THE CHOTA BASIN AND ITS SIGNIFICANCE FOR THE FORMATION OF THE INTER-ANDEAN VALLEY IN ECUADOR

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INTRODUCTION

The Chota Basin lies in the northern Inter-Andean Valley (IAV) (ca 15 km north of Ibarra; Fig. 1) and represents one of a series of sedimentary basins, which were active from the late Neogene to Quaternary (e.g., Winter and Lavenu 1989, Lavenu et al. 1995, 1996, Barragan et al. 1996, Ego and Sébrier 1996, Eguez and Beate 1994). These studies utilized chronostratigraphic, sedimentologic and tectonic data to attempt to reconstruct the tectonic history of the Inter-andean Valley. Recent work (Abegglen 2001, Tobler 2001, Villagomez this volume) has provided new data on the Chota, Guayllabamba and Quito Basins. In particular, a chronostratigraphic framework of the Chota Basin fill, determined from apatite (AFT) and zircon (ZFT) fission track analyses, has improved our understanding of the timing of the IAV formation.

DEFINITION OF THE PLIO-PLEISTOCENE INTER-ANDEAN VALLEY IN ECUADOR

The IAV is limited to the northern half of the Ecuadorian Andes. Morphologically, it is characterized by a row of depressions below 3000m between the Cordillera Real (CR) and the Cordillera Occidental (CO) (Fig. 1). The continuation of the IAV into Colombia (Cauca Valley) is not discussed here. The regional depression is bounded by reactivated crustal scale faults, which formed during the successive accretion of oceanic terranes during the Cretaceous and Tertiary (CPF, PelF, Fig.1). The IAV contains several sub-basins with sedimentary sequences that range between latest Miocene and Pleistocene. At the latitude of ≈ $2^{o}10'$ the depression swings westwards towards the Gulf of Guayaquil, dissecting the topography of the CO (Fig. 1). This area is characterized by the opening of the Pallatanga pull-apart basin, which has been forming since ca 2.5 Ma (Winter and Lavenu 1989). General right-lateral transpressive movement in the forearc and arc is compensated by extension in the Jambeli Basin. Since ≈ 5 Ma, volcanic activity has been restricted to north of the town of Pallatanga and is concentrated along the bordering faults of the IAV structure (e.g. Barberi et al, 1988). Inverted thermal histories of deformed rocks along the ChTSZ and the CCF (Ferrari & Tibaldi, 1992) (Fig. 1) document increased cooling rates in the bordering cordilleras since ≈ 6-5 Ma (Spikings et al. this volume), which we attribute to displacement and exhumation of the fault zones.

BASINS

The IAV hosts a series of distinct sedimentary basin fill sequences which overlie either exposures of basement rocks of the cordilleras (Pallatanga and Guamote units) or dominantly volcanic successions

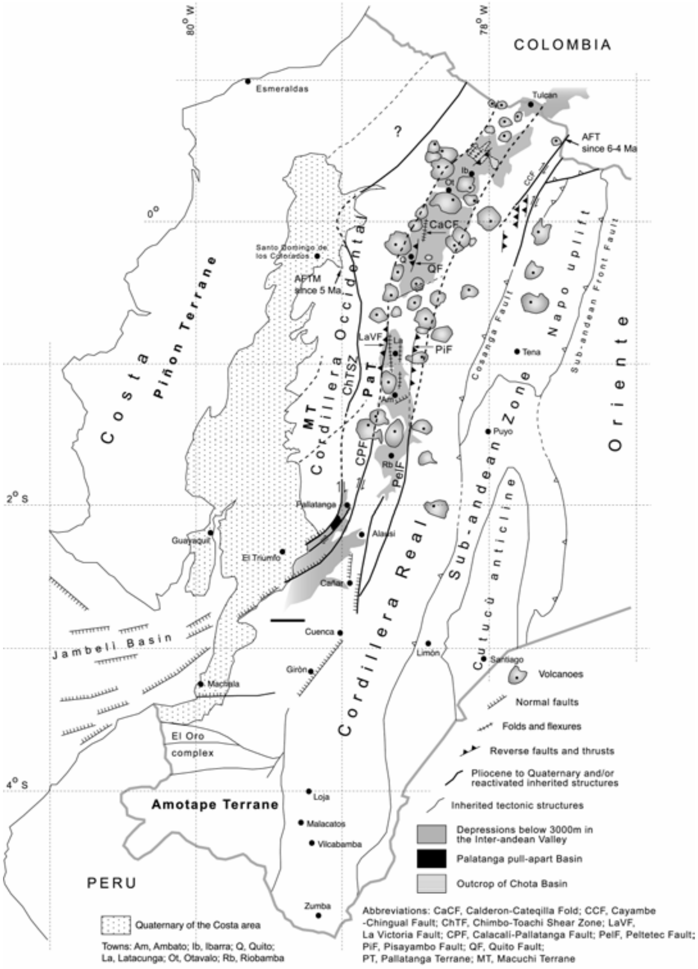

Fig. 1: Simplified geological sketch of the Inter-Andean Valley structure in the Ecuadorian Andes

