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The complex alchemy during andesite-dacite magma genesis in the Central Andes

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The Licancabur and Sairecabur are typical Plio-Quaternary calc-alkaline volcanoes of the Central Andes (Fig. 1). The lavas series are rather limited, ranging from andesites to dacites. These series are characterized by a simultaneous LREE increase and HREE decrease with increasing differentiation, resulting in a spectacular crossing-over of the REE trends in normalized diagrams (Fig. 2). Such kind of configuration implies that garnet has played an important role during magma genesis and evolution.

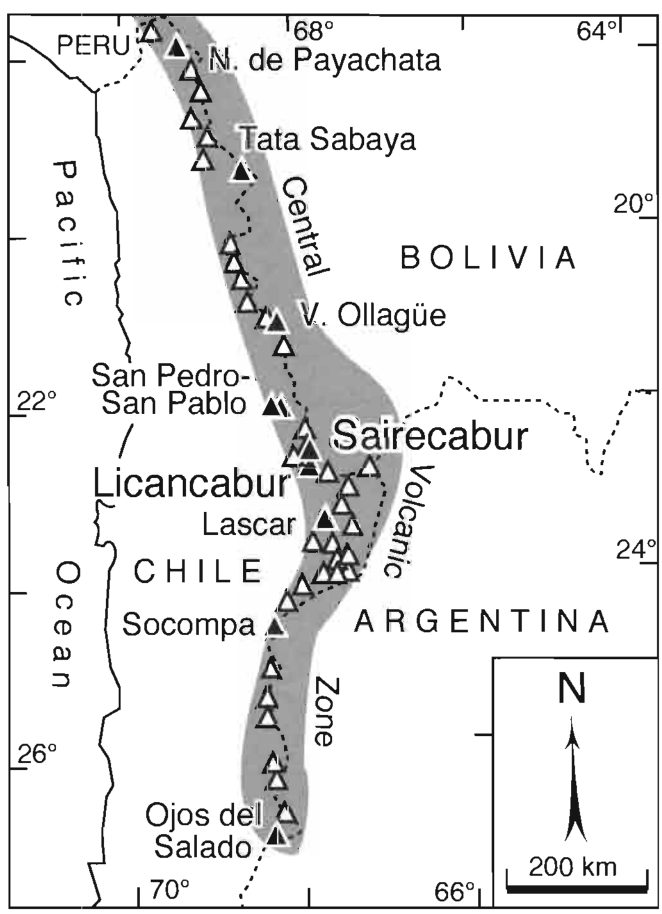

Fig. 1. Location of Licancabur and Sairecabur volcanoes in the Central Andes

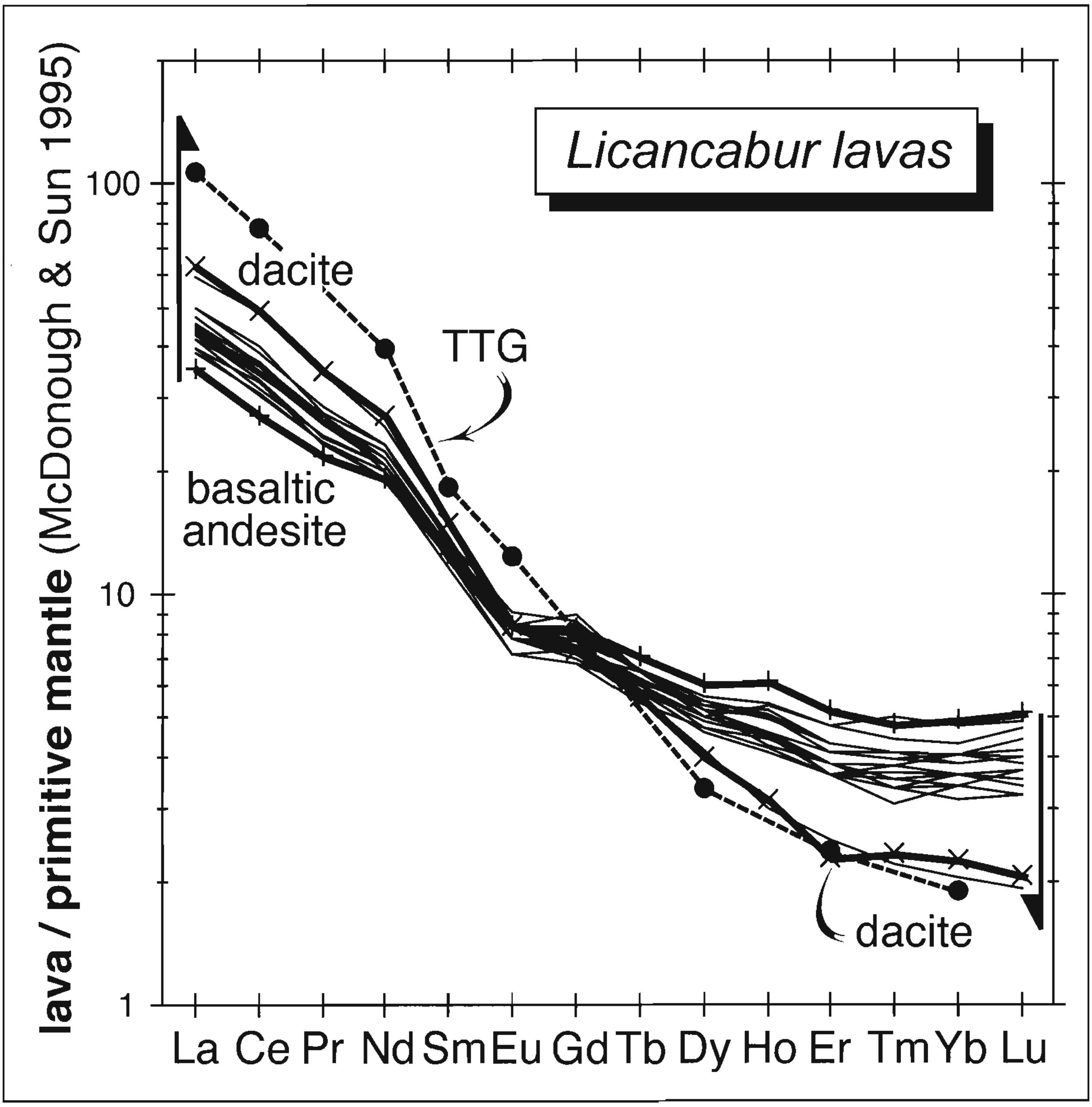

Fig. 2. Primitive mantle normalized diagram for Licancabur lavas. Arrows indicate increasing differentiation.

Many hypotheses concerning the genesis of calc-alkaline lavas from Central Andes have been suggested owing to the diversity of potential components (subducted slab including oceanic crust and sediments, continental upper mantle, lower and upper continental crust). Whatever the models proposed (e.g. MASH) they are all tributary to AFC modelling. Nevertheless none of these models has yet given a satisfactory explanation to the REE crossing-over effect.

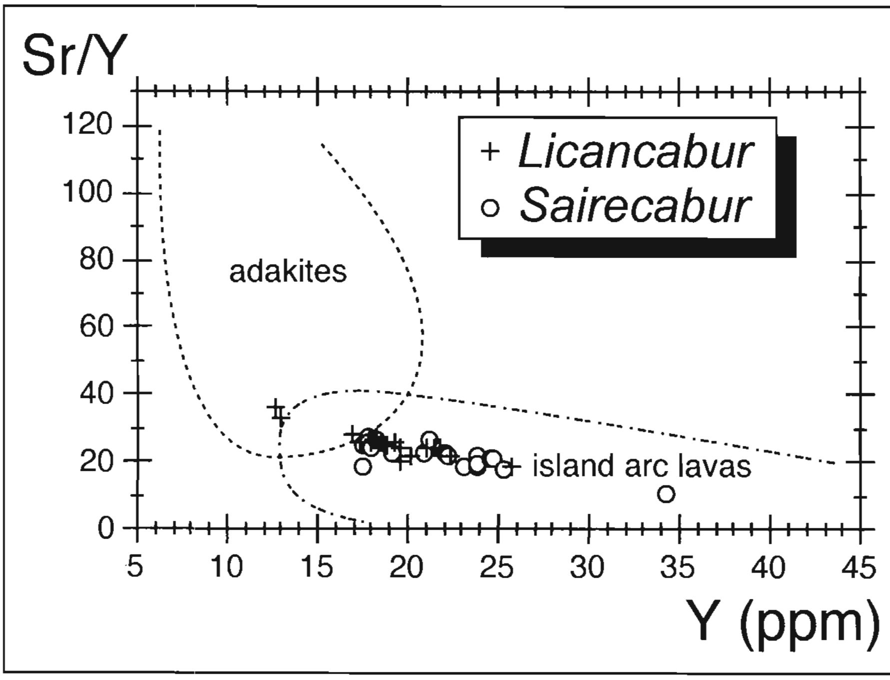

Fig. 3. Y-Sr/Y diagram for Licancabur and Sairecabur lavas.

