Andean volcanoes record carbonatite mantle metasomatism and CO_2 degassing at subduction zones

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The nature and the chemistry of the metasomatic agents (fluid or melt) at subduction zones depend on the composition of the slab sedimentary cover and on the thermal regime. In the SW margin of Colombia, the young Nazca plate (11-17 Ma) is covered by a thick pile of pelagic carbonates (ODP holes 504B) and the slab surface is expected to experience temperatures in the order of 850-950°C at pressures of 4.0-5.0 GPa (Syracuse et al., 2010). Such thermo-chemical environment is favourable to generate calcium-rich hydrous carbonatitic liquids.

Here we report the first record of aragonite and dolomite – Mg-calcite pairs in garnet-bearing carbonated mantle xenoliths from the Andean Granatifera Tuff of Mercaderes (SW Colombia, Weber et al., 2002). The xenoliths are characterized by a pristine garnet pyroxenite assemblage partly replaced by complex coronas of gedrite ± pargasite ± spinel ± saponite, and a variety of carbonates including multiple generations of calcite + dolomite ± aragonite. Dolomite grows as clustered euhedral grains with sector or hour-glass zoning, systematically combining compositional pairs at Ca/(Ca+Mg) = 0.45 and Ca/(Ca+Mg) = 0.41 respectively, and overgrown by a thin homogeneous rim. Aragonite grows as large euhedral crystals up to 500 µm often geminated and immersed in a fine matrix of Mg-rich micas intermixed with elongated calcite crystals. Microstructural evidences coupled to experimental data in $CaCO_3$-rich model systems point to the crystallization of dolomite and, eventually, aragonite from a silicate-carbonate melt, under mantle pressures of 3.0-4.0 GPa (Weber et al., 2002) and temperature of ca. 1070°C.

These unique carbonated mantle xenoliths support the hypothesis that hydrous and Ca-rich carbonatitic melts are able to form at active subduction zones.

Syracuse, E.M., van Keken, P.E., Abers, G.A. (2010), Phys. Earth. Planet. In., 183(1-2), 73-90.
Weber, M.B.I., Tarney, J., Kempton, P.D., Kent, R.W. (2002), Tectonophysics, 345, 49-82.