Microstructural Analysis of Quartz grains in Monomineralic and Polyphase domains: A case study from Main Central Thrust (MCT) Zone Mylonites, western Himalaya, India

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Ongoing collision in the Himalayan orogeny causes crustal deformation owing to the thrust activity. Hence, the movement along the Main Central Thrust (MCT) enhances ductile deformation of the crust widely distributed across the orogenic belt. Therefore, detailed microstructural analysis is necessary to define the shear zone by the degree of strain intensification across the MCT. A study area along Madhmaheswar Ganga valley, Rudraprayag district, Uttarakhand, India, has been chosen. Purpose of this study is to perceive the heterogeneity of the deformational behavior of quartz grains in terms of thickness of quartz layers and other associated phases along with the understanding of fabric development with respect to the MCT. In this research, the lower Greater Himalayan Sequence (L-GHS) of *c.* 1.5 km thickness on the hangingwall side and upper Lesser Himalayan Sequence (U-LHS or Munsiari formation) of *c.* 4 km thickness on the footwall side of the MCT, has been studied.

Microstructural observations are essentially focused on the quartzo-feldspathic gneiss of the Munsiari formation and L-GHS. At lower Munsiari formation, Quartz microstructures are characterized by subgrain rotation recrystallization (SGR). Polygonal quartz grains with triple point junction indicate SGR followed by static grain growth. At upper Munsiari formation, lobate boundaries of quartz grains with sweeping extinction and deformation lamellae indicate high temperature grain boundary migration (GBM) overprinted by late stage low temperature deformation. Quartz grains in the lower GHS rocks are coarser than that of the Munsiari rocks and highly amoeboid in shape. High temperature deformation is evidenced by the presence of elongated sub-grains within these irregular grains.

To carry out further microstructural studies, 14 samples were selected for EBSD analysis. Quartz *c*-axis fabric from ˜500-829 μm thick quartz-rich monomineralic layer shows a series of type-*II* crossed girdle fabrics with *Y*-maximum. Here, the quartz *c*-axes are aligned parallel to intermediate finite strain axis *Y*, revealing the intracrystalline deformation by active prism {10 -10} *a* slip system. In contrast, c-axis orientations obtained from thin monomineralic quartz layers (thickness ˜72-163 μm) records girdles ranging from small circle girdles to type-*I* crossed girdle fabric with r-maxima. In this case, the rhombohedral plane of quartz is aligned parallel to the foliation plane (*XY*), which indicate basal (0001) *a* slip and rhomb {10 -11} *a* slip system activity. Thus, there is an effect of thickness of monophase layers on fabric development and, perhaps the role of other phases has a strong impact on the fabric development for thin monomineralic layers.

On the other hand, polyphase domains are characterized by the quartz grains totally surrounded by other phases. The size of recrystallized quartz grains within polyphase domain increases from ˜64.4 μm in Munsiari to ˜109 μm in L-GHS. C-axes orientations are random for the Munsiari samples. Whereas, C-axis fabric with point maxima is observed for the L-GHS samples. However, those fabric patterns are strengthened with increasing modal abundance of quartz.

The strength of the quartz *c*-axis fabric is quantified as a function of eigenvectors (λ_1 = maximum; λ_2 = intermediate; λ_3 = minimum) from *c*-axes orientation distribution. Following, Vollmer (1990), three end member fabric types are determined from these eigenvectors; those are point (*P*), girdle (*G*) and random (*R*). Then, by introducing cylindricity index (*B*) of Vollmer (1990), the variation in fabric strength of quartz LPO is shown as a function of strain localization throughout the Munsiari formation. Progressive increase in fabric intensity for both thin and thick monomineralic quartz layers indicate an increase in strain towards the MCT.

Keywords: Main Central Thrust Zone, Quart c-axis fabric, Strain intensification

