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Polyphase serpentinization history of Mariana forearc mantle: observations on the microfabric of ultramafic clasts from ODP Leg 195, Site 1200

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In the forearc of the Mariana subduction zone system, a number of seamounts form from extrusion of blueschist and serpentine mud. Ocean Drilling Program Leg 195 drilled the South Chamorro seamount, where ultramafic clasts occur within the mud matrix. These clasts show a complex serpentinization history, which bears the potential for tracking the alteration history during uplift and cooling of mantle wedge rocks to the seafloor. Moreover, the microfabrics of the highly serpentinized harzburgite and dunite clasts exhibit evidence for multiple fracturing events in the forearc mantle. These, in turn, lead to fluid influx and varied styles of serpentinization of harzburgite and dunite.

The serpentinized ultramafic clasts exhibit a variety of microfabrics that range from virtually undeformed to strongly deformed samples. Pervasively serpentinized harzburgites feature either an equigranular fabric of serpentinized olivine and orthopyroxene crystals, or different vein generations related to multiple stages of serpentinization. Several types of fluid pathways in harzburgites are present:

(i) veins containing brucite and iron oxides, developed linearly without marked conformance with the rock fabric. In places, these veins developed mm-cm wide halos with finger-shaped serpentinization fronts. Veins of type (i) are either developed as syntaxial veins from a single crack-seal event with large magnetite crystals growing from one wall to the other (as confirmed with high-resolution X-ray microtomography), or formed by multiple fluid events.
(ii) serpentine veins that encompass regions of marginally serpentinized, microgranular olivine and large orthopyroxene crystals.
(iii) extensional serpentine veins (known as "Frankenstein" type). In the clasts studied, their occurrence is restricted to the halo region of type (i) veins.
(iv) as a late-stage feature, extensional veins documenting multiple crack-seal events can be present in the serpentinites (either in undeformed regions with preserved equigranular fabric, or in serpentinites of type (i) and (ii) where they crosscut and offset earlier vein generations).

In addition, serpentinized dunites can host syntaxial serpentine veins (ribbons). The ribbons separate regions, where recrystallization of serpentine and brucite can be observed. Presumably the lack of orthopyroxene locally influences the rheology and thus enable ribbon formation.

The serpentine and/or brucite assemblages formed during these different stages show distinct trace element patterns suggesting a diminished influence of slab-related fluids during later stages of serpentinization. Ongoing work is aimed at reconciling textural and geochemical co-evolution during serpentinization of the mantle wedge. In particular, deciphering deformation-related pathways for serpentinizing fluids and identifying their geochemical signatures may foster our understanding of shallow subduction-related mass transfer in supra-subduction zones.