Gislason, S.R., Arnorsson, S., Armannsson, H. (1990): Chemical denudation rates in SW-Iceland. Chemical Geology 84: 64-67

Owen, G., Matthews, J.A., Albert, P.G. (2007): Rates of Holocene chemical weathering, 'Little Ice Age' glacial erosion and implications for Schmidt-hammer dating at a glacier-foreland boundary, Fåbergstølsbreen, southern Norway. The Holocene 17/6: 829-834

Schneider, C., Glaser, M., Kilian, R., Santana, A., Butorovic, N., Casassa, G. (2003): Weather observations across the Southern Andes at 53°S. Physical Geography 24/2: 97-119.

Thomson, S.N. (2002): Late Cenozoic geomorphic and tectonic evolution of the Patagonian Andes between latitudes 42°S and 46°S: An appraisal based on fission-track results from the transpressional intra-arc Liquiñe-Ofqui fault zone. GSA Bulletin 114/9: 1159-1173

Paleogeographic boundary in the evolution of the Pucara Basin (Triassic-Liassic) and the Arequipa basin (Lias-Dogger): an inheritance of the block accreted during the Mesoproterozoic

Carlotto V 1, 2, Cardenas J 2, Cano V 2, Rodriguez R 1

1 INGEMMET, Av. Canadá 1470 San Borja, Lima, vcarloto@ingemmet.gob.pe
2 Universidad Nacional San Antonio Abad del Cusco UNSAAC

Regional studies recently carried out in the Totos and Paras region (Ayacucho), in the center of Peru, reveal the evidence of a regional system of E-W reverse faults named Abancay-Andahuaylas-Totos (A-A-T). This system defines the southern border of a Mesozoic structural high (Totos-Paras High), whereas the Cusco-Lagunillas-Mañazo (C-L-M) fault system defines the southern border of the Cusco-Puno High. In both cases, the A-A-T fault system and the Totos-Paras structural high are a prolongation of the C-L-M fault system and the Cusco-Puno High respectively. The northern boundary of the Puno-Cusco High is the Urcos-Sicuani-Ayaviri fault system, while the northern limit of the Totos-Paras High is covered by Cenozoic volcanic rocks. During the Mesozoic, the A-A-T and C-L-M fault systems, respectively dipping south and southwest, played as normal faults, separating the western (Arequipa) basin from the Totos-Paras and Cusco-Puno highs. It was controlling the marine and continental sedimentation, with higher thickness in the basin and lower thickness on the structural high. During the Cenozoic, these faults had several movements, first strike-slip and later reverse, rising up the NE edge of the former basin and filling in the old high, which behaved as a continental foreland basin. The NE-vergent foreland front is the C-L-M fault systems, which shows the greatest deformation and shortening (Carlotto, 1998). However, this fault shows an East-West strike in the NW, where it is called Abancay-Andahuaylas-Totos fault, whose

prolongation to the coast coincides with the boundary between the Arequipa and Paracas blocks (Ramos, 2008).

In the Totos-Paras area, the Chunumayo Formation of Toarcian-Bajocian age is 200-500 m thick and overlies volcanic rocks of the Permo-Triassic Mitu Group. Above of the Chunumayo Formation are 300 m of the Yura Group (Middle-Upper Jurassic) corresponding to a fluvial-deltaic environment. In contrast, to the south, in the Arequipa basin, these deposits have thicknesses greater than 2000 m, with deeper environments going from turbidite to slope and shelf deposits. Both in the high area and in the basin, the sequence ends with the Ferrobamba or Arcurquina (Albian-Turonian) limestones, deposited in restricted platform environments, and thinner in the high area (50 m) than in the basin area (600 m).

The A-A-T fault system strikes East-West, behaves as reverse faults and shows 5 thrust sheets. The thickness of the Jurassic-Cretaceous units increase to the south, from one sheet to another. Together with the presence of olistoliths and synsedimentary normal faults, these faults may be interpreted as older normal faults dipping to the south, and which have controlled the sedimentation of the Chunumayo Formation and Yura Group. Further in the north, at the core of the Mitu (Permo-Triassic) outcrops, the faults have controlled the structural high. These faults behaved as normal faults from approximately Toarcian to Turonian times, separating the Totos-Paras High in the Arequipa basin and controlling sedimentation and olistolith development. In the paleogeographic context, the Abancay-Andahuaylas-Totos (A-A-T) fault system is an extension of the Cusco-Lagunillas-Mañazo (C-L-M) system, also parallel to de southern edge of the Cusco-Puno High and separaing the Arequipa basin during the Jurassic and Cretaceous.

