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High-pressure petrofabrics near the subduction interface: Sivrihisar, Turkey

Donna Whitney, Christian Teyssier, Nicholas Seaton, and Erkan Toraman
University of Minnesota, Geology and Geophysics, Minneapolis, United States (dwhitney@umn.edu)

The exhumed subduction complex near Sivrihisar, Turkey, is one of the few places in the world that preserves pressure-temperature-deformation conditions from the lawsonite eclogite stability field. In the Sivrihisar complex, km-scale slices of lawsonite eclogite- and blueschist-facies rocks are in fault contact with a large metaperidotite body, providing a field-based view of the architecture of the subduction zone at 45-70 km depth. The Sivrihisar complex is dominated by Tethyan oceanic sediments – now marble and quartzite, with lesser amounts of metabasalt in layers and lenses – and as such it consists of very low density (buoyant) material compared to oceanic-crust dominated subduction complexes. Nevertheless, the Sivrihisar marble/quartzite units were subducted to $\sim$70 km depth before rapid exhumation.

Analysis of microstructures, reaction textures, and P-T conditions in lawsonite blueschist and eclogite documents a single-pass exhumation involving increasing amounts of pure shear relative to simple shear during ascent along the subduction channel, as well as strain localization and simple shear near the fault contact of the high-pressure (HP) unit and the metaperidotite body. All HP rocks, including eclogite lenses in blueschist, are extensively foliated and lineated; lineation is shallowly plunging and oriented E or NE, whereas foliation shows greater variability around the lineation. HP quartzite – some with sodic amphibole, lawsonite, phengite, garnet, and piemontite – contains quartz that is characterized in pole figures by a single girdle of c-axes, with a slight asymmetry indicating top-to-E or NE sense of shear. Marble consists of layers of rod-shaped calcite pseudomorphs after aragonite. The calcite rods range in orientation from near-perpendicular to sub-parallel relative to foliation defined by compositional layering, and are most commonly oblique in a direction consistent with top-to-E or NE shear sense. Irrespective of rod orientation relative to foliation, calcite c-axes display a strong maximum slightly off the normal to foliation, again indicating top-to-E or NE shear.

Comparison of the lawsonite unit with regions that have been overprinted during and after subduction allows us to interpret microstructures in the lawsonite eclogite/blueschist unit as the result of HP deformation. In contrast to the single-girdle c-axis patterns of quartzite in the lawsonite eclogite/blueschist unit, quartz in the overprinted regions, which range from epidote blueschist facies to a zone of Barrovian metamorphism, exhibits cross girdle c-axis patterns and tend toward constrictional fabric patterns that may record a transtensional event. In marble from the epidote blueschist region, calcite c-axes record the same single maximum pattern as calcite in the lawsonite eclogite/blueschist facies unit, even in marble in which calcite rods have been recrystallized. This pattern is obliterated only in the region of the Barrovian overprint, although massive marble that lacks calcite lattice preferred orientation records a strong lineation in other minerals. During heating and deformation related to exhumation and later tectono-thermal events, quartzite preserves the best record of HP mineral assemblages, but marble preserves the best record of HP microstructures.