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Cenozoic topographic build-up of the Iranien plateau: first constraints from low-temperature thermochronology

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The Iranian plateau is a smooth topographic high at the rear of the Zagros mountains, with average elevation of c. 1.5 km. Its formation is thought to result from the collision between the Arabian and Eurasian plates since ∼35 Myrs, following a long-standing subduction, and represents an interesting analogue to the so far better documented Tibetan plateau. Yet, while the Zagros orogeny was reappraised by numerous authors over the past few years, the topographic build-up of both the Zagros and the Iranian plateau remains ill-constrained.

We herein present (U-Th)/He and fission track (FT) thermochronology results to reconstruct the Cenozoic tectonic evolution of the Iranien plateau and quantify the age and amount of vertical movements. Apatite and zircon single grain cooling age data were collected on plutonic rocks (for which crystallization ages were already available: Chiu et al., 2010) from the internal domains of Sanandaj-Sirjan Zone (SSZ), Urumieh-Doktar magmatic arc (UDMA), Central Iran and, for comparison, Kopet Dagh. We stress that an important milestone for topographic build-up is the presence of the marine Qom formation (coeval with the external Asmari formation) in the UDMA and part of the SSZ, indicating that the plateau was at or near sea level at 20 Ma.

Temperature time paths inferred from low temperature thermochronology suggest a spatial and temporal separation of exhumation processes. The results show that the SSZ was exhumed very early in the collision process (essentially before 20 Ma), with a likely acceleration around the Oligocene (i.e. at the onset of continental collision) from 0.05 to 0.3 mm/yr. Post-collision cooling along the UDMA is marked by an average, constant exhumation rate of 0.3-0.4 mm/yr, which suggests that no significant increase or decrease of erosion occurred since continental collision. In Central Iran, the overlap (within error) of ZrFT, AFT and AHe ages from gneissic samples points to their rapid cooling during the upper Eocene (∼42°C/Ma). These results are consistent with the reported formation of several small metamorphic core-complexes in Central Iran towards the end of oceanic subduction, possibly associated with slab rollback.

Our thermochronological data allow to locate major topographic and erosional changes during the Cenozoic. Topographic build-up occurred in the SSZ during oceanic subduction and onset of collision (35 Ma) and shifted to the UDMA during continental collision (20 Ma), while progressing towards the external parts of the belt during the Mio-Pliocene (5-10 Ma). Most importantly, we conclude that the uplift of the Iranian plateau was a constant, steady process over the last 20 Ma, at least as a first approximation, as inferred from the combination of constant exhumation in the UDMA and sedimentary records of the central Iranian basin.