Geochronology and kinematics of flow of the Main Central Thrust zone in the Bhagirathi valley, NW Indian Himalaya

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The Himalayan belt has been long studied to deduce large-scale tectonics of shear zones regarding both their kinematics and the age of their timing, especially in the frame of exhumation of the Greater Himalayan Sequence (GHS), the metamorphic core of the orogenic belt. The GHS is delimited at its bottom by an orogen-scale shear zone, the Main Central Thrust zone (MCTz), a top-to-the-SW km-thick zone of intensively sheared rocks. As quantitative vorticity analyses in deformed rocks and isotope dating are fundamental in the study of the kinematics of flow and time of activity in shear zones, four samples have been investigated to infer these parameters along the two tectonic boundaries of the MCTz in the Bhagirathi valley: the Munsiari (lower) and the Vaikrita Thrust (upper).

To constrain the timing of deformations recorded within the Munsiari and Vaikrita Thrust rocks we undertook $^{40}Ar/^{39}Ar$ dating. We prepared biotite and muscovite separates with different degrees of purity in order to quantify the bias given by fine-grained impurity phases, which make 100% mica purity unattainable. Combining Argon Differential Release Plots (DRP) with EPMA and Ca-Cl-K signatures of each mica populations we identified the step ages dating deformation. Microstructures of the Munsiari Thrust show the occurrence of a main disjunctive foliation defined by biotite and minor muscovite. $^{40}Ar/^{39}Ar$ stepheating coupled with correlation diagrams constrains biotite growth on the main foliation at c. 5 Ma.

The microstructures of mylonitic micaschists from the Vaikrita Thrust include three different textural generation of micas: a relict foliation, a main mylonitic foliation, and a late generation of static muscovite and chlorite overprinting the relict foliation. $^{40}Ar/^{39}Ar$ dating constrains muscovite growth on the main foliation around 10 Ma and the growth of large, static muscovite at c. 8 Ma. In the study area, Bhagirathi valley (NW India), our results support an in-sequence shearing from Vaikrita to Munsiari Thrust from c. 10 to c. 5 Ma.

Adding information about the kinematic of flow to the age of the bounding shear zones of the GHS is a key purpose for its exhumation models. The use of stable porphyroclasts analysis used for vorticity estimates can suffer from severe limitations, because of the reduction to two dimensions of motion of rigid clasts that is a complex 3D problem. We propose an alternative method to acquire data based on the use of X-ray micro computed tomography that allows to considerably decrease the limitation of the method. We selected the mylonitic orthogneisses from the Munsiari Thrust containing K-feldspar porphyroclasts in order to estimate the kinematic vorticity, which ranges between 0.49 and 0.57. We stress here the importance of a multidisciplinary approach based on detailed meso and microstructural, chemical and geochronological investigations of pervasively sheared rocks from shear zones having multiple generations of fine-grained foliations.