Journal of Conference Abstracts
Volume 5(2), 255

Geochemistry and Age Patterns of Garnet Peridotite in Subducted Continental Crust

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"Alpine" or "orogenic" type peridotite masses within high-metamorphic grade gneisses in mountain belts are characteristic of continental crust terranes that have been subducted into the mantle. Garnet-bearing peridotite within eclogite-facies terranes imply crustal subduction to depths >60 km, and probably much more. Crustal subduction to these deep levels appears to be driven by two mechanisms. The first and most common is where a continental margin, or a sliver from that margin, is pulled by the adjacent oceanic lithosphere down an established subduction zone beneath either an arc or another continent. Subsequent slab-breakoff allows the buoyant continental crust to return, ultimately, towards the surface. While subducted, the crustal slab is intruded by peridotite from the overlying mantle wedge; a wedge that formerly existed above an active oceanic subduction zone. The peridotite is therefore affected by fluids and melts derived from ocean crust and subducted sediments. Pyroxenite intrusions and adjacent contaminated peridotite have LREE enriched patterns, high LIL concentrations and crustal oxygen isotope signatures (Medaris et al., 1995). Clinopyroxene (cpx) separates have relatively radiogenic Sr and Pb and non-radiogenic Nd isotope ratios (Brueckner & Medaris, 1998). These enriched chemical and isotopic patterns contrast with the depleted patterns shown by peridotite remote from subduction-related intrusions. Cpx from pyroxenites may define linear arrays on Sm-Nd evolution diagrams with "ages" that approximate the time of subduction. Garnet (grt)-bearing assemblages within both peridotite and pyroxenite give Sm-Nd mineral ages that are isochronous with recrystallization ages of the host crustal terrane indicating the garnet peridotite formed or re-equilibrated during subduction. Examples of "subduction zone peridotite" occur in terranes within the Caledonides, Alps and Variscides of Europe. They provide information on mantle processes associated with the Wilson Orogenic Cycle.

The setting for the second, rarer, crustal subduction process is remote from an active oceanic subduction system. The intruded peridotite is derived from sub-continental lithosphere and lacks the subduction zone signatures noted above. Linear arrays defined by cpx, and Sm-Nd mineral ages from grt-bearing varieties, define "ages" that significantly precede the Wilson Cycle associated with Orogeny (Brueckner & Medaris, 1998). The only documented examples of "relict" peridotite occur as lenses within the Western Gneiss Region of the Caledonides of Norway. They preserve information on processes during the middle to late Proterozoic evolution of the sub-Baltic Shield lithosphere: depletion at ca. 2.1Ga or earlier, pyroxenite intrusion and recrystallization to grt-bearing assemblages during the 1.5-1.7Ga Gothian Orogeny, partial re-equilibration of the grt-bearing assemblages during the 1.4-1.5Ga Trans-Scandinavian Granite-Porphyry event and the 0.95-1.25 Sveconorwegian Orogeny. These events mirror recrystallization and intrusion events in the overlying crust and indicate the Baltic crust and underlying lithosphere were coupled since the Mesoproterozoic. Caledonian effects at ca. 420Ma are restricted to mylonitization and the crystallization of secondary grt-bearing assemblages (Jamtveit et al., 1991). There is no evidence of contamination from melts or fluids related to the subduction of Iapetus. The intrusion of these peridotite lenses into the crust appears to require the development of large-scale intracratonic faults during continent-continent collision, which allow slabs of continental shield to be driven into the sub-shield mantle where they can be intruded by peridotite from the overlying wedge of sub-continental lithosphere (Brueckner, 1998).

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