Timing of Deuterium and Argon mobility along the Zanskar Detachment Zone: the deep reach of meteoric water

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The South Tibetan Detachment (STD) is a > 1500 km mylonitic zone, hundreds of metres thick, separating Palaeozoic sediments in the hanging wall from high-grade metamorphic rocks and syntectonic leucogranites (Greater Himalayan series, GHS) in the footwall.
Infiltration of meteoric fluids has been documented in the deformed footwall of the STD at ca. 15-17 Ma in the Mt. Everest area where hydrous minerals equilibrated with surface-derived fluids during deformation [1]. Such minerals provide important information on the fluid source and migration pathways associated with shear zones, as well as the fluxes of fluids involved in fluid-rock interaction that in turn place limits on the thermomechanical behaviour of the STD. Such fluids also yield paleoaltimetry estimates [2].
Here, we present hydrogen isotope (δD) data combined with microstructural observations and ^{39}Ar-^{40}Ar dating from the Zanskar detachment zone (ZDZ), a local name for the STD in NW India, that extend the spatial distribution of records from the Mt. Everest region. Hydrogen isotope ratios (δD) of synkinematic biotite, muscovite, and chlorite collected within the top 450 m of the ZDZ footwall are as low as -146‰, -127‰, -140%, respectively. Together with microstructural data, these results suggest that the rhomboidal shaped mica fish interacted with meteoric fluids sourced at high elevation during high temperature (re)-crystallization / deformation. In contrast, below 450 m down to 2 km, biotite and muscovite yielding higher δD values that range from -80‰ to -97‰, and from -60‰ to -68‰, respectively, indicate interactions with deeper crustal fluids.
One sample < 10 m from the ZDZ fault plane contains two chemically and chronologically distinct muscovite generations: Ms1, enriched in large mica fish and ca. 26 Ma old, and Ms2, ca. 24.5 Ma old, whereby step ages of both aliquots anticorrelate with the Ca/Cl ratio. The other six biotite and muscovite samples (> 200 m) give slightly but resolvably different ages of 19-20 Ma. There is no direct link between the δD signature of meteoric fluids sourced at relatively high elevation and the K-Ar ages. We propose that low δD values from samples located within the top 450 m of the ZDZ footwall have been acquired while the shear zone was active and infiltrated by surface fluids between ca. 24 and 20 Ma. Micas may have recrystallized locally without ingress of external fluids, at different times along the 2 km long studied transect; their compositional variations [e.g. 3] may reflect changing PTAX during exhumation; closed-system recrystallization occurring after cessation of the ZDZ that may have removed incompatible Ar but not stoichiometric hydrogen.
If the micas in the transect indeed record formation pressures ≥ 5 kbar, meteoric waters had to infiltrate as deep as 15 km. The hydrogen isotope data obtained from the ZDZ indicate that samples in the footwall interacted during high temperature deformation with meteoric fluids sourced at high elevation. These results suggest that the Zanskar region was likely lower than the Mt Everest region at ca. 17 Ma but still represented a regional topographic high.

[1] Gébelin et al, 2017, Tectonics, 36, doi:10.1002/ 2016TC004399; [2] Gébelin et al, 2020, this conference; [3] Montemagni et al, 2019, Geological Society of London Special Publications, 481, 127-146.

Mots-Clés : Zanskar detachment zone, ^{39}Ar-^{40}Ar dating, deuterium δD, meteoric water influx

Merci de ne rien inscrire dans cette zone et ne pas modifier les marges des pieds de page et entêtes.