
Climate-driven acceleration of denudation across the last glacial-interglacial transition

Romano Clementucci^{*1,2,3}, L. Lionel Siame², Aurora Lambiase⁴, Paolo Ballato¹, Claudio Faccenna^{1,3}, Laëtitia Leanni², and Aster Team Aster Team²

¹Dipartimento di Scienze Università Roma Tre – Italy

²Aix-Marseille Université- CEREGE – Aix-Marseille Université - AMU – France

³GFZ German Research Centre for Geosciences – Germany

⁴Swiss Seismological Service (SED)- ETH Zurich – Switzerland

Abstract

Climate change modulates topography, biogeochemical cycles, ecosystems and tectonics. Although the role of climate-driven erosion has been theorized, it has rarely been quantified, especially in mountainous regions where denudation rates are high and stratigraphic records are sparse. Slowly deforming tectonic settings offer a favourable framework for isolating climatic effects, as uplift operates steadily over long timescales and topography primarily reflects lithological strength contrasts. The Anti-Atlas and Western Moroccan Meseta in northwest Africa are Paleozoic orogens that preserve relict landscapes and experienced limited tectonic deformation throughout the Cenozoic but underwent pronounced shifts in climate and environmental conditions during Saharan greening phases. Here, we combine existing and new cosmogenic nuclide data (^{10}Be and ^{26}Al) from river-borne sediments and bedrocks to quantify denudation across the last glacial-interglacial cycle. Basin-wide ^{10}Be -derived denudation rates are relatively uniform across both domains (5 to 40 m/Myr), with lowest values on the low-relief landscape summit (a few m/Myr). We identify systematic discordance between rates from ^{26}Al and ^{10}Be across lithologies, despite limited evidence for sediment storage, implying temporal denudation variability. To test the climate-driven denudation hypothesis, we perform inverse modelling based on the stream-power law to reconstruct temporal changes in erosional efficiency. Our results reveal a rapid acceleration in denudation during humid interglacial periods, consistent with enhanced erosion during the African Humid Period and point to a nonlinear erosional response to climate variability.

Keywords: Quantitative Geomorphology, Climate changes, Surface denudation

*Speaker