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The magmatism in the easternmost sector of the Calama-Olocapato-El Toro transversal fault system in the Central Andes at 24°S: Geotectonic significance

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The easternmost sector of Calama-Olocapato-El Toro (COT) transversal fault system in the Central Andes at 24° S is characterised by the presence of a Miocene magmatic complex (Fig. 1) constituted by intrusive (Hongn et al. 2002) and volcanic rocks (Krallmann 1994, Hauser et al., 2005). Intrusive rocks consist of a laccolith-like intrusion having an U/Pb age on zircon of 14.4 Ma (Hongn et al. 2002) whereas new K/Ar age (this work) determinations indicate that the volcanic products emplaced in a span of time from 12 to 6 Ma. The lavas are located along fractures with ~E-W and ~NW-SE strike (Hauser et al. 2005) and the eruptive centres are distributed in an area of about 40 km^2. These Miocene igneous rocks are of particular scientific interest for their position at about 600 km from the Pacific trench and for the complex tectonic evolution of the area in which they emplaced. In fact in the last 10 Ma this sector of Central Andes was characterised by crustal thickening associated to extensive shortening. In this note, we report new geological and petrological data on the Almagro volcanic rocks (AVR from here) and Las Burras intrusion (LBI from here) that can allow us to: a) characterize the magmatism in trans-arc position very far from the trench b) to explain the mechanisms of pluton emplacement in a general compressive tectonic environment and 3) to define the role of the Calama-Olacapato-El Toro lineament (COT) in ascent of magmas.

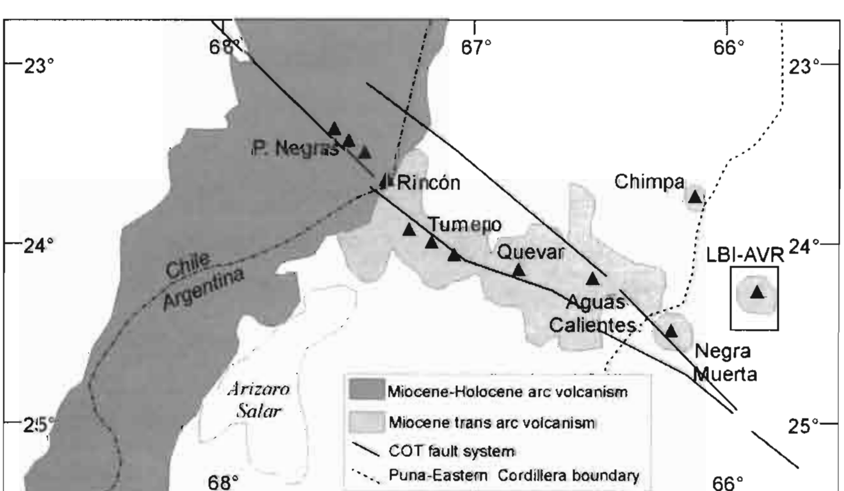

Figure 1: Geological sketch map of Central Andes at about 24° S of latitude.

The volcanic rocks have a composition ranging from basaltic andesites to dacites at the boundary with rhyolites. The basaltic andesites contain as dominant mineral phases olivine, zoned plagioclase, clino- and orthopyroxenes whereas the andesites and dacites contain plagioclase, abundant amphibole, clino- and orthopyroxene with scarce olivine. The presence of stable amphibole in these intrusive rocks, suggests magma storage at least at 200 MPa. The intrusive stock ranges in composition from monzogabbro to monzogranite through quartz-monzonite. The monzogabbros exhibit strongly zoned calcic plagioclase, augitic clinopyroxene and amphibole. The monzogranites and quartz-monzonite in addition to the same mineral phases of the monzogabbro have abundant biotite. The most mafic intrusive rocks plot on the alkaline field or on the Irvine and Baragar line in an TotAlk-SiO_2 diagram (Fig. 2). The monzogranites and quartz-monzonite fall in the subalkaline field together with all the volcanic products.

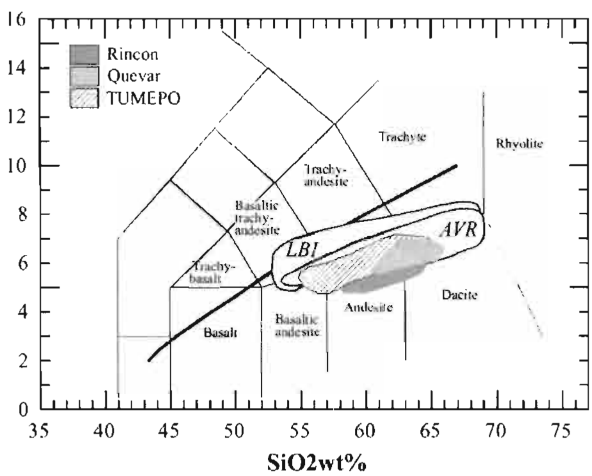

Figure 2: Total Alkali Silica diagram for the LBI, AVR and COT volcanites.

