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## EVOLUTION OF THE PAMPEAN FLAT-SLAB SEGMENT OF THE SOUTHERN CENTRAL ANDES

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Oceanic and seismological data constrain the Cenozoic interaction between the Nazca and South American plates, pointing out the timing and latitude of the collision of the Juan Fernandez aseismic ridge. Examination of the changes in the magmatism, time of uplift of the Main Andes, and the rupture of the Pampean foreland, show a close link between shallowing of the subducted oceanic plate and these processes. As a result of that, the Sierras Pampeanas have been uplifted in Late Miocene times. Fission track data on the basement rocks, geochronologic and magnetostratigraphic studies in the synorogenic deposits, together with some isotopic studies, show a wave of deformation from north and west, to south and east through time. The effects of shallowing subduction are first recorded by the changes in the composition of the magmatic rocks, and the expansion and migration of the arc-related rocks to the foreland until the final cessation of magmatism. Deformation started as a thin-skinned thrust-belt in the Principal Cordillera of the High Andes in the Early Miocene. It changed to the Frontal Cordillera as a thick-skinned thrust-belt after 9 Ma, at about one million year later than the time of collision of the Juan Fernandez oceanic ridge against the trench at these latitudes. Expansion and migration of the magmatism preceded tectonic uplift of the Sierras Pampeanas, as if a crustal thermal weakening was required to develop brittle-ductile transitions in the crust to foster rupture and uplift. Present neotectonics is concentrated in the interaction between Precordillera and Sierras Pampeanas, although minor ruptures occur in most of the Sierras Pampeanas broken foreland. Inception of the Quaternary and previous tectonic activity has been enhanced by weakness zones in the crust such as sutures, that have been reactivated as rift systems during the opening of the South Atlantic ocean, and later on contracted during Andean orogeny.

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## HORIZONTAL AND "HORIZONTAL" SUBDUCTION ALONG THE MIDDLE SECTOR OF THE BACKBONE OF THE AMERICAS: PARTITIONED SEISMOGENIC STRESS-STRAIN AND ACTIVE DEFORMATION

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The backbone of the Americas region between central Nicaragua, Costa Rica and northwestern Panamá has been and is currently being affected by the interaction of the Cocos, Caribbean and Nazca tectonic plates. These interactions result in a permanent and very active seismotectonic framework whose origin is mainly controlled by forces generated by plate movements. Subhorizontal subduction along the southernmost Costa Rican sector of the Middle America trench has traditionally been interpreted from regional and local seismological data, and related tectonic models have been developed to explain this behaviour. Relocation of seismic events and deployment of high resolution seismological networks along with existing and ongoing bathymetric and tomographic studies reveal a new scenario where the Benioff zone in this region dips at a high angle that is similar to that to the north. The difference is that the down-turn is farther from the trench. The consequence is a modern stress field with a regional maximum horizontal compressive stress SHmax that is consistently oriented with an average trend of N22°E. The stress field is oriented along and perpendicular to the Pacific margin and is consistent with the convergence direction of the Cocos plate. Thrusting, being moved by deep stresses, dominates below the shallow region and contrasts with an upper plate regional strike-slip regime which forms an X shaped pattern of NE and NW striking fault sets. These faults are strongly superimposed on a less well developed extensional regime within and around the volcanic edifices, showing the dominating influence of the shallow Cocos plate stresses and indenter effects in the Caribbean plate. Miocene to Paleocene rotation of the stress field and blocks due to interactions between the North America and South America plates, the formation of the Caribbean plate and the arrival of the Cocos ridge at the trench further complicate the present tectonic architecture. Destructive events (e.g., Limón earthquake, Mw 7.6; 22 April 1991), clearly exemplify the crustal instability within the local cordillera. These seismotectonic realities can assist in the reinterpretation of past behavior and forecast of future ones in other sectors of the backbone.

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## THE PERUVIAN FLATSLAB

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The modern Peruvian flat-slab, the world's longest, results mainly from 3 factors: subduction of the Nazca aseismic ridge and exhumed Inca Plateau, subduction of young oceanic crust and relatively fast westward absolute motion of South America. These factors can explain the observed 400-500 km length of the flat-slab, a lack of active arc volcanism, and Neogene undersaturated alkaline magmatism with arc affinities in eastern Peru. The impingement of the thick buoyant aseismic ridges changed the crustal state of stress increasing the coupling between the two plates and enhancing seismicity and crustal deformation. Despite the change, the rate of uplift and canyon incision in the flat segment is similar to that in the steeper subducting segment to the south, and there are no obvious differences between the two segments in intensity, timing or structural style of the Neogene Quechua orogenic phases. Both thick and thin-skinned characterize the fold-thrust belt above the flat-slab. The main controls on the structural style are likely lithofacies and inversion of Permian and Jurassic faults. Radiometric ages document several Cenozoic pulses of eastward magmatic migration. The cessation (12 Ma) of magmatism in the northern part of the flat-slab correlates with the complete subduction of the Inca Plateau and the arrival of the Nazca Ridge. The magmatic lull following Nazca Ridge subduction began at the end of the Miocene. Most of the emplacement of the Na-rich delamination-related magmas of the Cordillera Blanca Batholith and coeval ignimbrites along a major crustal lineament took place during the southern swept of the Nazca Ridge. Batholith emplacement involved crustal scale transtensional deformation that caused extensional collapse and lithospheric thinning beneath the Western Cordillera. Due to strain partitioning during oblique convergence, subduction of the Nazca Ridge also enhanced fore-arc extension and locally inverted Paleogene grabens. A long flat-slab running from north of Lima to the Chilean border (7°-18°S) is also postulated during the deposition of Neocomian quartz-rich sandstones in the Morro Solar Group/ Hualhuani Fm. Drowning and subsidence of the Jurassic arc, uplift of Paleozoic and Precambrian rocks and widespread extension and segmentation of the coastal ranges in fault-bounded basins accompanied an abrupt change in igneous activity.

