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High and Ultrahigh pressure peridotites: fossil reservoirs of subduction zone processes and deep crust-mantle wedge interaction

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The large-scale mass transfer allied with subduction recycles surface volatiles and crustal materials into the mantle, to affect its composition and rheology. Most geological processes related to subduction thus originate from an interplay between subducting plates and overlying lithospheric and asthenospheric mantle. Much information on phase relations during subduction has been provided by experiments and by studies of natural high- (HP) and ultrahigh-pressure (UHP) rocks and fluids. In contrast, knowledge on supra-subduction mantle wedges is much less. Here, the interaction between slab fluids and mantle rocks at variable subduction depths is discussed considering two case-studies: the UHP garnet websterites from Bardane (Western Gneiss Region, Norway) and the HP garnet peridotites from the Ulten Zone (Eastern Alps). The Bardane websterites derive from cold Archean subcontinental mantle involved in Scandian subduction to UHP. Subduction metamorphism was promoted by slab fluid infiltration in the overlying mantle up to P of 6.5 – 7 GPa (c.a. 200 km depth), as witnessed by micro-diamond-bearing inclusions and by crystallization of majoritic garnet in veins. The Ulten peridotites are slices of Variscan mantle wedge which experienced infiltration of metasomatic subduction fluids. These favoured transformation of spinel-peridotites into garnet + amphibole + dolomite peridotites at P < 3GPa. Formation of metasomatized garnet peridotite mylonites suggest channelled influx of subduction fluids.
The high XMg and the incompatible element-enriched composition of subduction minerals in Bardane indicate that previously depleted websterites were refertilized by COH subduction fluids. Comparison with the Ulten garnet + amphibole + dolomite peridotites outlines relevant similarity in the metasomatic fingerprints and in the COH fluid phase involved. This calls for concomitant subduction of the continental crust, to provide carbon and incompatible element-enriched fluids. For Bardane this implies crustal subduction to 200 km depth. Mantle refertilization by crust-derived COH subduction fluids thus operates over a large depth range during subduction. Textures of the Bardane and Ulten rocks indicate that mantle recrystallization and refertilization are concomitant with fluid input along channelways, outside which long-lasting pre-subduction stories and pristine compositions are preserved. Comparably with uprising magmas, the subducted continental crust efficiently carries to the surface mantle tectonic 'xenoliths', representing major observatories on the Earth's mantle at variable depths.