Mantle diversity beneath the Mercaderes region, Andean Northern Volcanic Zone, Colombia

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Mantle xenoliths have been described in the Andean region associated with alkaline magmatism related to the subduction of Nazca and Antarctic Plate beneath the South American Plate. The Mercaderes area in SW Colombia, located in the Northern Volcanic Zone (NVZ) is characterized by late Cenozoic volcanic activity. On the southeastern part of the Mercaderes Tableland lies the Granatífera Tuff containing mantle xenoliths, which provide a key area to improve the understanding of the mantle evolution in the NVZ. Mantle xenoliths are represented by garnet-bearing rocks, ranging from peridotites to websterites. Garnet-absent mantle xenoliths are also present, but less abundant, represented by pyroxenites and spinel peridotites.

Isotopic signatures were correlated to field, petrography, mineral/rock chemistry and pressure-temperature studies. Three main sources of these mantle xenoliths can be suggested. Websterites, with low pressure/temperature (1065ºC-16-kbar) and MORB signature, $^{87}Sr/^{86}Sr$ ratio of 0.7030 and $^{143}Nd/^{144}Nd$ ratio of 0.5129 represent one group of xenoliths. A second group, represented by garnet-peridotite/pyroxenite xenoliths, with middle pressure/temperature (29-35 kbar, 1250-1295ºC) suggested a similarity with a sub-oceanic geotherm, and an OIB signature, $^{87}Sr/^{86}Sr$ ratio of 0.7043 and $^{143}Nd/^{144}Nd$ ratio of 0.5129. The third group is characterized by garnet peridotite with a similar sub-continental geotherm (> 38 kbar, 1140-1175ºC), which could represent OIB source area, enriched in Nd and low Sr radiogenic ($^{87}Sr/^{86}Sr$ ratio of 0.7041 and $^{143}Nd/^{144}Nd$ ratio of 0.5135).

The presence of three distinct groups of mantle xenoliths in the Mercaderes area would represent a distinct provenance of melts. Since there are distinct isotopic signatures for these mantle xenoliths, different sources should be required. MORB mantle material xenoliths represent melts of upper mantle, while OIB mantle material are related to a mantle plume modified or not by subducted oceanic lithosphere and a delaminated continental lithosphere. Also, in the Mercaderes area, xenoliths could represent distinct events of mantle accretion during the evolution of NVZ or they could represent a vertical sampling of the mantle.

Major-element diversity of ocean island basalts: Constraints from melting phase relations of pyroxenite

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It has been widely suggested that mafic lithologies (pyroxenites) in the mantle play important roles in the genesis of ocean island basalts (OIB). A problem in quantitative understanding of the role of pyroxenite in the genesis of OIB is compositional diversity of both OIB and pyroxenites. Compositions of OIB span a wide range from silica-saturated (tholeiitic) basalts dominant in large ocean islands (e.g., Hawaii and Iceland) to silica-undersaturated compositions (alkali basalts, basanites, nephelinites) characteristic of relatively small ocean islands. Compositions of pyroxenites also range widely from near peridotitic to basaltic [1], which results in a wide range of melting behaviors.

A key feature in melting regime of pyroxenite at high pressure is the garnet-pyroxene thermal divide (Ca-Tschermaks -enstatite join) in the pseudoternary system forsterite - Ca-Tschermaks pyroxene - quartz projected from diopside [2]. In this system, silica-deficient pyroxenites, which plot on the Si-poor side of the thermal divide, produce low silica partial melts Silica-excess pyroxenites, which plot on the Si-rich side of the divide, produce siliceous partial melts. Our melting experiments [3,4] demonstrate that partial melts from a silica-deficient pyroxenite have silica-undersaturated compositions and that partial melts at 5 GPa are quite similar to primitive alkalic OIB lavas. Also, silica-excess pyroxenite produces silica-saturated partial melts similar in SiO_2 to tholeiitic OIB [5]. These silica-saturated partial melts may be parental to tholeiitic OIB if mixed with peridotite-derived melt. Thus, a wide range of major element signatures in OIB can be explained by involvement of partial melts from pyroxenite.

References

[1] Hirschmann M.M., and Stolper E.M., (1996) Contrib. Mineral. Petrol. 124, 185-208.
[2] O'Hara M.J., (1968) Earth-Sci. Rev., 4, 69-133.
[3] Hirschmann M.M., Kogiso T., Baker M.B. and Stolper E.M., (2003) Geology 31, 481-484.
[4] Kogiso T., Hirschmann M.M. and Frost D.J., (2001) EOS Trans. AGU 82, S429.
[5] Pertermann M. and Hirschmann M.M., (2003) J. Geophys. Res. 108, doi:10.1029/2000JB000118.