CRUST-MANTLE BOUNDARY BENEATH THE KERGUELEN PLUME-RIDGE SYSTEM

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Abstract
Deep-seated meta-igneous xenoliths brought to the surface by alkali basaltic magmas from the Kerguelen Islands reveal that basaltic magmas have intruded the upper mantle beneath the Kerguelen Islands throughout their geological evolution. These record volcanic activity associated with their early mid-ocean ridge (South East Indian Ridge) location and subsequent translation away from the ridge to an intraplate setting over the Kerguelen Plume. The meta-igneous xenoliths sample two distinctive magmatic episodes distinguished by major, trace element and isotope compositions: one tholeiitic transitional episode and one alkaline episode. Ultrasonic measurements of compressional wave speed Vp have been carried out at pressures up to 1 GPa, and densities measured, for representative samples of these two suites of meta-igneous xenoliths. A spinel harzburgite that represents the Kerguelen peridotitic upper mantle has been incorporated in the study. Vp and density have also been calculated using modal proportions of minerals in the xenoliths and, for Vp, appropriate elastic properties of end-members for the constituent minerals. Calculated and measured Vp agree well for rock types with microstructures not complicated by kelyphitic breakdown of garnet and/or pervasive grain-boundary cracking and alteration. Pyroxene granulites have measured and calculated (room temperature) Vp within the range 7.37 - 7.52 km/s; calculated velocities for the garnet granulites and pyroxenites range from 7.69 to 7.99 km/s, whereas measured and calculated Vp for a mantle harzburgite are 8.45 and 8.29 km/s, respectively. The seismic structure observed beneath the Kerguelen Plateau can be explained by (i) a mixture of underplated pyroxene granulites and ultramafic rocks responsible for the 2-3 km low velocity transitional zone below the oceanic layer 3, (ii) varying proportions of granulites and pyroxenites in different regions within the upper mantle producing the lateral heterogeneities, and (iii) intercalation of the granulites and pyroxenites throughout the entire upper mantle column, along with elevated temperatures, accounting for the relatively low mantle velocities detected seismically (7.70 - 7.95 km/s).