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Does lithology control post-orogenic topography and rock erodibility? Insights from Anti-Atlas of Morocco

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Rock erodibility plays a central role in setting topographic limits on relief development and is a key parameter in landscape evolution models. However, channel bed erodibility (K) is usually either fixed arbitrary or let varying over a wide range of values (10^{-12} – 10^{-3}) because it is difficult to estimate. The topography of ancient orogens offers favourable conditions to quantify bedrock erodibility through the stream profile analysis, because the channel steepness is directly related to rock erodibility rather than rock uplift or climate variability.

The Anti-Atlas is a Variscan (Paleozoic) orogen of NW Africa that has not been drifted for long distances over the late Cenozoic and hence has not experienced an extended shift across climatic zones. Furthermore, it is characterized by a well preserved uplifted relict landscape with rather uniform erosion rates since at least the last 120 - 100 Ma. This specific configuration allows studying in detail landscape erosional dynamics and erodibility.

Here, we combine geomorphic analysis of stream profiles with in situ-produced cosmogenic concentrations (^{10}Be) in river sediments, to decipher the surface evolution of the AntiAtlas and the adjacent Siroua Massif. In the Anti-Atlas, the basin-wide denudation rates determined for the relictal part of the landscape range between 5 and 20 m Ma^{-1}, consistent with rates estimated from the volume of volcanics eroded from the Siroua Massif during the last 12 - 10 Ma (10 to 20 m Ma^{-1}). The close agreement of short- and long-term erosion rates suggests a steady state landscape.

Our results demonstrate the main role of rock-type on sustaining post-orogenic landscape. Specifically, we find a striking correlation between erosion rates and normalized channel steepness per different rock-types. This allows estimating the erodibility within a narrower range of values (10^{-7} - 10^{-4}) as a function of the reference concavity values of the river network.