Compositional Zoning of Garnets across Main Central Thrust and its implication on Himalayan Tectonics, western Himalaya, India

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Metamorphic rocks of Himalayan belt are of great importance to understand the genesis of the Neoproterozoic-Cambrian Greater Himalayan Sequence (GHS) in terms of burial of the Mesoproterozoic Lesser Himalayan Sequence (LHS) beneath the Main Central Thrust (MCT) regarding the evolution of Himalaya during Miocene time (Hodges et al., 1992; DeCelle et al., 2000). Pronounced metamorphic inversion has been well documented within the LHS-GHS rocks with an increase in metamorphic grade towards structural high across MCT (Arita, 1983; Vannay and Hodges, 1996). In this study, we construct a geological map of the area along Madhmaheswar Ganga valley, Rudraprayag district, Uttarakhand, India. In order to estimate pressure (P)-temperature (T) condition and P-T paths of the study area and delineate the structural discontinuities such as MCT based on changes in P-T condition, it is necessary to understand the development of metamorphic facies from mineral assemblages and compositional garnet zoning pattern from pelitic schist in the study area. The study area which is a part of western Himalaya constitutes part of Lesser Himalayan Sequence (LHS) rocks comprised of amphibolite (~1.1 km), porphyritic schist (~3.2 km), micaceous quartzite (~2.9 km), garnetiferous pelitic schist (~2 km), and part of Greater Himalayan Sequence (GHS) rocks (~2.9 km) consisting of high grade kyanite-muscovite-biotite-garnet gneiss in an ascending order from south to north with increasing structural level. The location of MCT is defined by the abrupt change in metamorphic grade from garnet to kyanite zone (Valdiya, 1980). The pelitic rocks from upper LHS contain peak equilibrium assemblage quartz + muscovite + biotite + garnet + plagioclase with inclusion phases of illmenite + zircon + rutile within garnets. Pelites from lower GHS have mineral assemblage quartz + muscovite + plagioclase + garnet + kyanite with inclusion phases of zircon + rutile. In this study, SEM-EDS analysis is conducted to obtain chemical composition from core to rim of garnet grains and matrix biotite composition using BSE image and to acquire X-ray elemental map of garnets for four major element such as Ca, Fe, Mg and Mn from the samples collected across MCT. Furthermore, garnet-biotite Fe-Mg exchange thermometer is employed to determine the peak-T. Noticeable zoning is identified within the interior of the upper LHS garnets with monotonous decrease of X_Mn value from core to rim suggesting the grain growth during burial with increasing P and T (Spear et al., 1990). Appreciable zoning is not so obvious within the lower GHS garnets with small increase of X_Mn value at rim which could indicate diffusional modification together with significant retrograde reaction during exhumation and cooling of GHS rock (Florence & Spear, 1991). From the garnet-biotite geothermometer by Ferry & Spear, 1978, it is observed that the upper LHS rocks experienced high peak-T of about ~650°C where peak-T of about ~500°C is encountered from the rocks near MCT. Compared to the previous studies where the peak-T is greatly increased across MCT, we have not detected such increase in peak-T across MCT. Thus the reasons for this discrepancy are not clear which remains to be investigated.

References