Deciphering Phanerozoic km-Scale Vertical Movements in Morocco: A Qualitative and Quantitative Study of Post-Variscan Source-to-Sink Systems

Remi Charton[1], Giovanni Bertotti[1], Tim Luber[2], Angel Arantegui[2], and Jonathan Redfern[2]

[1]Geoscience and Engineering, Delft University of Technology, Delft, Zuid Holland, Netherlands.
[2]School of Earth Sciences, University of Manchester, Manchester, United Kingdom.

ABSTRACT

Low-T geochronology and time-T modelling studies conducted in Morocco document significant pre-, syn- and post-rift km-scale vertical movements. However, time-T modelling studies failed to reconstruct a unique time-constrained geological history for the Phanerozoic at the scale of the margin. Offshore Morocco, numerous wells located on the shelf encounter a nearly complete syn- and post-rift succession. The offshore basins have potential petroleum systems, however, to date hydrocarbon exploration has mostly been unsuccessful. To address this, source-to-sink systems need to be better defined and quantified. A key is to constrain when, where, and with what amplitude the exhumation events occurred in the hinterland to quantify potential volumes of eroded sediments. We used available time-T modelling results and dynamic geotherms for T to depth conversion. This allows calculation of denudation rates, presented in a series of contour maps. Similar models are grouped into three distinct regions, distinguished by timing and magnitude of exhumation: the Meseta (including the High Atlas Massif Ancien de Marrakech), Anti-Atlas and Reguibat Shield. The presently outcropping Variscan rocks in the Meseta were close to the surface during the Permian/Late Triassic, followed by subsidence until the Middle Jurassic, exhumation in the Late Jurassic/Early Cretaceous (0.01-0.09km/Ma), renewed subsidence during the Late Cretaceous and a final exhumation in the Cenozoic (0.01-0.21km/Ma). The sampled Anti-Atlas basement rocks were deeply buried in the Permian, exhuming from Triassic to Middle Jurassic (0.01-0.16km/Ma), subsiding during the Late Jurassic/Early Cretaceous, and were exhuming from Late Cretaceous onwards (0.01-0.05km/Ma). The Reguibat Shield is marked by subsidence from the Permian to Triassic, and exhumation from Jurassic onwards for most of the massif (0.01-0.06km/Ma). High denudation rates compare with values typical of rift flank, domal or structural uplifts and are only obtained in the Anti-Atlas during the Early to Middle Jurassic and in the High Atlas during the Neogene. The mean value of 0.04km/Ma compares with weathering/peneplain rates. Estimates of eroded volumes from Permian onwards are 2x106, 0.6x106, and 0.2x106 km3 in the Reguibat Shield, Anti-Atlas and Meseta respectively. The results provide several source-to-sink qualitative and quantitative maps for selected periods in Phanerozoic times.