New trace element and isotopic constraints on the genesis of andesites and dacites of the Quaternary Austral Volcanic Zone of the Andes

R. Kilian *Mineralogisch-Petrographisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany*

Ch. Stern *Department of Geological Sciences, University of Colorado at Boulder, Colorado 80309-0250, USA*

Isotopic and trace element data for andesites to dacites (SiO_2 = 58–67 wt.%) of the Andean Austral Volcanic Zone (AVZ) suggest three distinct magmatic evolutions for single AVZ volcanoes from south to north. Cook volcano (55°S) has formed low-K andesites with high Sr/Y (~350) and MORB-like $^{143}Nd/^{144}Nd$ and $^{207}Pb/^{206}Pb$ suggesting an origin from partial melts of subducted Antarctic plate fragments. Mt. Burney (52°S) has produced low-K andesites which may be derived predominately from melts of asthenospheric mantle mixed with partial melts of the subducted slab (MORB & sediments). The northern AVZ volcanoes (49°S) Aguilera, Viedma and Lautaro have formed med-K to high-K andesites which may have similar parent to that of Mt. Burney, but are also contaminated by isotopically enriched Paleozoic crust.

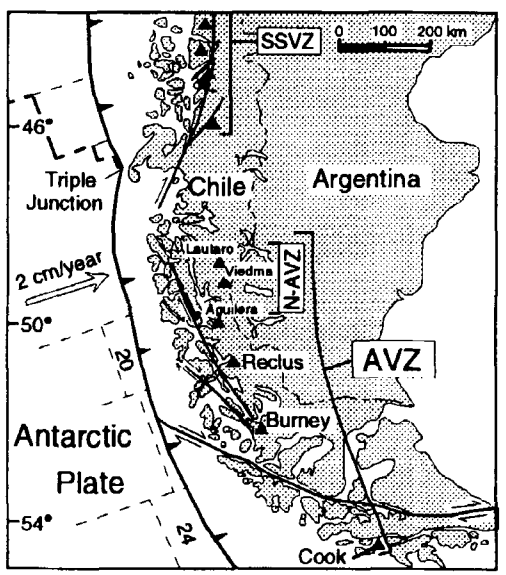

FIG. 1. Plate tectonic map of southern South America with localities of the investigated Austral volcanoes Lautaro, Viedma, Aguilera, Reclus, Mt. Burney and Cook (AVZ), and the southern part of the Southern Volcanic Zone (SSVZ).

Introduction

The formation of andesites and dacites of the AVZ is related to the subduction of young oceanic crust (~20 Ma) with low convergence rates (2.5 cm/year). These conditions may have produced relatively high geothermic gradients in the subduction zone enabling partial melting of the subducted oceanic crust and sediments (Futa & Stern 1988, Mahlburg-Kay *et al.* 1993, Peacock *et al.* 1994). We have compared dacitic AFC products from basalts of the SSVZ with our new trace element data of the AVZ to constrain the contribution of the subducted slab and the continental crust.

Petrogenetic constraints

Geochemical characteristics of 33 volcanic rocks of the AVZ are presented in Figs. 2 and 3. These data constrain three distinct magmatic evolutions for the AVZ, which are related to distinct plate tectonic setting and structure of the continental crust:

1) *Cook island volcano (55°S)* was formed at a transition between subduction zone and a transform fault. Its low-K andesites have very high Sr/Y (170–450), Sr/Nd (65–130), La/Yb (26–32), and low Ba/La (3–5), La/Nb (2.5–3.5), and Rb/Sr (~0.0015) suggesting an origin from partial melts of a basaltic to amphibolitic source. $\delta^{18}O$ (+5.5), $^{143}Nd/^{144}Nd$ (~0.51314) $^{207}Pb/204Pb$ (~15.52) are MORB-like suggesting a genesis from subducted slab fragments of the Antarctic plate and excluding an origin from amphibolitic lower crust.

2) *Mt. Burney (52°S)* was formed on a intensively fractured basement consisting mainly of Patagonian Batholith. Its low-K andesites to

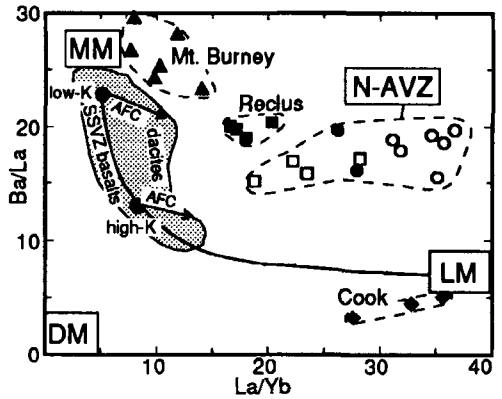

FIG. 2. Ba/La *vs.* La/Yb for andesites and dacites of the AVZ compared with basalts and dacitic AFC products of the SSVZ, and compositions for depleted mantle (DM), subduction modified mantle (MM), and lithospheric mantle (LM).

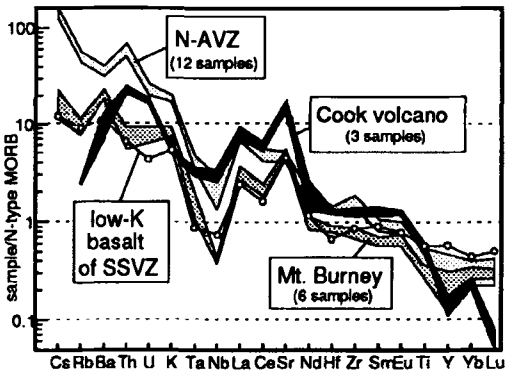

FIG. 3. N-type MORB normalised trace element pattern of andesites and dacites of the AVZ and a low-K basalts of the SSVZ.

dacites have similar trace element pattern as low-K basalts of the SSVZ (Fig. 3). This suggests a derivation in the asthenospheric mantle wedge, which may be contaminated by a subduction component. This source contamination may have produced the observed moderately depleted Sr, Nd, Pb isotopic data. However, Mt. Burney andesites have higher Sr/Y (35–150) and Sr/Nd (45–65) than common dacitic AFC products of parental Andean basalts. This may indicate a source contamination by partial melts of the subducted oceanic crust. Low $\delta^{18}O$ values (+6 to +7), and low U as well as Th concentrations are indicating little crustal contribution.

3) *The northern AVZ volcanoes Aguilera, Viedma and Lautaro (49–51°S)* may be related to a thicker and older crust than the southern AVZ volcanoes and to a subduction modified lithosphere. Mid-K to high-K dacites have similar Ba/La (15–20), Rb/Sr (~0.1), Sr/Nd (20–35) as andesites from the Southern part of the SVZ which were derived from basalts by crustal AFC processes. However, Sr/Y and La/Yb may indicate some source contamina-tion by partial slab melts. $\delta^{18}O$ (~8.3), $^{87}Sr/^{86}Sr$ (~0.7054), $^{143}Nd/^{144}Nd$ (~0.51254) data, and high Th/Ta (15–20) of these volcanoes indicate significant contamination by isotopically enriched Paleozoic crust.

References

Futa, K. and Stern, C. (1988) *Earth Planet. Sci. Lett.*, **88**, 253–62.

Mahlburg-Kay, S., Ramos, V.A., Marquez, M. (1993) *J. Geol.*, **101**, 703–14.

Peacock, S.M., Rushmer, T., Thompson, A.L. (1994) *Earth Planet. Sci. Lett.*, **121**, 227–44.