Pb-Sr-Nd-Hf isotope variations of megacrysts from Mesozoic Southern African kimberlites reflect mixing of HIMU melts with deep lithosphere

P.E. JANNEY[1] AND D.R. BELL[1,2]

[1]School of Earth & Space Exploration, Arizona State University, Tempe AZ 85287 (pjanney@asu.edu)
[2]Department of Chemistry and Biochemistry, Arizona State University, Tempe AZ 85287 (david.r.bell@asu.edu)

Clinopyroxene (cpx) megacrysts are abundant in southern African kimberlites and most have compositions that are not in equilibrium with normal mantle peridotite. Cpx megacrysts constitute a major part of the Cr-poor megacryst fractionation sequence. Although much of their major element variation is attributable to simple fractional crystallization, deflection of the frationation trends in many cases toward Cr- and Mg-rich compositions suggests that crystallizing megacryst parental magmas are not closed systems. We present Pb-Sr-Nd-Hf isotope data for cpx megacryst samples at regular intervals along evolution paths. The two localities we have examined in detail thus far, Pofadder and Monastery, display illuminating similarities and differences. Mg- and Cr-rich compositions dominate the cpx megacryst population at Pofadder, with only a minority of Cr-poor varieties. These megacrysts describe wide variations in all isotope systems (e.g. $^{206}Pb/^{204}Pb$ = 18.3 to 19.6) with the Cr-poor megacrysts having the most radiogenic Pb (although with lower Δ7/4 and Δ8/4), Nd and Hf isotope ratios. At Monastery, Cr-poor varieties dominate the cpx megacryst assemblage, with a small population of only moderately Cr-rich megacrysts. Here, isotope ratios display a much smaller variation (e.g. $^{206}Pb/^{204}Pb$ = 20.3 to 20.8) and encompass HIMU compositions comparable to the most extreme OIB at St. Helena. Pb becomes progressively less radiogenic as Cr# gradually drops with decreasing Mg#, and this progression continues as the evolution path is deflected toward higher Cr# and mildly increased Mg#. Our isotope data are consistent with an increasing degree of mixing between megacryst parental magmas having HIMU isotopic characteristics and deep lithospheric peridotite (having relatively unradiogenic $^{206}Pb/^{204}Pb$, Nd and Hf) with increasing magma evolution, the extent of assimilation appearing to be much greater at Pofadder than at Monastery. The nearly monotonic changes in the isotope ratios of cpx megacrysts from Cr-poor to Cr-rich compositions at these localities confirms that the two suites are petrogenetically related. Moreover, such mixing may be partly responsible for the lack of strong HIMU compositions directly observed in southern African kimberlites

Geochronological, geochemical and growth constrains of Alpine clefts from U-Th-Pb in monazite

EMILIE JANOTS[1], ALFONS BERGER[2], EDWIN GNOS[3], MARTIN WHITEHOUSE[4] AND ERIC LEWIN[1]

[1]ISTerre, Grenoble, France
(*correspondence: emilie.janots@ujf-grenoble.fr)
[2]Museum of Natural History, Geneva, Switzerland
[3]University of Kopenhagen, Denmark, [4]Museum of Stockholm, Sweden

Monazite is a powerful U-Th-Pb chronometer of geological processes. Although conditions that drive its dissolution and precipitation remain unclear, monazite occasionally occurs in hydrothermal veins. Recent studies showed that hydrothermal monazite is successful to date mineralization. The originality of the present work is to evaluate if compositional and isotopic signature of monazite can record the geochemical environment and duration of rock-fluid interaction.

For this study, the selected monazite crystals satisfy two criteria: they are geologically young to ensure a Ma-resolution in age, and large enough (~mm-sized) to detect an age evolution over a grain profile. Studied monazite come from two distinct Alpine clefts from Central Alps (Griesserental and Blauberg, Switzerland). U-Th-Pb isotopic data were measured using ion microprobe.

In the two hydrothermal monazite crystals, U-Th-Pb isotopic signature gives indications about the ages, duration, fO_2 and geochemical environment (close vs open system) of the mineralization. Geochronologically, the Th-Pb age is preferred to the U-Pb age (s), because of (1) the unusually low U/Th contents, (2) significant contribution of common Pb and (3) ^{206}Pb excess in the Griesserental crystal, related to significant incorporation of ^{230}Th. Blauberg and Griesserental crystals show similar Th-Pb ages ~12 Ma, with no significant variations. However, one younger analysis point (~10 Ma) suggests possible crystallization over 2 Ma in the Blauberg crystal. Compositionnally, both crystals show unusually high Th/U values, indicating oxidizing conditions and dominant hexavalent U. Blauberg monazite is rather homogeneous displaying some sector zoning. The Griesserental crystal has a rim with higher Th/U and ^{206}Pb excess (up to 80% of the ^{206}Pb) than in its core. This zoning is coherent with a two-stage crystallisation in a closed system. While ^{230}Th was in disequilibrium with the U-series when the core precipitates, the fluid had time to reach equilibrium when the rim crystallized.