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Compositional Variation of the Inclusions in Zircon and Matrix Minerals in the Himalayan HP and UHP Eclogites

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Chemical composition of the peak and retrograde stage minerals was determined from the inclusions in zircon and from the matrix assemblage of the Himalayan high- and ultrahigh-pressure (UHP) eclogites, Kaghan Valley of Pakistan in order to determine the metamorphic evolution of these rocks. The Himalayan eclogites were previously subdivided into two groups. Group I eclogites record high-pressure (HP) eclogite facies conditions with an average P-T estimate of 704 +/- 92 oC and 2.2 +/- 0.3 GPa. They are composed of garnet + omphacite + quartz + rutile + titanite + amphibole + apatite + epidote/allanite + symplectite with accessory ilmenite. At places these eclogites are strongly amphibolitized and contain abundant quartz-albite-amphibole symplectites. Group II eclogites are coesite-bearing (coesite occurs as relics within omphacite), recording an ultrahigh- pressure (UHP) conditions, show a P-T range of 2.7-3.2 GPa and 757-786 oC. They are composed of garnet + omphacite + phengite + quartz/coesite + titanite + amphibole + epidote + symplectite with accessory rutile, ilmenite, apatite and zircon. They are mostly fresh and the omphacite remains unchanged at the core or middle portions whereas rim portions are slightly retrogressed to quartz-albite-amphibole symplectites. Matrix minerals in both group eclogites are chemically distinct from the same minerals which occur as inclusions within zircon. Chemical composition of matrix clinopyroxene overlaps the composition of inclusions within zircons of Group I eclogites, however they do not contain symplectitic features or exsolution lamellae which is abundant in the matrix clinopyroxene. Chemical composition of clinopyroxene in matrix eclogite of Group II eclogites is different from the clinopyroxene inclusions in zircons. They contain abundant quartz rods and exsolution lamellae, and at places they are retrogressed to amphibole and quartz-albite-jadeite symplectites. In contrast, clinopyroxene inclusions in zircon do not contain quartz rods or exsolution lamellae and they are aegirine-poor and jadeite-rich. Chemical composition of garnet in the matrix of Group I eclogites show weak zoning with decreasing grossularite component from the core to rim. They are mainly almandine-rich. Chemical composition of garnet inclusions in zircons in Group I eclogites is also almandine-rich, however slightly different from the matrix garnet. Grossularite component is significantly higher in garnet inclusions in zircon compared with the matrix garnet. Similar increase in the spessartine component is also observed. Chemical composition of garnet inclusions in zircon from Group II eclogites is significantly different from the matrix garnet. They are mainly almandine-rich compared with matrix garnet.

Our results suggest that most of the matrix minerals were obliterated in chemical composition during retrograde stages of the metamorphism whereas the inclusions in zircon show peak eclogite facies stages.

Keywords: Himalaya, eclogites, matrix mineral, zircon inclusions, metamorphic evolution