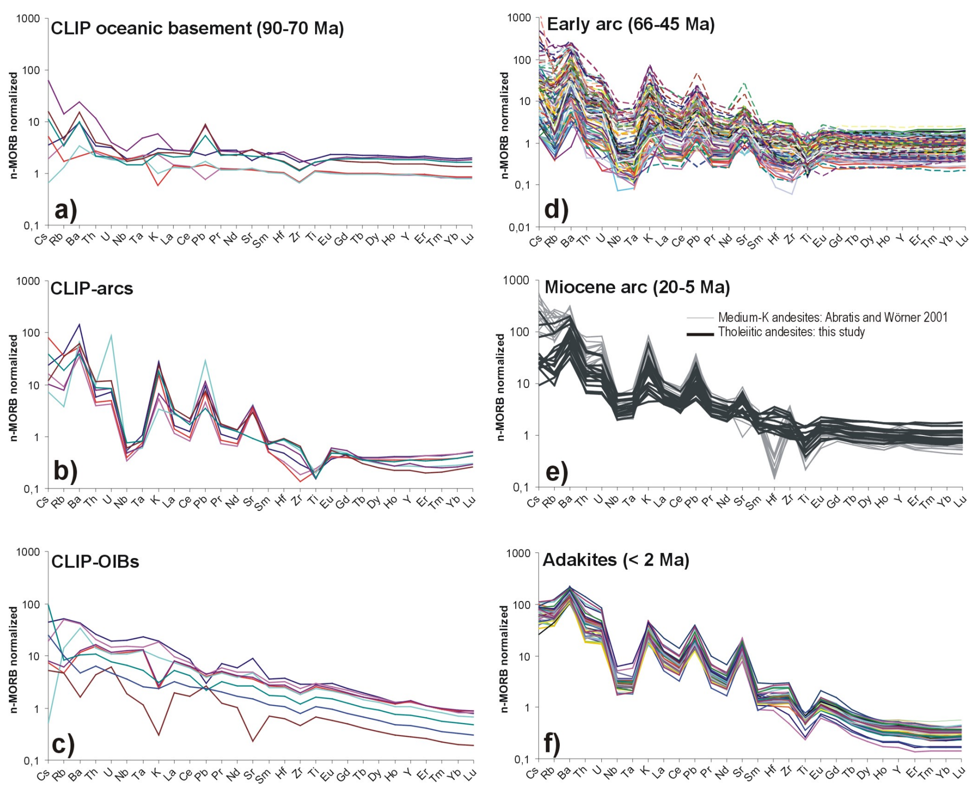

Figure 2: Fig. 2: Trace element patterns (normalized to n-MORB) through time for igneous rocks in Costa Rica and Panama.

SZ208 – Thu., 12.4., 17:30 - 17:50 · HSK

Gonzalez, G. *(....)*

SZ209 – Fri., 13.4., 10:10 - 10:30 · HSK

Schaaf, P. (México, D.F., Instituto de Geofísica, UNAM, México), Carrasco, G. (Centro de Geociencias, UNAM, Campus Juriquilla, Querétaro, México)

Pico de Orizaba (Citlaltépetl) Volcano, Eastern Trans-Mexican Volcanic Belt: what tells us oblique, sub-horizontal and delaminated subduction?

The Miocene to recent Trans-Mexican Volcanic Belt (TMVB) includes more than 8000 cinder cones and stratovolcanoes, distributed along a nearly 1000km long and 20-150 km wide W-E profile. Magma generation processes involve young and hot oceanic lithosphere in the western part of the arc (close to the trench), whereas at the eastern edge the slab is older and cooler, best interpreted as the result of oblique subduction of the Pacific Rivera and Cocos Plates in combination with different slab velocities and dip angles.Pico de Orizaba (or Citlaltépetl) is North America's highest volcano (5685 m.a.s.l.), located at the east-central TMVB where the subducted slab follows a sub-horizontal trajectory. The volcano can be divided into three main constructional stages. Its activity started during the mid-Pleistocene. The present cone was built on the remnants of the ancestral buildings by eruption of amphibole-two pyroxene dacitic lava flows, the most recent of which was erupted in the seventeenth century. The volcano is surrounded to the SW by monogenetic cindercones and maars, recently dated between 25 and 37 ka (luminescence dating on volcanic glass). All representative units were sampled for geochemical and isotopic purposes, including small quartzitic xenoliths found in the basaltic monogenetic suite. Volcanic products of the stratocone are quite heterogeneous and range from calc-alkaline basaltic andesites to dome rhyolites, also displayed by a wide range of SiO_2 and MgO (72.6-53.2 and 7.0-0.3 wt. %, respectively). In comparison to other TMVB stratovolcanoes (e.g., Colima, Nevado de Toluca), Pico de Orizaba shows also a similar and narrow 87Sr/86Sr range (0.7037-0.7048) but considerably more evolved Nd-Pb isotopic ratios (eNd: -1.8 to + 1.4; 206Pb/204Pb: 18.61-18.78). Elevated LILE concentrations and depleted HFSE witness the importance of slab-derived aqueous fluids and metasomatic reactions between the subducting lithosphere and overlying mantle wedge. On the other hand, Pico de Orizaba shows additionally elevated crustal contributions of a sourcewith depleted Sr and enriched Nd and Pb isotopic signatures, best explained by assimilation of the local Grenvillian basement. In contrast to Popocatépetl volcano with a high-level magma reservoir (7-8 km) and obvious interaction with a carbonate-dominated shallow basement (e.g., elevated 87Sr/86Sr ratios and CO_2 in gas plumes), this effect cannot be observed at Pico de Orizaba, although a Cretaceous limestone basement is also present. This, together with different lithologies of crustal xenoliths in stratocone and cindercone magmas gives evidence for a deeper situated magma chamber. In contrast to the western TMVB, where young and hot subducted lithosphere favours slab melting processes, the older and cooler slab underneath Pico de Orizaba displays more pronounced dehydratation and fluid fluxing effects. The complex and variable tectonic configuration of the Mexican continental margin affects the thermal state of the subduction zone, responsible for distinct geochemical and isotopic signatures of the along-arc magmas .

