The terraces of Petra, Jordan: archives of a lost agricultural hinterland

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Petra's arid landscape seems barren at first look, but the trained eye can spot omnipresent terrace remains.

- Easily visible terrace remains
- Not so easily visible terrace remains
Is this the agricultural hinterland once supplying Petra?

→ *multi-method project: biomarkers, pollen, phytoliths, soil studies*
Or was flood protection the main purpose?
Sampling sites near Petra

- Limestone terrace
- Sandstone terrace
- Monastery garden
- Control site: hilltop ruin
**Hydrological model:**

- Plant-available water in terraces > 200 mm annual precipitation
- 17 – 30 % of runoff is retained

→ *both agricultural use and flood protection feasible*
Terraces harvested not only water, but also aeolian sediments as main substrate! → creation of fertile soils on rock slopes → from Nabatean period onwards, partly still ongoing

High share of remote dust

High share of aeolian sand from surrounding sandstone cliffs (proximity effect)

Biomarkers provide clues on excrement remains (manuring & grazing)

**Stanols ratio 1**: marker of omnivore excrements (human or pig)

\[
\frac{5\beta-\text{cholestan-3\beta-ol} + 5\beta-\text{cholestan-3\alpha-ol}}{5\alpha-\text{cholestan-3\beta-ol} + 5\beta-\text{cholestan-3\beta-ol} + 5\beta-\text{cholestan-3\alpha-ol}}
\]

**Stanols ratio 2**: marker of herbivore excrements (grazing animals)

\[
\frac{5\beta-\text{stigmastan-3\beta-ol} + 5\beta-\text{stigmastan-3\alpha-ol}}{5\alpha-\text{stigmastan-3\beta-ol} + 5\beta-\text{stigmastan-3\beta-ol} + 5\beta-\text{stigmastan-3\alpha-ol}}
\]

**Stanols ratio 3**: ratio of omnivore vs. herbivore markers

\[
\frac{5\beta-\text{cholestan-3\beta-ol} + 5\beta-\text{cholestan-3\alpha-ol}}{5\beta-\text{stigmastan-3\beta-ol} + 5\beta-\text{stigmastan-3\alpha-ol}}
\]

**LCA/DCA**: bile acid ratio marking human, bird, and donkey excrements
During antiquity:

- Planned manuring
- Grazing limited

→ likely agricultural use of terraces!

Grazing dominates recent use
Intense manuring of monastery garden with human excrements

Monastery garden (Jh site 2)

Triclinium hilltop (Jf site 124/1) (control site)
- cereals and other crops were processed

-substantial amounts of charred material were deposited

(→ burnt dung for manuring?!)
Pollen sandstone terrace

- cereals suggest cultivation
- aquatic alga Spirogya suggests standing water for several months
→ large terraces stored and probably redistributed water
Conclusions

- Terrasses were constructed from the Nabatean period onwards, partly used opportunistically until present day
- Harvested water and aeolian sediments → creating fertile soils
- Hydrological model suggests agricultural feasibility + significant reduction/storage of flash floods
- Biomarkers suggest manuring with human excrements → agricultural purpose seems likely
- Pollen and phytoliths suggest cereal agriculture + temporary standing water + burnt dung (most likely as manure)
- Terrace remains represent Petra's lost agricultural hinterland!