The intrusive rocks are richer in K, Rb and Nb and poorer in Ba and Sr than the AVR volcanites. The Sr isotopic ratios of the LBI intrusion are low (0.70454-0.70531) whereas the Nd ratios are rather high (0.51268-0.51259). The volcanites show Sr isotopic ratios relatively high (0.70760-0.70923) and low Nd ratios (0.51241-0.51227). In Figure 3 the LBI and AVR isotopic data are compared to other Miocene volcanic complexes aligned along the COT. The isotopic data define a trend of decreasing $^{143}Nd/^{144}Nd$ with increasing $^{87}Sr/^{86}Sr$ where the LBI rocks plot in the lower part of the OIB field and represent the less radiogenic magmas emplaced along the COT at Miocene time. The AVR volcanics show more radiogenic features pointing towards the compositional field of the CVZ ignimbrites, characteristic of magmas with a relevant upper crustal component (e.g. Ort et al., 1996, Kay et al., 2000)

The structural data show that the area is mainly characterized by the presence of NW-SE and N-S trending fault systems, and suggest that this tectonic activity began at least since Miocene. The NW-SE faults are characterized by left-lateral motions and, subsequently, by extensional motions. NW-SE trending extensional fractures are also found. The N-S trending faults have a predominant dextral component of shear. The deformation associated with these N-S dextral faults is given by conjugate NE-SW left-lateral faults and by several folds with a NW-SE trending axis. Extensional motions are superimposed on some of the

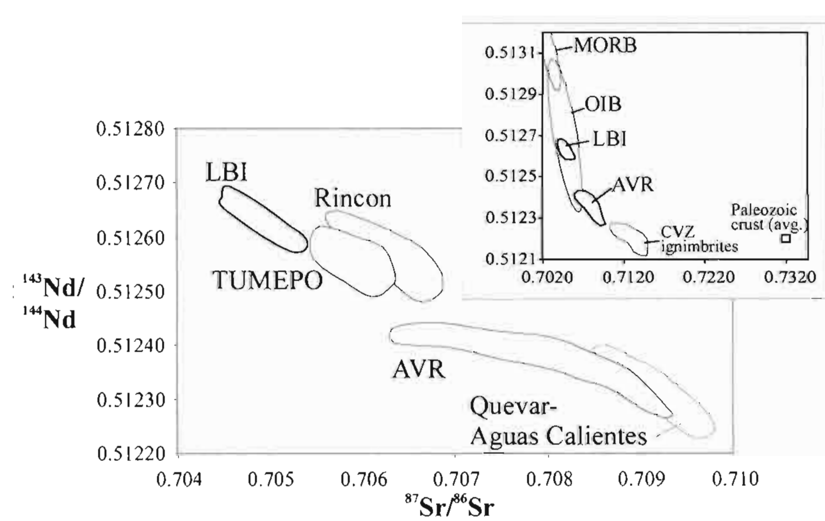

Figure 3: 87Sr/86Sr vs 143Nd/144Nd diagram comparing LBI and AVR with other miocenic volcanic complexes along the COT. In the inset the LBI and AVR products are plotted with MORB, OIB and Central Volcanic Zone ignimbrite compositional fields. In the diagram the average composition for Andean Paleozoic crust is also shown (Matteini et al., 2002 and references herein).

N-S faults. The N-S dextral faults seem to have controlled the rise of the monzogranite, forming a NE-SW trending releasing bend. The successive extension found along the NW-SE and the N-S systems can be interpreted as induced by the rise of magma along the COT.

The whole of the geochemical data suggest that LBI magmas could be generated by melting of a lithospheric mantle with relatively low Sr and high Nd isotopic ratios. The evolution processes which affected the LBI magmas (SiO_2 ranging between 54 and 68%) possibly occurred in a low radiogenic continental crust. The volcanics could be the result of a mixing process between a mantle-derived magma and crustal melts deriving by partial melting of Brasilian crust. The magma generating processes could be linked to an increase of isotherms due to the upflow of asthenosphere after the Quechua compressive phase and/or to a depressuring process due to the transtensional movements of the COT. In this case the COT played an important role either for the ascent of magmas.

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