SZ210 – Fri., 13.4., 10:30 - 10:50 · HSK

Freundt, A. (IFM-GEOMAR, SFB 574, Kiel), Kutterolf, S. (SFB 574, Kiel), Hansteen, T.H. (IFM-GEOMAR, Kiel)

Are magma production rates along the Central American Volcanic Arc controlled by slab hydration?

E-Mail: afreundt@ifm-geomar.de

Convergence of lithospheric plates at subduction zones forces the downgoing plate into the Earth's mantle and creates an output to the surface, consisting of intrusive and extrusive rocks forming the volcanic arc. Water stored in the slab and released during dehydration at depth, hydrates the mantle wedge and thus triggers partial melting to form the roots of the volcanic arc. However, quantitative links between input and output at subduction zones are poorly understood because mass budgets are difficult to determine. Here we determine magma production rates for a 1100 km long section of the Central American Volcanic Arc (CAVA) using two methods: 1) Magma masses produced by the CAVA volcanoes are derived from the volumes of the volcanic edifices, the volumes of widespread tephras mapped on land and offshore, and a minimum mass of parental basaltic magma trapped in the crust estimated from the degree of differentiation of eruption products. Long-term average magma fluxes of CAVA volcanoes, based on volcano ages, range from 0.6 to 280 kg/s. 2) Sulfur-dioxide fluxes measured at degassing open vents are converted to corresponding magma fluxes assuming 1000 ppm original sulfur concentration of the degassing melt. These magma fluxes of 87 to 8,900 kg/s are considerably higher than those from method 1. The volcanic arc is splitted into 60 to 170 km long tectonic segments which differ in magmatic compositions. The cumulative magma flux from method 1 of volcanoes on each segment divided by segment length yields an average magma production rate per unit arc length for each segment. This magma production rate varies systematically along the CAVA, increasing from Costa Rica to El Salvador to then decrease toward Guatemala. The analogous flux from method 2 is 2 to 23 times higher and yields a somewhat different pattern of along-arc variation. We attribute differences between results from methods 1 and 2 to (a) different time scales of observation, i.e. 10^5 years for method 1 versus 10^1 years for method 2, that capture variable aspects of possibly temporally variable magma fluxes, and (b) to the inability of method 1 to appropriately account for intrusive magma fluxes. The along-arc variation in magma production rates does not correlate with geochemical proxies of degree of partial melting or input of fluids or partial melts derived from subducted sediment. Magma production rates do, however, correlate with the intensity of bend-faulting of the subducting plate which is interpreted as a proxy of the degree of pre-subduction hydration of the crust and upper-mantle. Hydration before subduction may thus exert a more direct control on magma production than the details of dehydration at depth.

SZ211 – Fri., 13.4., 10:50 - 11:10 · HSK

Heydolph, K. (Kiel, SFB 574), Hoernle, K. (Kiel, IFM-GEOMAR/ SFB 574), Hauff, F., Bogaard, P.v.d. (Kiel, IFM-GEOMAR), Sadofsky, S. (Kiel, SFB 574)

Potential Source Components for NW Central American Arc Lavas

Our expanded geochemical data set from mafic volcanic centres along and behind the volcanic front in Guatemala, El Salvador, Honduras and Nicaragua put further constraints on the origin of north-western (NW) Central American Volcanic Arc (CAVA) lavas. The subduction input (consisting of subducting sediments, seawater altered and unaltered igneous crust and serpentinites), a variable slab dip, crustal composition and crustal thickness influence the composition of the erupted NW CAVA volcanic rocks to distinct degrees. New Sr-Nd-Pb and Hf isotope data from NW CAVA rock samples combined with trace element data show systematic variations for the NW Central American Arc lavas. A decrease in 206Pb/ 204Pb and increase in 143Nd/ 144Nd isotopic composition with increasing distance along the volcanic front towards the south-east combined with increasing Ba/la and U/Th trace element ratios generally suggest an increasing role for a hydrous fluid component and a decreasing influence of a sediment melt or crustal component in the generation of CAVA volcanic front (VF) and behind the VF lavas. Samples from behind the VF in Honduras have the most mid-ocean-ridge basalt (MORB) like compositions and are believed to represent the composition of the mantle wedge. Samples from the Nicaraguan VF have similar Nd but higher Sr isotope compositions most likely reflecting enrichment with slab derived fluids containing subducted sediment or seawater Sr. A positive correlation in 206Pb/ 204Pb vs. 207/Pb 204Pb isotope ratios for VF and behind the VF volcanic rock samples from El Salvador and Guatemala tends towards a granitic or metamorphic component in the generation of CAVA magmas. In addition combined eNd vs eHf isotope data for VF and behind the VF samples from Nicaragua to Guatemala tend from MORB like compositions towards continental crust like compositions suggesting the increasing significance of an underlying crustal component in the generation of the NW CAVA magmas.

