New evidence of eclogitic breccia in the Western Alps: deciphering the brittle deformation and the related fluid-minerals interaction under high-pressure conditions using chemical analyses of garnet

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Under high pressure/low temperature (HP-LT) eclogite facies conditions, rocks are assumed to deform in a ductile manner rather than in a brittle manner. However, evidence for brittle deformation was observed in the eclogite units of the western Alps (Sesia and Piemonte-Ligurian domains). Evidence suggests that the brecciation and mineral fracturation occurred co-seismically and was related to pervasive fluid-flow (Angiboust *et al.,* 2012; Giuntolli *et al.,* 2018; Broadwell *et al.,* 2019).

This study focuses on new evidence of eclogitic breccia from the Zermatt-Saas unit near the Mount Avic massif. The breccia is observed in a shear zone separating oceanic crust-derived meta-basalt and meta-gabbro in the hanging-wall from a massive serpentinite in the footwall. The shear zone consists of lenses of metasediments, eclogitic Fe-Ti gabbro and Al-Mg gabbro embedded in a strongly mylonitic serpentinite matrix. The breccia consists of cm-size garnet + omphacite + rutile +/- titanite clasts cemented by secondary omphacite. Besides, sub-millimetric fragments of grossular-rich garnet are scattered in the secondary omphacite matrix.

EPMA mapping of major elements show two generations of garnet growth in the eclogitic breccia. The first-generation garnet is almandine-rich with a spessartine-rich core (grt1, $Alm_{55}Grs_{25}Sps_{15}Prp_{2}$). Grt1 shows lobate structures, peninsulas and pervasive fracturation. The second-generation garnet is grossular-rich (grt2, $Alm_{50}Grs_{42}Prp_{5}Sps_{1}$), is marked by an oscillatory zoning composition with strong Ca-Fe-Mg variations, is surrounded by a Mn-rich rim, and is spatially associated with titanite. The grt2 seals the fractures of grt1 as shown by an enrichment in pyrope and a depletion in spessartine.

Grt1 lobate textures, peninsulas and calcic grt2 crystallization reflect a fluid-mineral interaction. This interaction consists in a resorption of grt1 and Mn mobility to the outermost rim of grt2, and is also responsible for the Ca enrichment that allowed the growth of calcic mineral phases. Fracturation of grt1 and micro-brecciation of grt2 provide evidence for brittle deformation of the two garnet types possibly associated with seismic events.

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