First Report and Microstructural Studies of Phyllonite of Gangori Shear Zone, Inner Lesser Himalaya, Bhagirathi Section, India

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We report ~ 55 m long ~ NE-SW sub-vertical exposure of a top-to-SW-down (extensional) sheared Gangori Shear Zone (GSZ) from the Inner Lesser Himalayan low-grade metamorphosed phyllonite near the village Gangori ~ 5 km NE to Uttarkashi, along the National Highway 108 in Uttarakhand, India. Sporadic brittle P-planes are present in the well distributed SW-dipping brittle Y-planes. Strong lineations were observed on the P-planes. Rock samples were taken from both the parts; i.e. where P-planes are developed and show shear sense mesoscopically, and also where the P-planes are not developed. Interestingly, all the thin-sections documented ductile shear of mainly quartzofeldspathic grains, even though brittle shear is revealed in meso-scale in terms of Y- and P-planes. XRD studies revealed presence of clinochlore and phengite in the GSZ samples. Clay/micaceous minerals define C shear planes dipping SW. At places the C-planes seem to be anastomosing, and at other they terminate abruptly. The distance between C-planes goes to a maximum of ~ 300 μm. Where several C-planes merge, the thickness of the zone is typically ~ 125 μm. No synthetic/secondary shear planes ($C^{/}$, $C^{//}$) were found, which indicates the shear dominantly resembles Couette flow. Grain boundary reduction/(dynamic) recrystallization, cataclasis (indicating < ~ 280-300 ^{0}C) and sigma structures of quartzfeldspathic

clasts are noted. Clast shapes are sigmoid, rhombic, parallelogram, polygonal and irregular. Overturned micro-fold restricted within weak clay/micaceous minerals, mantled porphyroclasts, micro-boudins, pressure shadows and fibres of quartzofeldspathic minerals at the interboudin-space between quartzofeldspathic minerals were also noted. Sigmoid mica fish are sparse. Bulging recrystallization was seen in quartz grains indicating 300-400 ^{0}C of deformation from both the sheared and unsheared parts of the rocks as observed in meso-scale. Stretched quartzofeldspathic grains rarely broke and developed pressure fringe defined by micas. A reverse ductile shear: top-to-NE (compresssional) was noted very rarely from thin-sections that are bound by C-planes that are parallel to those of the top-to-SW shear (extensional). Structural geologists commonly consider *(i)* stronger ductile shear where the C-planes are closer, *(ii)* more ductile shear leads to higher aspect ratio (R) of sheared clasts and lower angle (α) between their long axes and the C-plane. We plotted 35 quartzofeldspathic clasts in a width of shear zone (w) versus α, and w versus R. Moderate correlation was found as expected. We are now estimating strain from the GSZ samples.

Keywords: Gangori Shear Zone, Himalayan orogeny, ductile deformation, shear sense, shear sense indicators