Changes in mountain valley widening, river incision and sediment transport in North-West Africa during the last 180 ka of Saharan climate

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Abstract

The effects of climate on eroding landscapes and the delivery of sediment from these remain poorly understood. The sampling and dating of river terraces provide one way to address this question, because these embed information about the interconnected dynamics of mountain valley widening, river incision, sediment delivery, and their sensitivity to external forcing. We developed a new approach to OSL dose rate correction of gravels to derive the most detailed chronology of river terrace stratigraphy in NW Africa to date. We sampled river terraces 10-20 m above the modern river plain for dating in a 1200 km2 river catchment, the River M'Goun, eroding the High Atlas Mountains hinterland of the continental river Draa. We applied OSL and IRSL dating to determine the age of 23 samples, using Bayesian methods to derive a robust chronology. We show terrace strath planation starts at ˜180 ka in the MIS 6 glacial maximum, followed by aggradation from 140 – 57 ka in MIS 5 to MIS 4 which deposited the up to 10 m stratigraphy of fluvial conglomerate (imbricated rounded cobbles). Incision and abandonment of river terraces occur in MIS 3 to 2 during the transition to the last glacial maximum. Our results compared with an Atlantic record of aridity in the Northern Sahara over the last 120 ka show that aggradation and valley widening occur in response to periods of northward penetration of the African summer monsoon into the High Atlas. We note that these signals persist across the different tectonic zones, from the fold and thrust belts into the sedimentary basins. More widely, our data demonstrate how changes in monsoon patterns can cause changes in the erosion of mountains and transport of sediment in arid continental interiors and these form new inputs for numerical landscape evolution models.

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OSL/IRSL dating applied to st rath terraces in the High Atlas Mountains

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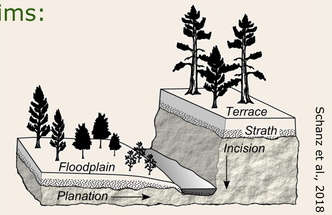
1. Motivation and Aims:

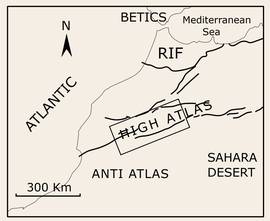
Strath terraces form as rivers switch between planation and incision, which depends on the sediment to water discharge ratio. At high latitudes, this connects to glacial activity and eccentricty cycles.



Schanz et al., 2018

But...

- When do rivers form terraces in the High Atlas?
- How does this timing reflect Quaternary climate change?
- What are possible mechanisms of switching between incision and aggradation?

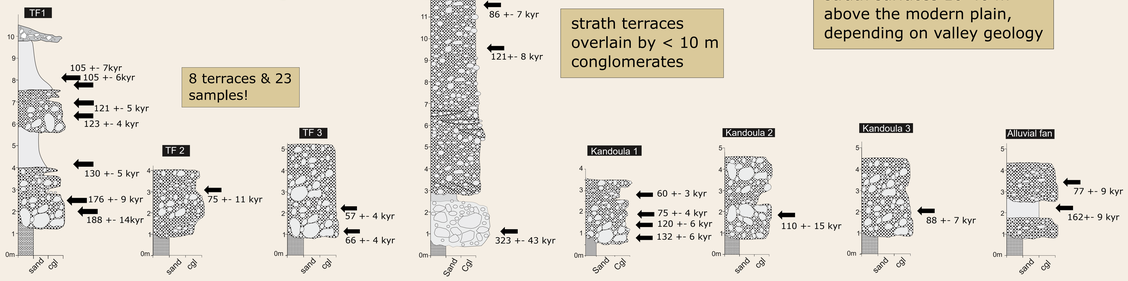


2. Methods

1. Sampling sand tubes, conglomerate blocks and bedrock. Measuring in-situ radioacivitiy to calculate dose rates
2. Quartz and Feldspar OSL/IRSL measurements

3. Results - Age Data

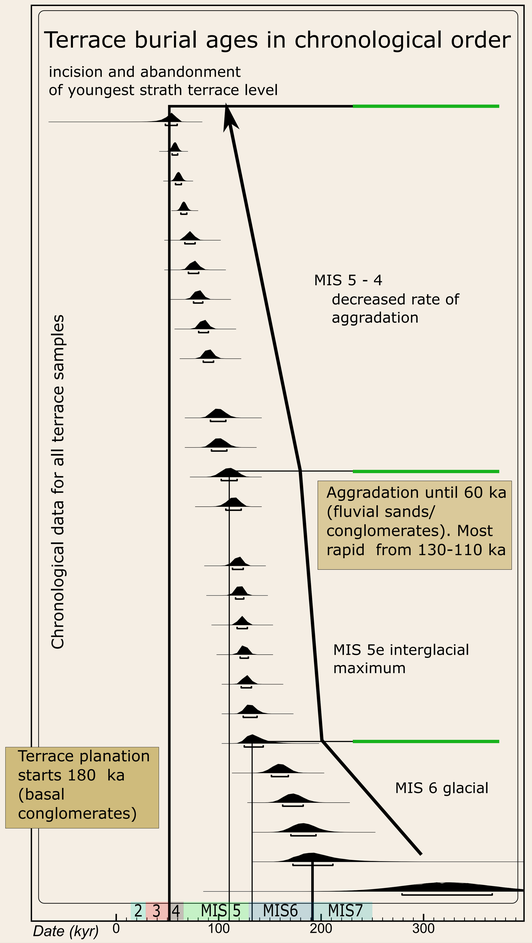
Photo



8 terraces & 23 samples!

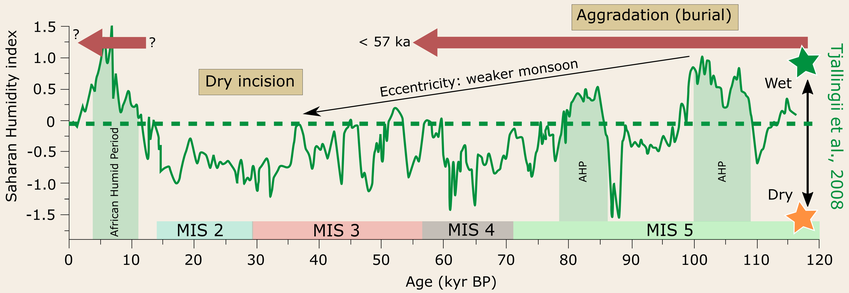
strath terraces overlain by < 10 m conglomerates

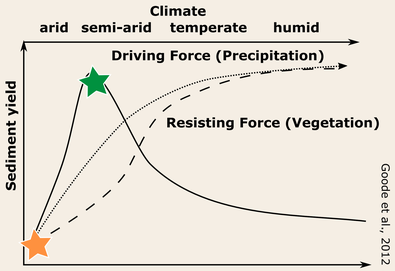
strath surfaces 10-40 m above the modern plain, depending on valley geology



4. Discussion - Saharan climate & aggradation

We compare the distribution of burial ages of overlying sediments with an Atlantic record of humidity in the Northern Sahara over the last 120 ka.
Aggradation occurs over a 100 kyr + time period with humid peaks every precessional cycle. Incision occurs during an extended dry period in the eccentricity cycle.





5. Conclusions

- Most recent and extensive terrace level aggraded since 200 ka and abandoned post 60 ka
- Coincides with low amplitude in precessional African humid period penetration
- Lower sediment yield during extended dry period could explain terrace incision

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More about landscape evolution in the High Atlas

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