Duration of metamorphism in the Karakoram Metamorphic Complex, North Pakistan

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Metamorphic modelling of zoned garnets from peraluminous metapelites from two separate regions of the Karakoram metamorphic complex, North Pakistan, has produced new insights into the P-T-t evolution of the deep crust along the Asian margin of the India-Asia collision zone. P-T pseudosections have been constructed in the MnNCKFMASHTO system using THERMOCALC v3.33 on a total of six samples to model peak metamorphic conditions, and U-Pb geochronology of metamorphic monazites has provided age constraints. Two previously unverified metamorphic events in the thermo-tectonic evolution of the Hunza Valley have been documented; an andalusite-grade metamorphic event associated with the closure of the Shyok Suture Zone (c. 105.52 Ma) before the India-Asia collision, and a kyanite-grade overprint on sillimanite-grade rocks (c. 28.22 Ma) after the collision. A kyanite-grade event observed in the Baltoro with similar peak P-T conditions has had peak metamorphism dated at c. 21.81 Ma, suggesting that metamorphism and deformation for this event may be diachronous between the two regions. However previous studies have also suggested that this kyanite-grade event commenced in the Baltoro as early as 28.0 Ma, indicating prolonged duration at peak metamorphic conditions before exhumation commenced. A calculated P-T path for this kyanite-grade event in the Baltoro indicates that primitive garnet growth occurred on an initially high geothermal gradient (~30°C) followed by a near-isothermal rapid increase in pressure. This event is thought to represent early stages of intrusion and lateral migration of the Baltoro batholith, comparable with tectonic models of magmatic over-accretion producing similar shaped P-T paths.

Peak P-T conditions and prograde P-T paths were calculated using compositionally zoned garnets. Where possible, to assess the reliability of calculated peak P-T conditions, the fractionation of major cations from the matrix during porphyroblast growth was modelled in THERMOCALC. When garnet makes a significant contribution to the rock bulk composition, results suggest that the fractionation of cations during growth affects the assemblage and individual phase proportions calculated at peak metamorphic conditions. In this example, employing fractionation resulted in more petrographically reliable assemblages and proportions, therefore it is suggested that, if possible, the use of fractionation should be employed for future work to allow more accurate modelling of chemical equilibrium in natural systems.