of Oligocene to late Miocene age, which are also exposed outside the present IAV in the Sierra of southern Ecuador (Fig. 2).

Chota Basin: The basin sequence has a thickness of ≈ 1200-1400m and its exposure is divided into two parts by an extensive lahar sheet, across which (W to E) lithologic correlations are difficult. In contrast to earlier propositions, we find that the Peñas Coloradas Fm., which yields a ZFT age of 5.4±0.4 Ma and is cut by a dyke that yields an AFT age of 3.7±1.7 Ma, is the same age or partly pre-dating the Chota Fm. Alluvial fan deposits of the Peñas Coloradas Fm.were supplied from the east (Barragan et al. 1996) and the heavy mineral assamblage is diagnostic of a source terrane composed of medium to high-grade regional metamorphic rocks (garnet, epidote, clinozoisite, zoisite, kyanite) and low-grade granitic rocks (zircon, tourmaline, rutile) such those as present in the CR today (Abegglen 2001, Tobler 2001). In the east, the formation is overlain by upper sequences of the meandering fluvial to lacustrine (bottom to top) Chota Fm. The dominance of magnesio-hastingite hornblende, basaltic brown hornblende and clinopyroxene of diopsidic composition documents a source region composed of andesitic and basaltic (likely in part coeval) volcanics. The presence of medium to high-grade metamorphic minerals in the lowermost part of the Chota Fm. corroborates the here proposed stratigraphic succession. A total of 5 ZFT and AFT ages (ash beds) in the western sector of the

Chota Fm. range between 4.8±0.4 and 2.9±1.5 Ma. The AFT age of 1.1±0.6 Ma obtained from an ash bed just beneath the lahar in the east is difficult to interpret although we tentatively ascribe it to the Chota Fm. (Abegglen 2001). The alluvial fan facies of the Santa Rosa Fm., including the massive Gavilanes breccia, prograded from the west on the Chota Fm. (Barragan et al. 1996, Tobler, 2001). In addition to andesitic volcanic debris, the reworking of augite, hypersthene and diopside indicates that basic rocks of the Pallatanga unit contributed to the sedimentary flux. The basin series was deposited in a normal fault bounded pull-apart basin, which was subsequently inverted by ≈ E-W shortening, driving intensive folding and thrusting of both the sediments and the dykes/sills (Barragan et al. 1996, Tobler, 2001, Abegglen 2001). Undeformed tuffaceous volcanoclastic rocks unconformably overlie the Santa Rosa Fm. and yield a ZFT age of 0.5±0.2 Ma (ZFT), which constrains the minimum age of the folding event.