SZ212 – Fri., 13.4., 11:10 - 11:30 · HSK

Kutterolf, S. (Kiel, SFB 574), Freundt, A. (Kiel, IFM-GEOMAR / SFB 574), Perez, W. (Kiel, SFB 574), Schmincke, H.-U. (Kiel, IFM-GEOMAR / SFB 574)

Cyclicity and compositions of Plinian volcanism along the Central American Volcanic Arc (CAVA) – the long-term marine tephra record

Ash plumes of numerous plinian, phreatoplinian and ignimbrite-forming eruptions from calderas and stratocones along the Central American Volcanic Arc (CAVA) were dispersed westward across the Pacific. The mostly non-erosive submarine environment preserves an almost complete record of large eruptions in which the intercalation of deposits from different volcanic sources facilitates the relative and absolute timing of their activities. Mapping the marine ash layers is thus essential to constrain the magnitudes of single eruptions as well as to assess lateral and temporal variations in magma production along the volcanic arc. Gravity cores were collected during SONNE Cruise SO173/3 and METEOR Cruises M54/2 and M66/3 offshore Central America on the lower continental slope and on the oceanic plate, at distances of 150-350 km from the Central American Volcanic Arc (CAVA). 56 cores reaching up to 11 m below seafloor contain a total of 207 ash-bearing horizons. Ash layer thickness ranges from 0.5 to 23 cm with typical grain sizes from medium silt to coarse sand. Correlations between the cores and well dated on-land tephras are constrained by petrographical and stratigraphical criteria, major element geochemistry of glasses and minerals, and trace element data from LA-ICP-MS analyses. 4800 glass shard analyses facilitate 118 correlations between cores and to 27 eruptions from CAVA volcanoes. Correlated tephras of known age allow to determine pelagic sedimentation rates which, in turn, are used to constrain ages of undated ash layers. The resulting stratigraphic framework of Plinian deposits along the CAVA allows to make the following observations: 1) Periods of frequent highly-explosive activity alternate with periods of low activity at 110-150 ka and >320 ka (to possibly 400 ka). It seems that CAVA volcanism was not steady but evolved in cycles. 2) For the past 400 ka, Plinian-eruption frequency decreased toward Costa Rica. 3) Basaltic Plinian eruptions form a major component of Plinian volcanism in Central Nicaragua to Southern El Salvador, accounting for 50% in Central Nicaragua. 4) Coarser-grained ash layers suggest more intense, mainly silicic Plinian eruptions at northern El Salvador and Guatemala; this is discussed in the context of increasing crustal thickness.

SZ2P01

Burkert, C. (Kiel, SFB 574, University Kiel), Freundt, A. (Kiel, IFM-Geomar, SFB 574, University Kiel), Kutterolf, S. (Kiel, SFB 574, University Kiel), Strauch, W. (Managua, INETER)

Geological evolution of the Xiloà Maar in Nicaragua

E-Mail: Cosima.Burkert@gmx.net

The Chiltepe peninsula at the western shore of Lake Managua is a volcanic complex that is dominated by the central Apoyeque volcano, a stratocone formed largely as a pile of dacitic lava domes and flows with a huge crater that formed by the plinian eruption of the Chiltepe Tephra 1.5-2 ka ago. The phreato-subplinian eruption of the Xiloà Tephra 6100 years BP excavated the Xiloà Maar crater in the southern lowland of Chiltepe peninsula at the foot of Apoyeque volcano. The crater walls expose a succession of older volcanic deposits, and the area has been covered by tephras from two younger subplinian and plinian eruptions. Our geological mapping has identified the stratigraphic sequence of eruption products of the Xiloà area which marks the crossing point between the NW-SE trending volcanic arc and the N-S trending Nejapa-Miraflores line of volcanoes which offsets the arc by about 20 km of left-lateral displacement in response to slightly oblique subduction. The basement exposed in the northern walls of Xiloà Maar consists of a >10 m thick package of andesitic lava flows which probabaly represent an stage in the evolution of Apoyeque volcano. This package is unconformably overlain to the east by the proximal facies of >15 m thick dacitic ignimbrite containing numerous breccias of dacitic lava blocks. The ignimbrite forms the basement of the low plateau of the southern Chiltepe peninsula and, judging from lithic fragments in younger volcanics, continues to the west of Managua. It is compositionally similar to the 12400 years old plinian dacitic Upper Apoyeque Tephra. The source vent(s) for this tephra and ignimbrite are unknown but may have lain inside Lake Managua. The El Tamarindo dacitic block-and-ash-flow deposit, derived from collapse of one of the Apoyeque lava domes, overlies the andesitic lava cliff to the west and hence postdates the Xiloà eruption. The exposed basement at the southern rim of Xiloà Maar begins with a basaltic lava flow that is overlain by the San Isidro Tephra. This andesitic evolves upward from a phreatomagmatic breccia to increasingly strombolian scoria fallout. The San Isidro Tephra marks the first maar-forming event at Xiloà, which thus is a multiple maar. Erosional unconformities and a paleosol separate the San Isidro from the overlying dacitic Xiloà Tephra, which consists mainly of pyroclastic surge deposits but also includes ash-rich fallout and an ignimbrite at the top. Other unconformities underlie the stratigraphically following dacitic Los Cedros Tephra, which forms a southward fallout fan reaching into western Managua. Its source vent is unknown, but its thickest exposures consisting of pumice lapilli fallout capped by fine ash rich in accretionary lapilli occur on the eastern shore of Laguna Xiloà; possibly this tephra was also erupted from Xiloà crater. The youngest volcanic deposits in the Xiloà area is the Chiltepe Tephra that was erupted from Apoyeque volcano. A sediment delta at the northern shore of Laguna Xiloà hosts an active field of sulfurous fumaroles, suggesting that the Chiltepe/Xiloà magma system is still active.

