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How Chapedony metamorphic core complex (Central Iran) became cool and how it was overprinted by Neogene asthenosphere uprise: Inferences from (U-Th)/He thermochronology

Fariba Kargaranbafghi (1), Jurgen P. T. Foeken (2), Franz Neubauer (1), Finlay M. Stuart (2)

(1) Department Geography and Geology, University of Salzburg, Austria (Email: fariba.kargaranbafghi@sbg.ac.at; Fax: ++43-662-8044-621). (2) Isotope Geosciences Unit, Scottish Universities Environmental Research Centre, East Kilbride, UK.

Apatite and zircon He thermochronometry is used to determine the late-stage cooling history of the Chapedony metamorphic core complex (CMCC) in the Saghand region of central Iran. Our data helps to constrain the Cenozoic tectonic evolution of Central Iran block of the Eurasian-Arabian collision zone. We found three age groups, and – unexpectedly - younger ages in the hangingwall block of the metamorphic core complex. We conclude that:

(1) (U-Th)/He ages of zircon and apatite indicate that the Chapedony complex had cooled to less than 50˚C by 30 Ma. These ages are consistent with a period of extremely rapid cooling from 700˚C (based on U-Pb and $^{40}Ar/^{39}Ar$ ages) within less than ca. 15-20 million years. This corresponds to cooling at a rate of 40–80˚C/Myr. Using mineral thermobarometry constraints on the initial depth (13 km) we calculate that the region underwent erosional exhumation at a rate of 0.6 to 1.3 km/Myr. Within the limits of the data there appears to be no consistent regional difference in cooling histories of the complex. These data show that the CMCC exhumed during the main phase of subduction of the Arabian plate beneath the central Iranian Plate at 49 to 30 Ma (Hafkenscheid et al., 2006 and references therein). The deformation phases recognized from the cooling phase occurred in the middle and late Eocene to early

Oligocene is characterized by palaeo-stress evidence for sub-vertical $\sigma 1$ and oblique $\sigma 2$ and $\sigma 3$, which indicate extension perpendicular to the collision zone associated with normal faulting possibly due to a post-orogenic collapse. The majority of the exhumation appears to have occurred prior to later N-S to NE-SW trending transpression occurred from the late Oligocene to Pliocene (which is correlated with the current transcurrent tectonics controlled by central Iran).

(2) **However:** The apatite He age of a granodiorite and from two samples sedimentary rocks from the hanging wall unit in the northern part of the core complex reveals a significantly younger cooling age (21 Ma). These data are consistent with previous (U-Th)/He apatite ages (Verdel et al. 2006) from the hangingwall unit exposed to the east of the Chapedony metamorphic core complex at c. 20 Ma. This pattern is consistent with recent reports of a crustal thinning and a shallow, low-velocity asthenosphere in Central Iran, and the age gradient matches the eastwards uprising of the base of the lithosphere (Paul et al., 2006; Kaviani et al., 2007). Consequently, we explain the apparent age reversal as an early Miocene overprint of the Chapedony metamorphic core complex by thinning of the lithosphere.

(3) Weak evidence for a third event at ca. 12 Ma could be directly related to the activity of the Post-e-Badam strike-slip fault during Miocene.

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