Carbonatite metasomatized peridotite xenoliths from southern Patagonia: implications for lithospheric processes and Neogene plateau magmatism

Matthew L. Goring · Suzanne M. Kay

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Abstract The mineral chemistry, major and trace element, and Sr–Nd isotopic composition of Cr-diopside, spinel peridotite xenoliths from the Estancia Lote 17 locality in southern Patagonia document a strong carbonatitic metasomatism of the backarc continental lithosphere. The Lote 17 peridotite xenolith suite consists of hydrous spinel lherzolite, wehrlite, and olivine websterite, and anhydrous harzburgite and lherzolite. Two-pyroxene thermometry indicates equilibration temperatures ranging from 870 to 1015 °C and the lack of plagioclase or garnet suggests the xenoliths originated from between ~40 and 60 km depth. All of the xenoliths are LILE- and LREE-enriched, but have relatively low ⁸⁷Sr/⁸⁶Sr (0.70294 to 0.70342) and high εNd (+3.0 to +6.6), indicating recent trace element enrichment (~25 Ma, based on the low ⁸⁷Sr/⁸⁶Sr and high Rb concentrations of phlogopite separates) in the long-term, melt-depleted Patagonian lithosphere. Lote 17 peridotite xenoliths are divided into two basic groups. Group 1 xenoliths consist of fertile peridotites that contain hydrous phases (amphibole ± phlogopite ± apatite). Group 1 xenoliths are further subdivided into three groups (a, b, and c) based on distinctive textures and whole-rock chemistry. Group 1 xenolith mineralogy and chemistry are consistent with a complex metasomatic history involving variable extents of recent carbonatite metasomatism (high Ca/Al, Nb/La, Zr/Hf, low Ti/Eu) that has overprinted earlier metasomatic events. Group 2 xenoliths consist of infertile, anhydrous harzburgites and record cryptic metasomatism that is attributed to CO₂-rich fluids liberated from Group 1 carbonatite metasomatism of the backarc continental lithosphere. Extremely variable incompatible trace element ratios and depleted Sr–Nd isotopic compositions of Lote 17 peridotite xenoliths indicate that the continental lithosphere was neither the primary source nor an enriched lithospheric contaminant for Neogene Patagonian plateau lavas. Neogene plateau magmatism associated with formation of asthenospheric slab windows may have triggered this occurrence of “intraplate-type” carbonatite metasomatism in an active continental backarc setting.

Introduction

Recent studies have demonstrated the importance of both carbonatite- (Yaxley et al. 1991; Dautria et al. 1992; Hauri et al. 1993; Rudnick et al. 1993; Ionov et al. 1994) and adakite- (Kepezhinskas et al. 1995, 1996; Schiano et al. 1995; Kilian 1995) metasomatized peridotite xenoliths in mafic lavas for providing information about lithospheric mantle processes and chemistry. Carbonatitic metasomatism is associated with carbonatite magmas that are thought to represent melting of mantle carbonate (Green and Wallace 1988) or are immiscible liquids exsolved from alkaline, CO₂-rich silicate magmas (Hamilton et al. 1979). Carbonatitic metasomatism is characterized by high whole-rock Ca/Al, Zr/Hf, Nb-Ta, and very low Ti/Eu ratios in mantle xenoliths. Carbonatite metasomatized peridotite xenoliths are dominantly found in intraplate settings (Tanzania, Rudnick et al. 1993; Samoa, Hauri et al. 1993); however, rare occurrences have recently been documented in the backarc of active margins where old oceanic lithosphere is subducting (southern Kamchatka, Kepezhinskas and Defant 1996). In contrast, adakitic metasomatism is associated with adakite magmas (Drummond and Defant 1990), which are melts of broadly dacitic composition that represent small-percentage partial melts of subducted oceanic crust (Kay
Adakitic metasomatism is characterized by high Na, Al, Sr/Y, and low Y, Yb, in mantle xenoliths and is commonly found only in active arc regions where young (~20 Ma) oceanic crust is presently subducting (i.e., southern Patagonia, Kilian 1995) or where subduction has recently ceased (northern Kamchatka, Kepezhinskas et al. 1995, 1996).

We have collected a suite of 20 peridotite xenoliths from the Estancia Lote 17 locality in southern Patagonia (48.5°S, 70.2°W; Fig. 1) that record strong carbonatite metasomatism of the backarc mantle lithosphere. Lote 17 peridotite xenoliths are texturally and chemically similar to other carbonatite metasomatized xenolith suites from continental intraplate settings (e.g., Yaxley et al. 1991; Dautria et al. 1992; Rudnick et al. 1993). The Lote 17 xenolith suite consists of a variety of anhydrous and hydrous (amphibole ± phlogopite ± apatite) spinel peridotites that display four distinct metasomatic styles. In this paper, we report on petrographic, whole-rock and mineral, and Sr–Nd isotope compositions for ten representative Lote 17 peridotite xenoliths in order to constrain metasomatic processes in backarc continental lithosphere and to assess the role of the lithosphere and asthenosphere in the petrogenesis of Neogene Patagonian plateau lavas.

**Geologic setting**

Several peridotite xenolith localities are known in southern Patagonia (Ramos et al. 1982; Fig. 1). The three best characterized sites are the Estancia Lote 17 (48.5°S), Cerro del Fraile (50.5°S; Kilian 1995), and the Pali–Aike localities (52°S; Stern et al. 1989, 1999). The Estancia Lote 17 locality lies within the basaltic plateau known as the Meseta Central. The site is located in the southwestern corner of the Deseado Massif and is ~250 km behind the northernmost Austral Volcanic Zone (AVZ) centers (Fig. 1). Lithosphere beneath the Deseado Massif is thought to be as old as ~1100 Ma (Pankhurst et al. 1994). This is considerably older than late Proterozoic (~650 Ma) and mid-Paleozoic...