SZ2P02

Hartmann, A. (CAU Kiel - SFB 574), Freundt, A. (CAU Kiel - SFB 574, IFM-GEOMAR, Kiel), Kutterolf, S. (CAU Kiel - SFB 574), Strauch, W. (INETER, Managua, Nicaragua)

Geological evolution of the Tiscapa Maar in Managua, Nicaragua

E-Mail: hartmannanja@yahoo.com

The Tiscapa maar within the megacity of Managua formed by a surtseyan eruption. The Tiscapa tephra is a succession of basaltic, hydroclastic surge and fallout deposits covering an area of approximately 1.2 km2 with an estimated erupted magma mass of 4*109 kg. Its high concentrations of LILE and LREE and similar modal composition indicate a genetic relation with the low-Ti magmatic suite of the N-S striking Nejapa-Miraflores volcanic alignment 5 km to the W of Tiscapa. Vertical zonation of the Tiscapa tephra to more evolved composition reflects fractionation of the olivine, clinopyroxene, plagioclase and (titano-) magnetite phenocryst assemblage. The crater walls excavated by the hydroclastic eruption form the only exposure in Managua where basement rocks can be studied in stratigraphic sequence.

The lowermost formation 1 of the Tiscapa basement includes three thick layers of basaltic-andesitic ignimbrite of which the third layer contains accretionary lapilli and formed by a phreatomagmatically affected eruption. These are overlain by a basaltic-andesitic phreatomagmatic succession of ash-rich fall, flow and surge layers. The chemical characteristics of formation 1, and its age of < 25 ka constrained by the overlying distal Upper Apoyo Tephra (formation 2), suggest an origin at the Las Nubes Caldera in the Masaya area 15 to 20 km to the SE of Tiscapa. The compositional zonation of formation 1 results from evacuation of a zoned reservoir by fractional crystallization of clinopyroxene, plagioclase, orthopyroxene, olivine and titanomagnetite at mid-crustal levels as constrained by mineral geothermobarometry.

The subsequent formation 2 contains basaltic-andesitic scoria as well as dacitic or rhyodacitic pumice fallout deposits that are separated by paleosols and can be petrographically and geochemically correlated with widespread plinian tephras outside Tiscapa: (1) the about 30 ka Fontana Tephra that erupted near the Masaya Caldera, (2) the 25 ka Upper Apoyo Tephra from the Apoyo Caldera, and (3) the Lower and Upper Apoyeque (12.4 ka) tephras from the Chiltepe peninsula. The age range of formation 2 is thus about 30-12 ka.

Fluvial deposits of a SSW-NNE running paleo-river system build formation 3 of the stratigraphic sequence at Tiscapa. The fluvial sediments are mainly composed of scoria particles which have chemical compositions corresponding with the Fontana Tephra and with the < 6 ka old, basaltic San Antonio Tephra. Pumice lapilli which chemically correspond with the Apoyo and Apoyeque tephras as well as the 6.1 ka Xiloà Tephra represent another component that is mixed with the scoria particles but also forms reworked layers. The age constraints provided by these correlations confirm that the paleo-river system in the Managua lowland was time-equivalent to a regional erosional unconformity of > 10 m amplitude in the highlands S of Managua. Intercalated with the sediments of formation 3 occur primary pyroclastic deposits that change upward from phreatomagmatic to magmatic and are chemically, mineralogically and petrographically similar to the formation 1-deposits. A thick weathering horizon and paleosol separates formation 3 from the overlying formation 4, the hydroclastic deposits of the Tiscapa maar eruption, which thus formed much less than 6 ka ago. All deposits at Tiscapa are displaced at the left-lateral Tiscapa fault zone which crosses SW-NE through the maar, was active during the 1972 earthquake, and possibly acted as ascent pathway for the Tiscapa magma.

SZ2P03

Hradecký, P., Šebesta, J. (Czech Geological Survey, Prague), van Wyk de Vries, B. (University Clermont Ferrand), Havlíček, P., Mlčoch, B., Staník, E., Tomas, R. (Czech Geological Survey, Prague), Strauch, W. (INETER Managua)

Geological and geomorphological map of the Nicaraguan Volcanic chain

E-Mail: hradecky@cgu.cz

The volcanic chain of Nicaragua is a part of the Central American Volcanic Front, and includes 18 volcanic centers, of which 8 are considered active. The young volcanoes are clustered in several morphologically well defined complexes, in some cases, separated one from another by NE trending, sinistral strike-slip faults (van Wyk de Vries (1993), Carr and Stoiber (1977).

The individual complexes, as listed below, were studied during 1997-2001 within a long term Cooperation Program between Czech Geological Survey and Nicaraguan Geosciences Institute (INETER) under the guaranty of Ministry of Environment of Czech Republic.

a) Cosigüina shield volcano

b) San Cristóbal - Casita complex

c) Telica complex

d) El Hoyo - Cerro Negro complex

e) Momotombo -Malpaisillo - La Paz Centro complex

f) Apoyeque silicic shield volcano

g) Miraflores - Nejapa volcano-tectonic zone

h) Masaya volcanic complex

i) Apoyo - Mombacho - Zapatera volcanic complexes

j) Nandaime - Granada volcano-tectonic Aligneament

k) Ometepe island volcanoes, Concepción and Maderas

The results of the studies - several reports with numerous specific maps on 1:50 000 scale and GIS coverages are available at INETER Managua and CGS Prague.

A revision of this work and was carried out in 2006 with the aim to produce a comprehensive map on 1:200 000 scale to illustrate the main geological and geomorphological complexes and features of the Nicaraguan Volcanic Chain. Previously and newly gained radiometric data are included. On the presented geological map, the volcanic sequences are characterized by similar processes of formation, composition and/or age.

The so-called basal ignimbrites, are defined as Las Sierras sensu stricto, the Nandaime, Tipitapa and Las Banderas facies.

The profile of the pyroclastic deposits in the Cosigüina shield volcano yielded new data confirming the ages of several eruptions which preceded the volcanic explosion of 1835.

