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Deformation and melt transport in a highly depleted peridotite massif from the Canadian Cordillera: Implications to seismic anisotropy above subduction zones

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Seismic anisotropy in subduction zones results from a combination of various processes. Although it depends primarily on the orientation of olivine in response to flow, the presence of water and melt in the wedge may modify the deformation of olivine. The melt distribution also influences anisotropy. Direct observations of the deformation and melt-rock interactions in a strongly depleted spinel-harzburgite massif from the Cache Creek terrane in the Canadian Cordillera allow evaluating the relative contribution of each process. Structural mapping shows that this massif has recorded high-temperature, low-stress deformation, high degrees of partial melting, and synkinematic melt-rock interaction at shallow depths ($<$70 km) in the mantle, probably above an oblique subduction. Deformation, marked by shallow-dipping lineations and steep foliations, controlled melt distribution: reactive dunites and pyroxenite dykes are dominantly parallel to the foliation. Analysis of olivine crystal preferred orientations (CPO) indicates deformation by dislocation creep with dominant [100] glide. Glide planes are however different in harzburgites and dunites, suggesting that higher melt contents may favor glide on (001) relative to (010). Seismic properties, calculated by considering explicitly the large-scale structure of the massif, the olivine and pyroxene CPO, and possible melt distributions, show that the strain-induced olivine CPO results in up to 5% P- and S-wave anisotropy with fast seismic directions parallel to the lineation. Synkinematic melt transport by diffuse porous flow leading to melt pockets or dykes aligned in the foliation may significantly enhance this anisotropy, in particular for S-waves. In contrast, focused melt flow is not recorded by seismic anisotropy,

unless associated with very high instantaneous melt fractions. Orientation of pyroxenite dykes suggests that the present orientation of the structures is representative of the pre-obduction situation, implying trench-parallel fast polarizations and high delay times as observed above the Kurils, Ryukyu, Taiwan, and Tonga subductions.