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A METAMORPHOSED EARLY CAMBRIAN CRUST-MANTLE TRANSITION IN THE SPEIK COMPLEX, EASTERN ALPS, AUSTRIA

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In the Austroalpine Speik Complex (Eastern Alps, Austria), highly melt-depleted, metamorphosed harzburgites are interlayered with a suite of metamorphosed orthopyroxenites, clinopyroxenites and gabbros. Small pods and narrow bands of chromitite are abundant in the Kraubath and Hochgrössen massifs. At Kraubath, coarse-grained orthopyroxenites occur as cm- to m-wide veinlets and pods, but also as intrusive plugs several tens of metres wide. Intimately associated metaclinopyroxenite and metagabbro are present as bodies up to several metres thick at a distinct stratigraphic level within the Kraubath and Pernegg massifs. In the ultramafic rocks, relict magmatic olivine, orthopyroxene, clinopyroxene and spinel are overprinted by a metamorphic assemblage of forsterite, diopside, tremolite, anthophyllite, chlorite, serpentine, talc and Cr-Fe-rich spinel. Calcic amphibole, epidote, zoisite and chlorite dominate the metamorphic paragenesis in metagabbros, besides few relicts of clinopyroxene and garnet. The polymetamorphic evolution of the Speik Complex includes rarely preserved pre-Variscan (> 400 Ma) eclogite facies conditions [1], Variscan (~300 Ma) amphibolite facies (600–700°C, > 5 kb) and Eoalpine (~100 Ma) greenschist- to amphibolite facies conditions reaching 550°C and 7–10 kb.

Orthopyroxenites are characterized by high concentrations of SiO_2, MgO and Cr, and by U-shaped chondrite-normalized rare earth elements (REE) patterns similar to those of their harzburgite hosts [4]. The REE patterns of the clinopyroxenites are flat to slightly enriched in light REE [4]. Metagabbro compositions are variable, but generally characterised by low SiO_2 and high *mg*-numbers (61–78). Their REE patterns all have $Gd_N/Yb_N > 1$; some samples have large positive Eu anomalies implying the original presence of cumulus plagioclase.

In metaperidotites, two types of chondrite-normalized platinum-group element (PGE) patterns are observed: (1) flat patterns without significant fractionation from Os to Pd; Re_N/Os_N is < 0.5. (2) Positively sloping patterns with low concentrations of the IPGE, but significant fractionation between IPGE and PPGE (Pd_N/Os_N = 10 to 50) are observed in a few peridotites; Re_N/Os_N ranges from 2 to 17. Chromitites have a variety of normalized PGE patterns, and carry up to 4 ppm total PGE [2, 3, 5]. Many have negative slopes typical for ophiolitic-podiform chromitite. Also present are flat patterns, zig-zag patterns with positive peaks of one or more of the PGE, and positive slopes. In the orthopyroxenites and clinopyroxenites, Pt, Pd and Re are distinctly enriched compared to the IPGE.

$^{187}Os/^{188}Os_{(i)}$ ratios are chondritic to slightly suprachondritic, ranging from 0.1185 to 0.1288 in most metaperidotites of the Speik Complex, and from 0.123 to 0.127 in most chromitites. In-situ LA-ICPMS analyses of platinum-group minerals (laurite, ruarsite) separated from podiform chromitite reveal a large variation from subchondritic to chondritic $^{187}Os/^{188}Os$ (0.1158–0.1244) [3]. Those metaperidotites that have positively sloping chondrite-normalized PGE patterns, have significantly lower Os (< 1 ppb) and/or higher Re concentrations (up to 0.8 ppb); these samples yield radiogenic $^{187}Os/^{188}Os$ ratios ranging from 0.17 to 0.77. Radiogenic $^{187}Os/^{188}Os$ (0.14 to > 10) and $^{187}Os/^{188}Os$ (~0.7 to > 400) are also typical for orthopyroxenite, metaclinopyroxenite and chromitite associated with orthopyroxenite.

The Os isotopic data of the metaperidotites contain no or little age information, because (1) of large scatter in $^{187}Os/^{188}Os$, and (2) low Re/Os ratios. On the other hand, the Re-Os isotope compositions of the pyroxenites define an errochron at 550 ± 17 Ma and a supra-chondritic $^{187}Os/^{188}Os$ of 0.179 ± 0.003 (Fig. 1A). An isochron age of 554 ± 37 Ma with $\varepsilon_{Nd(i)}$ +0.7 is indicated by the Sm-Nd isotope compositions of whole-rock pyroxenites and gabbros from the Kraubath massif (Fig. 1B). The harzburgites of the Speik Complex plot on an errorchron of 745 ± 45 Ma and $\varepsilon_{Nd(i)}$ +6; this possibly dates an ancient melt extraction event in the mantle.

The pyroxenites and gabbros represent a cogenetic suite of magmatic dykes intruded into uppermost, highly depleted suboceanic mantle close to the crust-mantle transition zone in an oceanic basin close to the north-western margin of Gondwana. Second-stage melting in a supra-subduction zone setting during the Early Cambrian resulted in formation of highly depleted residual mantle and radiogenic, high-(Si, Mg) mantle melts. From such melts, the intrusive orthopyroxenite/clinopyroxenite/gabbro suite formed as cumulates under the influence of variable melt-rock reaction. Despite the polymetamorphic history of the Austroalpine basement complex, geochemical data, in combination with Re-Os, Sm-Nd isotope investigations provide constraints for the age, origin and source of melts percolating refractory upper mantle.

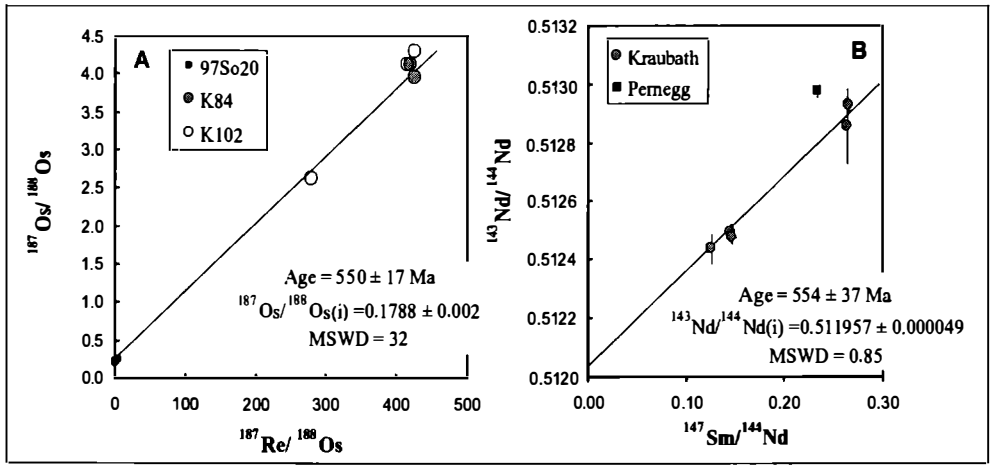

Fig. 1

Radiometric data from the Speik Complex. A) Re-Os errorchron of orthopyroxenites from the Kraubath massif. B) Sm-Nd isochron of orthopyroxenites and metagabbro from the Kraubath massif.

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