The San Cristóbal-Casita complex is characterized by two volcanic structures, of which the San Cristóbal is the highest active volcano in the country. The Casita stratovolcano of Pleistocene age, is well known for the desastrous lahar triggered by heavy rains during Hurricane Mitch, in 1998. The pyroclastic sequences of both volcanoes are basaltic and andesitic in composition (rarely also dacitic in Casita).

The Telica complex is an active volcano, surrounded by satellite cones. The system produced voluminous pyroclastic deposits of basaltic composition. The caldera deposits of the El Hoyo volcanic complex record a complicated history of volcanic events. The El Hoyo shield volcano is surrounded by extinct cones and scoria volcanoes (Las Pilas). Among these, the Cerro Negro is the youngest (1850) and one of the most active volcanic center of Nicaragua endangering León city, second largest town of the country.

The Pleistocene Malpaisillo and La Paz pumice ignimbrites cover vast areas in the W and N of a complex of stratovolcanoes, among which the active cone of Momotombo volcano is the most conspicuous structure. Small, extinct and altered volcanic cones surround the massif. The Monte Galán caldera is filled with white calcareous sediments, which contain gastropod shells.

Recent geological investigation led to an up-to-date model for the evolution of the Apoyeque silicic strato-shield (Hradecký et al., this volume).

The City of Managua, Capital of Nicaragua, has been built on pyroclastic sequences from several volcanic centres, including those of the Miraflores-Nejapa lineament, Apoyeque, Masaya, Tiscapa, and Apoyo.

The Masaya volcanic complex can be considered a system of calderas formed during a regressive regime. In the map was inserted a correlation chart, related to Managua area and Masaya and Apoyo volcanoes, which includes various pyroclastic horizons from this area.

Towards the SE of the Masaya, the Apoyo-Mombacho-Zapatera volcanic complexes were defined. The Apoyo group includes pumiceous horizons produced during multiple Plinian-type and phreatomagmatic eruptions. The effusive rocks of the Mombacho volcano were affected by several gravitational collapses. Towards SE, the mostly explosive complex extends up to Lake Nicaragua, including a part of the Zapatera volcanic field. The neighbouring Granada-Nandaime volcano-tectonic alignment was a source of basic magma, which produced cinder cones and maars.

The volcanic island of Ometepe was studied by van Wyk de Vries (1993). Minor monogenetic volcanic centers of basic composition border the massifs of the active Concepción volcano and Maderas, an extinct volcano.

SZ2P04

Hradecký, P., Hrubeš, M. (Czech Geological Survey, Prague), Ševčik, J. (GEKON Ltd., Prague), Strauch, W. (INETER Managua)

The Apoyeque silicic strato-shield volcano, Nicaragua

E-Mail: hradecky@cgu.cz

Apoyeque volcano dominates the Chiltepe peninsula in Lake Managua and is situated only 8 km N of Managua, the Capital of Nicaragua. The study of Bice (1985) brought first comprehensive information on the volcano. Hradecký and Taleno (1988) and Hrubeš, Hradecký et al. (2001) contributed to more detailed volcanologic and stratigraphic knowledge.

Several horizons of Plinian pumice, ash and ignimbrite were documented. The volcanic center developed upon two fault systems: a normal NW-SE fault and N-S dextral strike-slip of Nejapa-Miraflores volcano-tectonic zone. The oldest stratovolcanic edifice (Plio-Pleistocene) is overlain by several, mostly dacitic pyroclastic units which can be traced on the slopes of volcano and further up to Managua urban zones. Two pumice fall horizons were dated by Bice (1985) at ages of 12, 8 and 6 ka, respectively. Moderately welded ignimbrite and block-and-ash flows can be traced at the foots of the volcano. Recent data of the Santa Catalina pyroclastic flow yielded 6193-7520 yrs. (Hradecký, Hrubeš et al., 2001).

The oldest volcanic unit, destroyed later by explosive events, is designated as Pre-Apoyeque and was formed by an alternation of andesitic, dacitic lavas and tuffs.

The younger Apoyeque sequence is a product of several phreatomagmatic and subplinian eruptions which deposited widespread rhyolitic and dacitic pumice, by both falls and flows, some small glassy dacite lava and finally, block-and-ash flows.

The overlaying Xolotlán sequence represents pyroclastic flows and surges of a SE directed blast, some pumice and co-ignimbrite ashes covered the famous Acahualinca human footprints (6 ka). The associated Jiloá crater, most likely, is a tectonically formed depression. No significant maar deposits were observed around the structure. The so-called Jiloá pumice (Bice, 1985) can thus be interpreted as a distal fall of the Xolotlán unit. A gravelly surge unit of this eruption can be traced towards the Jiloá depression which is believed to be formed subsequently as a tectonic collapse.

Individual volcanic sequences show some variability in their chemical composition. All analyzed samples are of Ca-alkaline suite. Generally, the compositions, range from dacite to andesite within all determined sequences. If the Cas, Wright (1987) model of magma bimodality is considered, then the basaltic-tholeiitic cinder and scoria cones in the nearby Nejapa-Miraflores lineament could fit this concept.

The explosive nature of its former activity, the frequent seismic unrest (swarms of shallow seismic events with magnitudes up to 5.1 Richter beneath the volcano), as well as the existence of fumarole fields indicate that the possibility of reawakening of strong volcanic activity cannot be excluded in the future. This could have a fatal impact to the capital.

