Fluid-rock-deformation interactions in the fossil Zanskar detachment footwall (NW India) revealing past topography

Aude Gébelin* , Richard D. Law[1], Timothy J. Webster[2], Bassi Bah[3], Donald Stahr Iii[1], Andreas Mulch[4,5], Christian Teyssier[6], and Olivia Mauguin[7]

[1]Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061, USA – États-Unis
[2]School of Environment, Earth and Ecosystem Sciences, The Open University, MK7 6AA, UK – Royaume-Uni
[3]GeoRessources, F-54506 Vandœuvre-lès-Nancy, France – Université de Lorraine, UMR CNRS 7359 – France
[4]Senckenberg Biodiversity and Climate Research Centre, 60325 Frankfurt, Germany – Allemagne
[5]Goethe University Frankfurt, Institut für Geowissenschaften, 60438 Frankfurt, Germany – Allemagne
[6]Dept. of Geosciences, University of Minnesota, Minneapolis, MN 55455-0149, USA – États-Unis
[7]Géosciences Montpellier, Plateforme MAGE, Montpellier, France – Université de Montpellier, CNRS, UMR 5243 – France

Résumé

The South Tibetan detachment parallels the east-west trending axis of the Himalayan range
over $>$ 1500 km and represents an untapped source of information for understanding the coupling among multi-scale deformation processes, fluid flow, exhumation of high-grade rocks, and topography. Here, a combination of microstructural, electron microprobe micro-analyzer (EPMA), thermometry, together with U-Pb geochronology and hydrogen isotope data from samples collected systematically over 2700 m of structural section from the Zanskar detachment zone (ZDZ) into the underlying mylonitic footwall document intense meteoric fluid-rock-deformation interactions within the top 483 m of the exposed fossil mylonitic front which was active at 22-20 Ma.

In contrast to low d2H values characterizing the synkinematic silicates from the top of the ZDZ footwall, biotite and muscovite grains collected at greater depth yield high d 2H values reflecting a signature of deep crustal fluids. These contrasting hydrogen isotope results can be correlated with quartz and muscovite microstructures as well as EPMA data, highlighting high iron and magnesium and low aluminium contents for muscovite at the top compared to those at the bottom of the section.

Deformation temperatures estimated using the opening angle of quartz c-axes fabrics increase from 483∘C at the top of the section to 681∘C at the bottom; this gradient corresponds to the combined effects of crustal thinning, low-angle normal faulting/shearing, and refrigeration by convective circulation of surface fluids.

*Intervenant

Calculated d 2Hwater values ranging from -115 ‰ to -95 ‰ suggest that the Zanskar area was standing at least above 2500 -3000 m mean topographic elevation during the early Miocene. When compared with previous data obtained from Mount Everest, our results suggest that high topography along the Himalayan range was diachronous occurring at _˜20 Ma in the western Himalaya (> 3000) and at _˜15 Ma in the Central Himalaya (> 5000m). This study highlights the close relationships between topography, meteoric fluid flow, high heat flux, and exhumation of the Himalayan Crystalline Core.

Mots-Clés: South Tibetan Detachment, Fluid, Rock Interactions, Hydrogen Isotopes, Quartz c, axis Fabrics, EPMA data