Two opposite kinematics shear zones in the Alaknanda – Dhauli Ganga valleys (NW India): insight from microstructural and geochronological investigations

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Shear zones play a fundamental role in building up the architecture of the orogens and deeply affect their tectono-metamorphic evolution. Nevertheless, constraining the temporal evolution of a shear zone is a key problem to face with in the study of a collisional belt (Challandes et al. 2003). Since shear zones are characterized by intense deformation and are preferential path for fluid circulation leading to mineral reactions, the interpretation of geochronological data may be difficult. Therefore, a multidisciplinary approach based on detailed microstructural, chemical and geochronological investigations is necessary to deal with rocks coming from shear zones.

In the Himalaya, two opposite kinematics-crustal scale shear zones, the Main Central Thrust zone (MCTz) and the South Tibetan Detachment System (STDS), run for all over the length of the belt (Hodges 2000). Nowadays, in spite of numerous different studies focusing on the two regional shear zones, their age of motion is still debated. In the Alaknanda – Dhauli Ganga valleys (Garhwal, NW India) both the STDS and the MCTz crop out. We selected three representative samples from the STDS, located in the northernmost portion of the study area, in order to bracket its temporal activity. Microstructural observations reveal different deformation features from the uppermost sample to the lowermost one paired with decrease in $^{40}Ar/^{39}Ar$ ages on muscovite that is deformed in the uppermost sample and is undeformed in the lowermost one. $^{40}Ar/^{39}Ar$ dating on muscovite span from c. 16 Ma down to c. 14 Ma structurally downward.

The MCTz crops out in the southern part of the study area and is delimited by two discrete shear zones/faults, the Vaikrita Thrust at the top and the Munsiari Thrust at the base. Three samples from the Vaikrita Thrust, regarded as the MCT sensu stricto, were selected to constrain its time of shearing. Microstructural investigations reveal the occurrence of various generations of micas in three different structural domains: a relict, only locally preserved, foliation, a main mylonitic foliation, and a late generation of coronitic micas around garnet related to its breakdown. Biotite and muscovite separates from all three samples were dated by $^{40}Ar/^{39}Ar$ step-heating. Combining microstructural, chemical and geochronological data, we infer that the growth of mica along the main mylonitic foliation occurs at c. 9 Ma, whereas formation of coronitic muscovite yields c. 6 Ma. Therefore, our geochronological results support that the STDS and MCT in the Garhwal Himalaya are not coeval, and the movement along the MCT lasted until 7 Ma later than the STDS. This has important consequences on the current tectonic models used to explain the exhumation of the metamorphic core of the Himalaya, delimited by the MCTz and STDS.

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Hodges, K.V. 2000. Tectonics of the Himalaya and southern Tibet from two perspectives. Geol. Soc. Am. Bull., 112, 324-350.