SZ2P05

Lenhardt, N., Trauth, N., Hornung, J., Hinderer, M. (Institut für Angewandte Geowissenschaften, TU Darmstadt, Darmstadt), Torres Alvarado, I.S. (Centro de Investigación en Energía, UNAM, Temixco, Mexico), Böhnel, H. (Centro de Geociencias, UNAM, Queretaro, Mexico)

Depositional processes of Miocene volcaniclastic series at the southern edge of the Transmexican Volcanic Belt

E-Mail: lenhardt@geo.tu-darmstadt.de

In Miocene times, a major volcano-tectonic change took place in West and Central Mexico due to a reorganization of the tectonic plates in the western Pacific region. Since the Mid-Miocene, the Transmexican Volcanic Belt (TMVB) began to form. Until present, few data exist about its initial phase because the older volcanic products of the TMVB are widely covered by young volcanic rocks. We have investigated outcrops at the southern edge of the TMVB where lower to mid-Miocene volcaniclastic deposits emerge underneath Quaternary volcanics (the so called Tepoztlán Formation). Based on sedimentology, petrography, palaeomagnetics, and geochemistry we aim to establish a stratigraphic framework and a palaeoenvironmental interpretation of the Tepoztlán Formation and hence contribute to the controversially debated question about the origin of the TMVB. The Tepoztlán Formation consists of a succession of pyroclastic rocks (ash-flow, surge and fall deposits), lahars (debris-flow and hyperconcentrated-flow deposits), fluvial and lacustrine sediments and occasional andesitic to dacitic lava flows. The clastic material is of purely volcanic origin and all depositional processes are closely linked. The whole succession attains a thickness of up to 800 meters. We documented, measured and sampled six sections and 15 representative 2D-panels. The sedimentological analysis is based on the classification of lithofacies types, depositional units, and architectural elements, as well as measurements of natural gamma ray emission, magnetic susceptibility and palaeomagnetic remanence. Vertical and lateral distribution of depositional units together with stratigraphical data (Ar/Ar of pyroclastic units, palaeomagnetics) will be used to reconstruct the evolution of the depositional environment with time, to identify volcanic centres, and to find out cyclicities of volcanic and fluvial processes and process-coupling, e.g. increased debris flow activity after paroxysmal eruptions and the establishment of a braided river system in times of reduced volcanic activity.

Web page: http://www.iag.tu-darmstadt.de/members/lenhardt/lenhardt.tud

SZ2P06

Rapprich, V., Hradecký, P., Erban, V. (Prague, CGS), Hernández, W., Pullinger, C. (San Salvador, SNET)

Volcanic history of the Conchagua peninsula (eastern El Salvador)

E-Mail: rapprich@cgu.cz

The Gulf of Fonseca, traditionally used as a natural harbour between today´s El Salvador and Nicaragua, is located on the crossing between Comayagua and Central grabens. It separates Nicaraguan and Salvadoran segments of a single volcanic chain, which is related to the Central American Trench.

The Conchagua Peninsula, limiting the Fonseca Gulf on the Southwest, is named after the dominant peak of the Conchagua Volcano (1231 m). However, the history of the entire peninsula is not related solely to the Conchagua volcano, but also several other, more ancient, volcanic episodes.

The basement of the Conchagua Peninsula consists of welded rhyolitic ignimbrites, presumably corresponding to the Chalatenango Formation. These ignimbrites are cropping out along the northeastern coastline of the peninsula, forming cliffs with pseudo-carst caves. The same ignimbrites build also the basement of the Zacatillo Island, separated from the mainland by north-south trending tectonic depression (probably related to the Comayagua graben).

Later evolution of the studied area was documented in the western part of the peninsula, where occurs a sequence of andesitic lavas and ´block and ash´flows of the so-called Pozo formation. Its name comes from spanish word for well (pozo), as it has been documented mainly from dug wells and less so from scarce natural outcrops. The sequence is strongly altered and weathered.

Deposits of the La Unión caldera cover the Pozo sequence. Succession of fall-out and pyroclastic-flow deposits shows two obvious eruptive events, the third event is hardly recognizable. Deposits of mixed pumice (dominating) and scoria fragments with abundant banded pumice fragments document the process of interaction between two distinct magma types. The eruptionwas probably triggered by a basaltic melt injection into a dacitic magma chamber. The basaltic member is represented by pure scoria fall-out layer close to the base of the sequence. Non-welded and weak pyroclastic material of the La Unión caldera was easy to redeposit subsequently. It forms fine-grained lahars and stream sediments in distal parts of the volcanic edifice. The age of La Unión caldera was estimated by palaeo-botanic investigations in the maar of El Naranjo, coeval with the La Unión caldera, showing uppermost Pliocene to lower Pleistocene age.

Two effusive events that produced plateau lavas of basalt to basaltic-andesite composition buried all previous deposits. The Inferior lavas are of slightly more evolved character than the Superior ones. The surface of the former is marked by a thick laterite layer, whereas the weathering of the upper unit is much less obvious.

The present Conchagua volcano is formed by two edifices - Conchagua and Ocotal. Both cones consist of numerous strata of Strombolian scoria with uncommon intercalations of olivine basalt lavas. Neither deposits nor any other signs of Holocene activity of this volcano were documented.

The youngest volcanic material observed in the area are distal tuffs of Tierra Blanca Jóven, originating from the eruption of the Ilopango caldera (140 km to the west of Conchagua).

The study was carried out in cooperation of the Czech Geological Survey and Servicio Nacional de Estudios Territoriales in the year 2003. The Czech Ministry of Foreign Affairs, within the framework of the Czech Development assistance projects, financially supported the field campaign on the Conchagua peninsula. Subsequent studies were covered by the project 205-06-1811 granted by the Czech Science Foundation.

SZ2P07

Rapprich, V. (Prague, CGS), Holub, F.V. (Prague, Charles University), Erban, V. (Prague, CGS)

Concentric olivine-plagioclase glomerocrystin basaltic lava from the San Diego Volcano (Western El Salvador)

E-Mail: rapprich@cgu.cz

In the Central America, the volcanic activity is concentrated into two tectonic settings. Apart from the most abundant volcanoes of the supra-subduction volcanic front, numerous volcanic edifices are associated with N-S oriented extensional structures behind the arc. One of such structures is the Ipala Graben, most of which belongs to Guatemala. Only a few volcanic clusters are situated also in the western El Salvador, the most prominent being the San Diego volcano within the Metapán volcanic field. Its latest activity of the Strombolian type dates before the Tierra Blanca Jóven tuff. Lava flows are even older, but probably still of Holocene age.

