Geophysical Research Abstracts
Vol. 16, EGU2014-6939-3, 2014
EGU General Assembly 2014

Deformation styles and exhumation patterns in the Northern Iranian Plateau: New results from integrated balanced cross sections and low-temperature thermochronology (AHe and ZHe)

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The Iranian Plateau is situated in the collision zone between the Arabian and Eurasian plates and forms a NW-SE elongated, 40- to 50-km-thick crustal block, delimited to the north by the Urmieh Dokhtar Volcanic Zone and to south by the High Zagros Mountains. The plateau is characterized by a series of basins and mountain ranges bounded by reverse and transpressive faults. These mountain ranges reflect a history of strong collisional deformation, with intensely faulted and folded Pre-Cambrian (basement) to Miocene (terrestrial sediments of the Upper Red Formation) rocks. Based on the structural evolution, high mean elevation of 2 km, and a crustal thickness of up to 56 km, the realm of the present-day plateau must have absorbed a significant fraction of past plate convergence between Eurasia and Arabia. However, according to seismic and GPS data active deformation is rather limited. In addition, the exact timing and style of deformation, the extent of crustal shortening and thickening on the northern Iranian Plateau during continental collision remain unclear.

To address these issues we collected structural data and modeled deformation scenarios cross four mountain ranges that constitute the northern margin of the Iranian Plateau (NW Iran). The Tarom, Mah Neshan and Sultanije mountain ranges are NW-SE oriented, while the northernmost (Bozgosh) is E-W aligned. Due to the lack of subsurface data, several forward and backward models were generated with MOVE (Midland Valley, structural modelling software). The model with the simplest and most robust geological explanation of the field data was chosen. In addition, we combined our structural work with an apatite (U-Th)/He study (AHe) along two transects (Bozgosh, Mah Neshan) and Zircon (U-Th)/He data (ZHe) on higher exhumed locations.

In the northern sector of the plateau late Cretaceous (or Paleocene?) rocks had been deposited unconformably onto older, deformed rocks. This suggests that the Arabia-Eurasia collision was predated by at least one contractional episode, which was most likely associated with the deposition of red continental conglomerates (Fajan Fm.). Consequently, some of the major faults affecting Tertiary units in the region may be inherited structures, reactivated during collisional deformation. Our structural results indicate that the different mountain ranges constituting the northern plateau are characterized by thick-skinned deformation (tectonics) with major deep-seated faults exposing basement rocks. Locally, thin-skinned tectonics occurred, with multiple detachment horizons within evaporites of the Lower and Upper Red formations (Oligo-Miocene), and shales of the Shemshak (Jurassic), and the Barut (Cambrian) formations. The first obtained AHe cooling ages for this area suggest that the more internal sectors of the Iranian Plateau (SW of the Mah Neshan profile) record an early cooling phase at 25-20 Ma. This was followed by outward propagation of deformation fronts to the north and northeast from approximately 12 to 8 Ma. This resulted in the development of a contractional basin and range morphology of the Iranian Plateau.