TTG is a probable component in the Archean continental crust of the Andes. TTG are thought to be the products of MORB partial melting leaving an eclogite residue. It is noteworthy that REE patterns for rocks of the tonalite-trondjheimite-granodiorite (TTG) suite are steeper than those for calc-alkaline lavas. Nevertheless, assimilation of TTG material by mantle-derived magmas is not a suitable explanation to explain the REE crossing-over because they have extremely radiogenic ($^{87}Sr/^{86}Sr > 0.810$) present day isotopic composition resulting in very low (< 3 wt %) rates of assimilation.

Adakites are also thought to be the products of MORB partial melting leaving an eclogite residue. Adakites have been described in Austral and Septentrional Andes, but no attempt has been made to relate their genesis to that of typical calc-alkaline lavas from Central Andes. Many geochemical characteristics of andesites-dacites from Central Andes are similar to those of adakites : $SiO_2 > 56$ wt % ; $Al_2O_3 > 15$ wt % ; Yb < 1.9 ppm ; Y < 18 ppm ; Sr > 400 ppm (Fig. 3); Sr and Eu negative anomalies in spidergrams. But the $^{87}Sr/^{86}Sr$ and epsNd values of the calc-alkaline lavas are in the ranges 0.7076-0.7085 and -6.2 to -7.4, respectively.

Assimilation of liquids resulting from partial melting of the miocene subducted oceanic crust by a magma derived from partial melting of peridotites in the South American mantle wedge could possibly generate the primary magmas for andesites and dacites with their characteristic LREE-HREE crossing-over.