Vesiculated lavas on the NE flanks of the volcano contain abundant olivine-plagioclase glomerocrysts set in a fine-grained matrix. These aggregates up to 12 mm in diameter display roughly concentric structure with macroscopically green cores dominated by olivine and white rims built of predominant plagioclase. Due to this arrangement the glomerocryst sections have shapes of flowers.

There are small (0.1 mm) crystals of chromite in the very core of described structures. Chromite is surrounded by often radial olivine Fo80-81.5. Outer zone of the glomerocrysts consists of roughly radially arranged crystals of plagioclase. These are oscillatory zoned in the distal sector with general decrease in anorthite component from An85 to An72 towards the rim.

Composition of minerals in the host olivine basalt differs from the glomerocrysts significantly. Spinel-group minerals are represented by dendritic Ti-magnetite compositionally distinct from Cr-rich oxides in the glomerocrysts. Olivine composition ranges from Fo77 in cores to Fo70 in rims.

Complex compositional changes were documented on large plagioclase phenocrysts, not associated with glomerocrysts. These show symmetric growth and significant oscillatory zoning. Some phenocrysts have anorthitic cores (aprox. An90) whereas central parts of others correspond to labradorite-bytownite (aprox. An70). Composition of the growth zones vary between An65 and An87, being predominantly An70-80. Crystal rims are much more sodic, ranging from An37 to An56. Typical composition of plagioclase in the matrix is about An50.

Clinopyroxene phenocrysts are scarce and range in composition from Wo42 En44.5 Fs12.5 in the core to Wo41.5 En32 Fs23.5 in the rim. Pyroxenes of the matrix have two contrasting compositions: one is augite (Wo44 En42.5 Fs12) and the second corresponds to subcalcic augite with a much less magnesian composition (Wo22.5 En34.5 Fs38.5).

Origin of the glomerocrysts is interpreted as a polyphase process. The first stage could

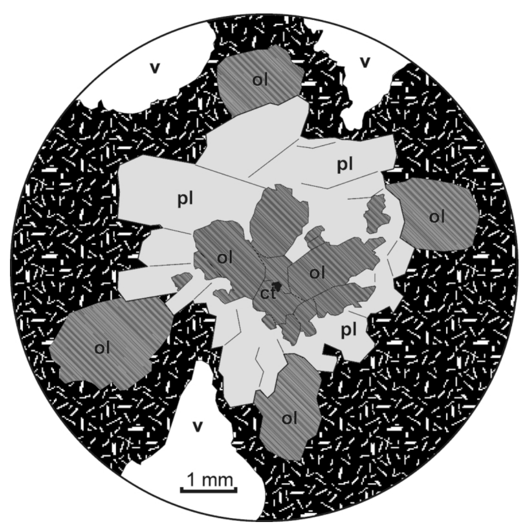

Figure 1: Idealised scheme of the concentric olivine-plagioclase glomerocryst from basaltic lava of the San Diego Volcano. ct = chromite; ol = olivine; pl = plagioclase; v = vesicle

have been crystallization and perhaps also accumulation of magnesian olivine from a hypothetic, rather primitive basaltic magma within a relatively deep-seated magma chamber. Second stage crystallization could have been triggered by distinct magma batch invading the crystallizing chamber. The olivine crystals captured by this more evolved magma from the yet unconsolidated cumulates could have served as sites for rapid, heterogeneous nucleation of plagioclase. The abrupt compositional changes recorded by the plagioclase rims of the glomerocrysts can be explained by changes in physicochemical conditions associated with magma ascent and/or mixing of distinct magma batches.

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SZ2P08

Rausch, S., Wörner, G. (GZG, Universität Göttingen)

Evolution of adakitic magmas at Volcan Baru (Panama)

Adakitic magmatism in SE Costa Rica and western Panama has been related to melting the subducted oceanic Cocos Plate. Because of its relatively large age (> 10 Ma), thermal, geochemical and isotopic constraints have argued for melting at the edges of slab windows (Johnston and Thorkelson, 1997, Abratis and Wörner, 2001). The nature and composition of the basaltic rocks of the subducted crust are quite variable and comprise Cocos plate MORB, OIB basalts of the Cocos Ridge (and potentially other subducted aseismic ridges) that were derived from the Galapagos Plume and potentially older basalts of the Caribbean Large igneous province. Volcan Baru (Fig.1) is the largest and potentially active adaktic volcano in Central America (Camacho on line 2006) and is comprised of three distinct stratigraphic stages. The oldest stage is characterized by a shield of lava flows and pyroclastic deposits including ignimbrites. This old cone (Stage I) is deeply eroded and suffered gravitational flank failure(s). This collapse produced a large (ca. 160km^2) hummocky debris avalance deposit up to 30km distance towards the WSW and torewa blocks up to 2km wide at the base of the cone. A second cone (Stage II) formed inside the collapse crater and partly overflowed its rim towards the E. This younger cone suffered minor gravitational collapses and the present summit (stage III) is formed by a complex of domes and related block and ash flows, which mainly filled the collapse scarps of stage I and II.

