Geological Evidence for the Timing of Long-Wavelength Surface Uplift of the Atlas Mountains of Morocco

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The timing of the rise of mountains is important to understand the relationship between tectonics and erosion. It is also critical to determine the degree to which various mechanisms -thickening of the crust, thinning of the mantle lithosphere- contribute to the elevation. One of the main difficulties in establishing uplift histories lies particularly in defining paleoaltitudes. This is the reason why the occurrence of elevated marine sediments, deformed paleohorizontal markers or particular drainage patterns can provide powerful geological tools to unravelling the poorly known uplift history of mountainous regions such as the Atlas of Morocco.

Three observations yield evidence for the history of surface uplift in the Atlas domain. First, late Miocene (Messinian: 5.3-7.1 Ma) undeformed marine sediments outcrop in the Skoura area of the Middle Atlas at an elevation of 1100 m. Second, early Pliocene lake deposits in the Saharan region south of the High Atlas (Hamada du Guir) are tilted to the south over 250 km, implying ca. 700 m of relative uplift of the High Atlas piedmont since then. Third, the rivers draining from the northern slopes of the Middle Atlas flow N to NE to cross the Rifian front and enter the Pre-Rif thrust belt. This pattern indicates a northward tilt of the surface that dominated over the topographic building of Rif wedge, and its timing is constrained by Pliocene-age lacustrine limestones of the Saiss basin incised by the rivers.

These lines of evidence point to a recent, long-wavelength surface uplift of the Atlas domain in post-Miocene times. The scarce compressional deformation of the mentioned sedimentary formations and the wavelength of the doming indicate a mantle origin for the uplift. A mantle component of uplift for the Atlas mountains and plateaux has yet been put forward by several authors, but its chronology remained uncertain. Our observations indicate that the current mean elevation of the system is young in comparison with the Cenozoic crustal thickening that built the High and Middle Atlas deformed belts.