Constraing pre-Himalayan fabric by SHRIMP U-Pb zircon dating

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The Himalayan Orogen is a result of continent-continent collision no later than 57 Ma. The collision tectonics has remobilized the Archean to Proterozoic continental lithosphere in a thick NE-dipping ductile slab-like folded Himalayan Metamorphic Belt (HMB). The Himalayan Metamorphic belt (HMB) forms nappes of regional dimension in the frontal parts within the Lesser Himalaya and the Higher Himalayan Crystallines (HHC) in the inner part within the Higher Himalaya. The Higher Himalayan Crystalllines (HHC) are thrust southward over the Lesser Himalayan Proterozoic sedimentary zone, along the Main Central Thrust (MCT) and associated splays like Jutogh/ Munsiari/ Vaikrita Thrust. The southern part of this belt is thrust southward and exposed as metamorphic klippe within the Lesser Himalaya and is known as the Salkhala Nappe in Kashmir having Paleo-Mesozoic sedimentary cover, the Chamba Nappe and Chail Nappe in Himachal, the Garhwal Nappe including the Banali-Satengal-Lansdown klippe in Garhwal, the Almora- Dudatoli Nappe in Garhwal- Kumaon, and also incorporating the Ramgarh Nappe and Askote- Baijnath- Nandprayag Klippe. The HHC forms the hanging wall of the Main Central Thrust (MCT) and incorporates pelitic, psammitic and quartzite sequences together with thin amphibolite and calc-silicate bands along with granitoids of various ages. It forms the remobilized basement, which is extensively deformed and metamorphosed under middle greenschist to almandine-amphibolite facies due to collisional tectonics and uplifted to the highest elevation in the Himalaya.

Evidence of the pre-Himalayan fabric and associated metamorphism have been inferred from contact relations of 2.0 to 0.50 Ga granitic plutons and revealed extensive involvement of the middle Proterozoic basement in the central Himalayan collision zone. Although several contributors point to such an event, but there is no general agreement regarding the existence of a pre-Himalayan metamorphism. Field investigations within the HHC indicate the pre-Himalayan metamorphism and include the metamorphic banding/ layering having earliest F_1 folds, where tiny mica flakes trend uniformly across their hinges and parallel the lithological layering on their limbs. S_1 foliation has been preserved in the hinge zones of the rootless F_2 folds indicating intense transportation of the earlier structures. Crystallization of minerals such as quartz, muscovite, chlorite, biotite, feldspar, occurred during the development of F_1 folds and are preferably oriented along the axial plane foliation S_1 and, therefore, are related to the D_1 deformation. Presence of this mineral assemblage along the F_1 folds indicates greenschist-facies pre-Himalayan metamorphism. The inherited garnet ages from the Higher Himalayan Crystallines (HHC) have also been corelated to the pre-Himalayan orogeny (Alakhnanda valley: 534±24 Ma; NW Himalaya: 467±3 Ma; Central Nepal: 445±16 Ma; Namche migmatites: 548±17 Ma; Barun Gneiss: 436±8 Ma).

The observation made by us in the Mandi area of Himachal Himalaya indicates contact relationship of the Jutogh Group metamorphism with Mandi Granite. The relationship can be observed along the Mandi-Kulu road section along its eastern margin along the river bank (about 50 m below the road) where the Beas River change its course from NNW to WSW between village Karg and Badanun. The field evidences indicate a sheared contact of Mandi Granite with the Jutogh metamorphic marked by very sharp boundary, where psammites are intensely sheared. The granite contact trends parallel to the older lithological banding having a foliation S_1, which has undergone ductile shearing along S_2 foliation. At this locality both Mandi Granite and the Jutogh Group metamorphic are characterised by a common shear foliation, which is the most prevalent planar fabric of HMB and have been generated as a result of Himalayan collisional tectonics. This shear fabric transforms the older S_1 fabric of Jutogh metamorphic into well defined NW-SE trending planar fabric. This S_1 fabric is lacking in the Mandi granite and from the field evidences it appears that the Mandi Granite is intruded along this foliation plane. Therefore, the dating of Mandi Granite will constrain the age of the pre-Himalayan S_1 fabric. Keeping this in mind the dating of the Mandi Granite has been attempted to constrain the pre-Himalayan fabric by SHRIMP U-Pb technique. One coarse grained undeformed samples were subjected to standard mineral separation to

extract zircons. Cathodoluminescence (CL) imaging of zircons show oscillatory growth and sector zoning of primary magmatic zircons. Sixteen (16) near-concordant analyses on zircon grains on the core and rim of grains gave a mean $^{206}Pb/^{238}U$ age of 469±8 Ma, which is the best constrained age of this body so far.

Field relationship and SHRIMP U-Pb dating of Mandi Granite has revealed that distinct intrusive granite pluton was emplaced within the Himalayan Metamorphic Belt (HMB). Such similar granitic plutons are known to exist, however, their intrusive relationships such as apophyses and xenoliths and structures along the contacts have not been explored so far. However, the contact relationship of the well-exposed contact of Mandi Granite has clearly demonstrated presence of pre-Himalayan deformation fabric, which is atleast 469±8 Ma old.