Mantle wedge heterogeneties recorded by microstructural evolution

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The uppermost part of a mantle wedge is the site of complex activities of partial melting, melt percolation, and fluid migration. To constrain melt-fluid-rock interactions, we studied the microstructural development and consequences for seismic anisotropy in peridotite xenoliths derived from the uppermost mantle of southwestern (SW) Japan (Seifu seamount, Fukuejima, Oki-Dogo, Onyama and Shingu). The mineral chemistry of Onyama peridotites show uniform composition in olivine (Fo_{89}-Fo_{91}) and spinel (Cr# = 0.1). However, the other suites show variable compositions, indicating they preserved intensive melt-rock reactions. Most of the olivine crystal preferred orientations (CPOs) display a well developed [100] concentration indicating (010)[100] slip system dominantly and {0kl}[100] subsequently. Onyama peridotite xenoliths show a weak CPO patterns compared with other localities, suggesting they were deformed under low shear strain. Seismic properties deduced from the mineral CPO show that Onyama peridotites, with their weak CPO, have significantly lower anisotropy than other suites. Combined with petrological and microstructural observations, we argue that a suite of the peridotite xenoliths recorded a rare snapshot of uppermost mantle flow in the mantle wedge. Geochemical characteristics and microstructural observations reveal that the presence of small melt fractions enhances the degree of deformation and thus, asthenospheric flow. Our results demonstrate the importance of the heterogeneous structure above the Philippine Sea slab with regard to the tectonics of SW Japan, and the effect preserved deformation during back-arc spreading could have present-day mantle flow.