Paleogeographic studies in the Norian-Pliensbachian limestones of the Pucara Group (Chambara, Aramachay and Condorsinga Fms) show that the Pucara basin developed mainly in central and northern of Peru. Norian transgression (Chambara Formation, Norian-Rhaetian) reached the Totos-Paras area, but not the south, where there is no record. In the Totos-Paras High, the Chunumayo Formation (Toarcian-Bajocian) directly overlies Permian-Triassic units, with no Pucara Group, and in the south, in the Arequipa basin, the Chocolate Formation (Sinemurian) directly overlies the Proterozoic substrate.

The Sinemurian-Pliensbachian transgressions (Aramachay and Condorsinga formations) reached the structural high of Totos-Paras and extended toward the south, to the Arequipa basin, where the deposits are known as Lagunillas Formation (Hettangian-Sinemurian) and Chocolate Formation (Sinemurian).

The C-L-M fault system is the boundary between the Cusco-Puno High and the Arequipa basin, located to the south, while to the north, the U-S-A fault system is the boundary with the Peruvian south eastern basin. This paleogeography developed during the Jurassic-Cretaceous. Furthermore, the Totos-Paras high is the extension of the Cusco-Puno High, separated from the Arequipa basin to the south by the A-A-T system, and with Pucara basin to the north. In addition, the Cusco-Puno structural high, currently corresponding to the Western Altiplano, in the north is separa-

ted from the Eastern Altiplano or southern edge of the Eastern Cordillera by the U-S-A fault system, and in the south, from the northern edge of the Western Cordillera by the C-L-M fault system. In this region, mineralogical, geochemical, isotopic and geochronological data allow to distinguish three associations of potassic (P) and ultrapotassic (UP) rocks (Carlier et al., 2005). The first group, mostly composed of Oligocene lamproites with phlogopite in the Eastern Altiplano, demonstrates the presence of a Paleoproterozoic to Archaic (TDM = 1130-2485 Ma; εNd = -5.0 to –11.4; $^{87}Sr/^{86}Sr_i$ = 0.7100-0.7159) metasomatized harzburgite mantle beneath this domain. Beneath the Western Altiplano, the deep lithosphere corresponds to a younger (TDM = 837-1259 Ma; εNd = +0.6 to –6.3; $^{87}Sr/^{86}Sr_i$ = 0.7048-0.7069) metasomatized lherzolithic mantle, as indicated by a second group of Oligocene and Miocene P-UP diopside-rich lavas (leucitites, tephrites with leucite, traquibasalt with olivine and diopside). A more recent (< 2 Ma) third group crops out at the boundary between both Altiplano domains and is composed of lamproites with phlogopite and diopside, kersantites, minettes and augite trachybasalts, showing a mantle source which probably includes an astenospheric component, apart from material derived from the two lithospheric mantles previously described (TDM= 612-864 Ma; εNd = -1.1 to -3.5; $^{87}Sr/^{86}Sr_i$ =0.7051-0.7062). This third group, present as volcanic edifices, dikes, stocks, domes, etc., is located over the still active fault system of the U-S-A or Cusco-Vilcanota, and marks the boundary between both parts of the Altiplano.

Summarizing, the older Cusco-Puno High has a deeper metasomized lerzholithic mantle lithosphere below the Western Altiplano. This block is separated from the Western Cordillera by the C-L-M fault system. Beneath the Eastern Altiplano, corresponds to a Paleoproterozoic to Archaic metasomatized harzburgite mantle. This is added to the presence of the Arequipa Massif (with ages between 1900 and 600 Ma) which is the basement of the Western Cordillera (oldest Arequipa basin). Hence, the lithosphere of the western margin of the South American continent is a mosaic of amalgamated lithospheric blocks (terranes) accreted to Amazonia during the Sunsás orogeny at 1000 Ma. This was a complex collision between a large block, the Arequipa Massif, and other small lithospheric blocks which later formed the substrate for the Western and Eastern Altiplano. If we consider the Totos-Paras High as a prolongation of the Cusco-Puno High, then the substrate would be the same which comes from Cusco-Puno High. This study shows how the older structures control not only Meso-Cenozoic paleogeography, but also Andean deformation.

References

Carlier G, Lorand JP, Liégeois J, Fornari M, Soler P, Carlotto V, Cardenas J (2005) Potassic ultrapotassic mafic rocks delineate two lithospheric mantle blocks beneath the southern Peruvian Altiplano. Geology, 33 601-604.

Carlotto V (1998) Evolution andine et raccourcissement au niveau de Cusco (13°-16°S, Pérou). These Université de Grenoble, France 159 p.

Ramos V (2008) The Basement of the Central Andes: The Arequipa and related Terranes, Annual Review of Earth and Planetary Sciences 36: in press.