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# Unraveling the history of complex zoned garnets in retrograde eclogites: Insights from the North Motagua Mélange in central Guatemala

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Garnets is a key mineral to record the evolution of a rock through changing pressure-temperature-deformation-fluid conditions thanks to chemical (major and trace element) zoning, mineral inclusions, and potential deformation. This work focuses on peculiar zoning patterns observed in eclogitic garnets from the Guatemala Suture Zone (Central Guatemala), and tries to link these patterns to condition changes or mineral reaction.

Eclogites from the Guatemala Suture Zone, are found as relicts within mafic bands in a coherent metamorphic belt or as enclosed blocks in two serpentinite mélanges (South Motagua Mélange and North Motagua Mélange). Among the eclogites from the North Motagua Mélange analyzed to unravel their P-T paths, four partly retrograde samples show peculiar features in garnet zoning. Garnet grains are euhedral to sub-euhedral and have glaucophane, epidote, titanite and albite inclusions in the cores of garnet, and omphacite, rutile, epidote and phengite inclusions in the rims. These inclusions record a prograde PT path from blueschist- to eclogite-facies. In contrast, the omphacite matrix is partly replaced by glaucophane, phengite, epidote, titanite, magnesio-hornblende, albite, late biotite and chlorite, showing a retrograde P-T path through the blueschist- and greenschist-facies.

X-ray maps acquired by EMPA on garnet grains reveal two types of zoning: (i) concentric zoning with a spessartine-rich core, almandine-rich mantle, and pyrope+grossular-rich rim, attributed to garnet growth, and (ii) enigmatic grossular-rich patches distributed in the cores, mantles, and rims. Trace elements were analyzed by LA-ICP-MS in the different garnet zones (both concentric and patchy zoning). Finally, EBSD images on the garnets grains were acquired to determine the crystallographic orientations among the different zones.

In all four samples, the REE patterns and spider-diagrams acquired in the inclusions and similar species in the matrix (epidote, phengite, omphacite) show a systematic enrichment in HREE in the inclusions in comparison to the matrix, while the growth zones of garnet as well as in the grossular-enriched patches show similar REE patterns. The lack of variation in LILE of minerals present as inclusions and in the matrix indicates that no major fluid influx/outflux occurred during prograde metamorphism, arguing for a nearly closed system at the sample scale. Therefore, hypotheses that Ca-rich patches formed by dissolution/reprecipitation or incongruent dissolution of garnet are not supported. EBSD measurements show a consistent orientation between the host garnet and the Ca-rich patches, indicating that the main garnet did not incorporate earlier Ca-rich relics. Interestingly, garnet patches are often found in association with other Ca-rich minerals, like epidote, and sometimes in a somewhat lozenge-shape area. We hypothesize that these patches grew at the expense of lawsonite, upon increasing temperature.