EGU21-13646, updated on 25 Jan 2022
https://doi.org/10.5194/egusphere-egu21-13646
EGU General Assembly 2021

Tectonic deformation and mantle-driven uplift of the Middle Atlas mountain belt (Morocco) during the late Cenozoic

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The Middle Atlas mountain range represents the northeastern branch of the Atlas system, which spans approximately 2000 km from the Atlantic coast of Morocco to Tunisia. The Atlas system is a prominent example of active intracontinental mountain belts that developed in the African plate of the Cenozoic Alpine belt.

The Middle Atlas is an inverted Mesozoic rift that began to rise during the late Cretaceous with limited crustal thickening. It can be divided into two geomorphological provinces: 1) an elevated, low-relief area called Tabular Middle Atlas (TMA), which is located in the north-western orogenic sectors and consists of weakly deformed Mesozoic sediments in stratigraphic contact with the Paleozoic basement of the western Meseta, and 2) a deeply dissected, high-relief area known as Folded Middle Atlas to the southeast, where crustal deformation is dominated by transpressive tectonics induced by a NNW-SSE maximum shortening direction. Seismicity and geomorphic landforms suggest that tectonic deformation is still active, at least in some sectors of the orogen.

In order to investigate the tectonic evolution of the Middle Atlas, we combined structural and geomorphic analysis. Although the age control of the continental syn-orogenic deposits is limited, the eastern boundary of the orogen shows evidence of recent tectonic deformation and flexural subsidence with the development of a foreland basin. Conversely, the western boundary of the orogen does not include syn-orogenic foreland basins suggesting the lack of flexural subsidence. This boundary is also characterized by alkaline late Miocene-Quaternary lava flows over a wide surface of ca. 960 km^2. These lava flows cover part of the TMA where they fill valleys crossing the Meseta and draining towards the Atlantic Ocean. The degree of subsequent fluvial incision of the lavas is lower in the TMA than in the Meseta. While incision does not go beyond the stratigraphic contact lava-substratum in the TMA, it goes further down in the Meseta indicating a higher magnitude of uplift. The lack of contractional deformation, however, suggests that such an uplift is not controlled by tectonics.

Overall, our preliminary observations suggest the occurrence of an asymmetry between the two orogenic flanks. Uplift along the eastern orogenic boundary has been triggered by late Cenozoic contractional deformation, whereas deep-seated, most likely mantle-driven processes essentially control uplift of the western boundary.