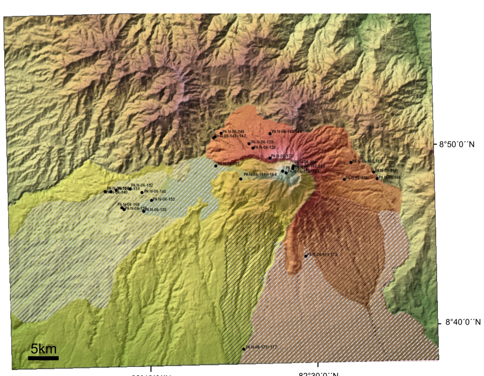

Figure 1: Map displaying sample locations and Baru collapse events.

The geochemical composition of volcanics from these three stages ranges from basaltic andesites to andesites (52 to 62 % SiO2). A pumice deposit from the most recent eruption is found in the modern soil cover and represents the most evolved composition (dacite, 65 % SiO2).

Comparing El Baru with other adakitic centres in Costa Rica and Panama (El Valle, LaYeguada, Talamanca, Abratis and Wörner, 2001, Defant et al., 1991a, Defant et al., 1991b, Leeman et al., 1994) we find that there are surprisingly small differences in trace element characteristics between these centres (Fig. 2) even though the thermal conditions and nature of the subducted basalts should vary significantly between these occurrences.

Assuming that the adakites represents melts from basaltic rocks with a garnet residue (Defant and Drummond, 1990) we calculated the composition of such melts by a simple batch melting model. Typical MORB of Galapagos OIB are unlikely precursors to the adakites because MORBs are too depleted and OIBs too enriched in incompatible trace elements. The composition of intra-plate tholeiitic basalts, such as found in the Caribbean large igneous province (CLIP) are more adequate precursors. However, these rocks are only known to occur as tectonic slices that have been obducted or accreted to the upper plate since ca. 90 Ma (Hoernle et al., 2002). This creates the problem of how to involve these rocks in partial melting in the subduction zone. At our poster, we will discuss the different melting models and their tectonic implications.

References

Abratis M, Wörner G (2001) Ridge collision, slab-window formation, and the flux of Pacific asthenosphere into the Caribbean realm. Geology 29: 127 - 130.

Camacho EA, Los Volcanes de Chiriqui. Laboratorio de Geofísica e Hidrogeologia, Universidad de Panama, Online reference.

Defant MJ, Drummond MS (1990) Derivation of some modern arc magmas by melting of subducted lithosphere. Nature 347: 662 - 665.

Defant MJ, Richerson PM, de Boer JZ, Stewart RH, Maury RC, Bellon H, Drummond MS, Feigenson MD, Jackson TE (1991a) Dacite Genesis via both Slab Melting and Differentiation: Petrogenesis of La Yeguada Volcanic Complex, Panama. Journal of Petrology 32, part 6: 1101 - 1142.

Defant MJ, Clark LF, Stewart RH, Drummond MS,de Boers JZ, Maury RC, Bellon H, Jackson TE, Restrepo JF (1991b) Andesite and dacite genesis via contrasting processes: the geology and geochemistry of El Valle Volcano, Panama. Contrib Mineral Petrol 106: 309 - 324.

Hoernle K, van den Bogaard P, Werner R, Lissinna B, Hauff F, Alvarado G, Garbe-Schönberg D (2002) Missing history (16-71 Ma) of the Galapagos hotspot: Implications for the tectonic and biological evolution of the Americas. Geological Society of America 30, no. 9: 795 - 798.

Johnston ST, Thorkelson DJ (1997) Cocos-Nazca slab window beneath Central America: Earth Planet Sci Lett 146: 465 - 474.

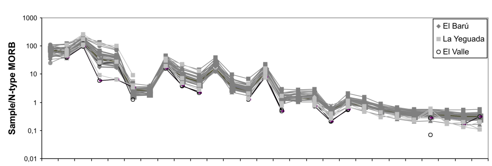

Figure 2: Trace element pattern normalized to n-MORB of Panamanian adakites.

SZ2P09

Gutiérrez, L., Strauch, W., Tenorio, V. (Managua, INETER), Ibañez, J. (Granada, Spain, Instituto Andaluz de Geofísica. Campus de Cartuja s/n. Universidad de Granada), Ramírez, J., Benítez, C. (Granada, Spain, Departamento de Teoría de la Señal, Telemática y Comunicaciones. Escuela Técnica Superior de Ingeniería Informática)

Classification of volcano-seismic signals using Hidden Markov Models Application to Telica and San Cristóbal volcanoes, Nicaragua

E-Mail: `ligdamis.gutierrez@gf.ineter.gob.ni`

Recordings of different seismic event types are studied at two active volcanoes; Telica and San Cristóbal in Nicaragua. We observe the classification and recognize the signals by means of the validity of the hidden Markov modelling (HMM) method. We use data from two field surveys carried out in March 2006. For Telica volcano we define four types of seismic signals; Strombolian explosions, Telica explosions, Telica Long Period signal, volcanic tremor and background seismic noise. For San Cristóbal volcano we identify three types of signals; Strombolian explosions, San Cristóbal explosions, volcanic tremor and background seismic noise. We initially proceeded to identify the signals visually, and to segment the data to obtain a model for each event class. We applied these models separately for each volcano data set, and finally mixed both data sets as a test of the portability of the system. The method analyzes the seismograms comparing the characteristics of the data to a number of event classes defined beforehand. If a signal is present, the method detects its occurrence and produces a classification. The recognition and classification system based on HMM is a powerful, effective, and successful tool. From the application performed over our data set, we have demonstrated that in order to have a reliable result, a careful and adequate segmentation process is crucial. Also, each type of signals requires its own characterization. That means, each signal type must be represented by its own specific model, which would include the effects of source, path and sites. Once we have built this model, the success level of the system ishigh. The high success rates obtained imply that the method is fully able to detect, isolate, and identify seismic signals on raw seismic data. These results imply that, once an adequate training process has been used, the present method is particularly appropriate to work in real time, and in parallel to the data acquisition.

List of Authors