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Tectono-thermal evolution of the Atlas system – SW Morocco

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In Morocco, the High and Middle Atlas of Morocco are intra-continental fold-thrust belts situated in the southern foreland of the Rif orogen. The High Atlas and its eastern continuation in Algeria and Tunisia is an ENE–WSW to E-W trending belt about 2000kms long and 100kms wide. It is a key natural laboratory because it 1) is the southern and westernmost expression of Alpine-Himalayan orogeny, and 2) encompasses Pre-Cambrian to recent evolution of the region. Phases of shortening and exhumation of this orogen remain however ill constrained and the few available quantitative, data do not allow the present-day high topography (over 4000m) to be explained. In order to put constrains on the recent orogenic growth of the Atlas system, we investigated the temperature-time history of rocks combining extensive low-temperature thermochronological analysis (Fission tracks and (U-Th)/He on zircon and apatite), and sub-recent denudation rates using cosmogenic Neon and Beryllium analysis.

The target area is a NE-SW oriented transect between Marrakech and Igherm crossing the different structural segments of the western Atlas away from present-day fault systems. Results are much contrasted from one domain to the other: Pre-Cambrian bedrocks from the Anti-Atlas domain yield old Fission-Track ages on zircon (380-300 Ma), apatite (180-120 Ma) but also U-Th/He (150-110 Ma) still on apatite that are discussed in another contribution. U-Th/He ages on apatite are many from the High-Atlas (#>20) and much younger ranging between $\tilde{3}5$ and 5 Ma. We performed a detailed vertical profile in the axial zone of the High-Atlas. Age-elevation relationship suggests that exhumation increased towards 1.0 km/my by the Late Miocene ($\tilde{1}3$-12 Ma). Further, continental series of Cretaceous age from the adjacent Sub-Atlas domains indicate total resetting to temperatures greater than 80°C suggesting that a post Cretaceous sedimentary pile of at least 3 kilometres in thickness is missing. The timing of the erosion of this pile is being constrained by the combination of thermal modelling on the substratum of these domains with in situ cosmogenic analyses on present-day river sands to determine sub-recent denudation rates.

Our extensive thermochronological dataset provide for the first time constraints that evidence heterogeneous exhumation history across and along the chain, e.g. the High and Anti-Atlas are constituted in parts of bedrocks with roughly similar ages (absolute) but with very different ages for the ultimate phase of uplift/deformation. All these constraints are put together with structural and geomorphological informations to discuss the most recent tectono-thermal evolution of the Atlas system in SW Morocco.