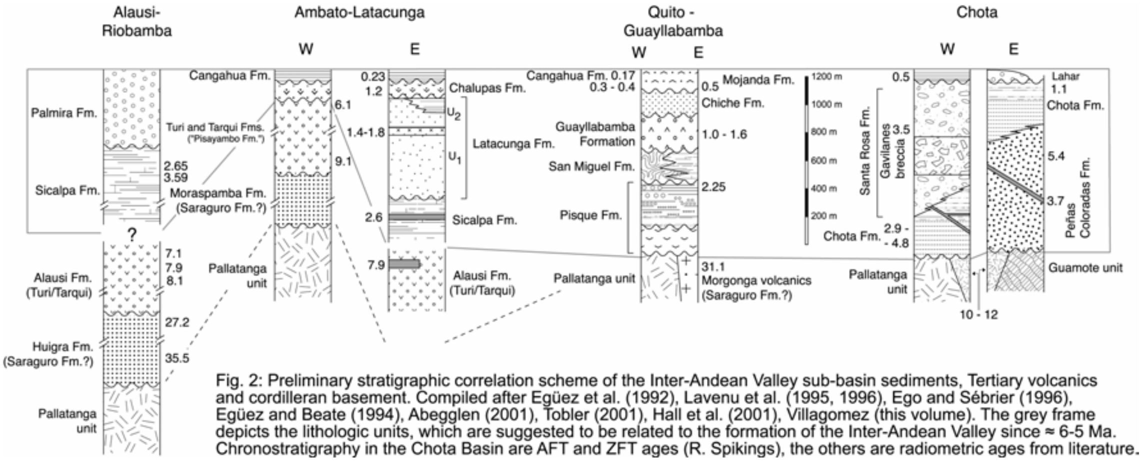

Fig. 2: Preliminary stratigraphic correlation scheme of the Inter-Andean Valley sub-basin sediments, Tertiary volcanics and cordilleran basement. Compiled after Egüez et al. (1992), Lavenu et al. (1995, 1996), Ego and Sébrier (1996), Egüez and Beate (1994), Abegglen (2001), Tobler (2001), Hall et al. (2001), Villagomez (this volume). The grey frame depicts the lithologic units, which are suggested to be related to the formation of the Inter-Andean Valley since ≈ 6-5 Ma. Chronostratigraphy in the Chota Basin are AFT and ZFT ages (R. Spikings), the others are radiometric ages from literature.

Quito and Guayllabamba Basin: The sedimentary rocks of the Quito and Guayllabamba basins consists of a complex series of volcanic and volcaniclastic deposits (Alvarado, 1996; Ego and Sébrier, 1996; Lavenu et al., 1996; Villagomez, this volume; Fig. 2). Lacustrine, deltaic, fluvial and alluvial fan facies prevail in the upper Pisque Fm., the San Miguel and Chiche Fms. In situ radiometric ages of strata are rare although correlations between volcanic edifices into the basins provide approximate chronostratigraphic constraints (e.g. Olade 1980, Barberi et al. 1988, Robin et al. 1977) (Fig.2). Further radiometric analyses are in progress although previous work suggests the sedimentary rocks are younger than 6-5 Ma . The Quito and Guayllabamba basin series are deformed by the large scale ≈ N-S trending Calderon-Catequilla/Quito Folds and the Quito/Botatero thrust Faults (Ego and Sébrier 1996, Villagomez, this volume). Tentative estimates suggest that the main compressive tectonic activity started at ≈ 1.0 Ma (Ego and Sébrier 1996, Villagomez, this volume).

Ambato-Latacunga Basin: In this area the basin fill series wedge out towards the CO in the west. Volcaniclastic rocks of the fluvial/lacustrine Sicalpa Fm. overlie volcanic rocks of the Turi and Tarqui Fm. The lower Latacunga Fm. is mainly of volcanic origin, whereas the upper Latacunga Fm. consists of lacustrine and fluvial deposits (Lavenu et al. 1995). Unconsolidated pyroclastics unconformably overlie these early basin series. The Ambato-Latacunga Basin is bounded by thrusts in the east (east-dipping Pisayambo Fault) and in the west (west-dipping La Victoria Fault). Both faults represent segments of the Calacali-Pallatanga and Peltetec Fault systems respectively. Stratigraphic evidence suggests that a significant phase of compressive deformation occurred between ≈ 1.85 and 1.2. Ma, i.e during deposition of the U2 unit (Lavenu et al. 1995, 1996).

Alausi-Riobamba Basin: The Pleistocene, alluvial fan and fluvial, conglomeratic Palmira Fm. overlies the Pliocene Sicalpa Fm. with an angular unconformity (Egüez et al. 1992, Lavenu et al 1996) (Fig. 2). The presence of these coarse sediments, which were derived from the east, is an important indication of a significant tectonic and/or climatic change during the late Pliocene (Lavenu et al 1996).

CONCLUSIONS

In the IAV since latest Miocene (≈ 6-5 Ma) several sedimentary sub-basins formed, which are younger than the Intermontane Basins in the Sierra of southern Ecuador. There is general agreement that during the early stages of sub-basin formation, local pull-apart extension occurred, possibly starting in the north (Chota Basin) and prograding southward. Inversion to ≈ E-W compressive deformation presumably started in late Pliocene in the south and in the Pleistocene in the north. The larger IAV Basin can be interpreted as a spindle shaped pull-apart basin which formed since ≈ 6 Ma, presumably in response to enhanced coupling of the eastward subducting Carnegie Ridge with the NNE trending Ecuadorian arc and forearc (Spikings et al. 2001). Volcanic activity appears to be closely linked with deep crustal wrench faults due to the general right-lateral transpressive tectonic regime.

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