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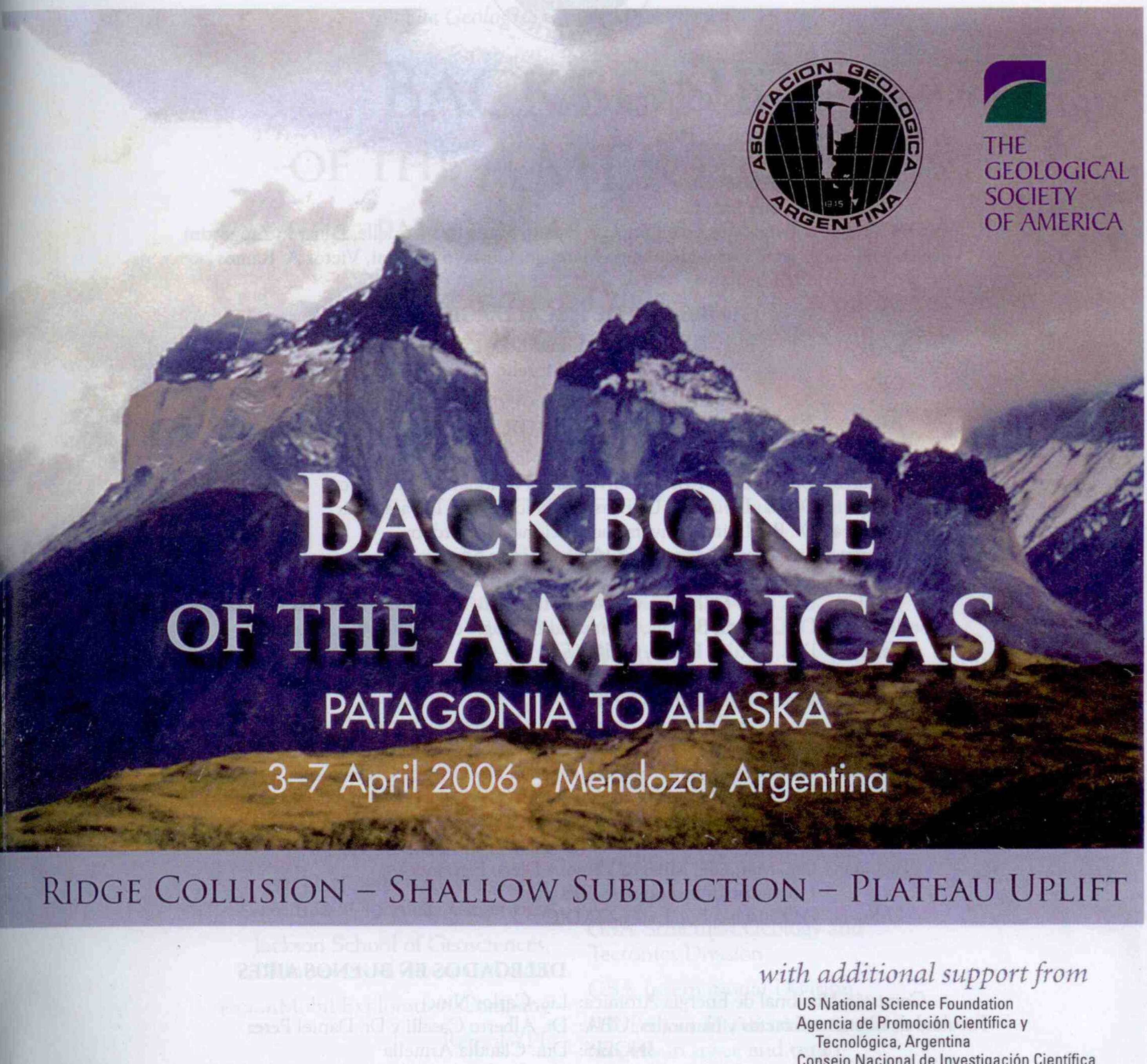


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