Middle to Late Pleistocene alluvial surface ages recorded by their spectral reflectance in Patagonia, Argentina

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Problem:

Dating alluvial surfaces e.g. with cosmogenic nuclides is costly and very time consuming!

Our Approach: **A spectral-age model**

→ Linking spectral response of surface weathering to cosmogenig nuclide (^{10}Be) exposure age data.

Background: **A previous spectral-age model "just" spans the last 120 ky in the Basin and Range province, California.**

We sampled 12 of 20 terrace steps for CNE - ^{10}Be. Ages range from ca. 60 ky to probably 1.2 My. The terrace steps seem to have a 100 ky cyclicity (see Poster #15938 by V. M. Fernandes). The model will enable us to infer ages of more terraces in the region.

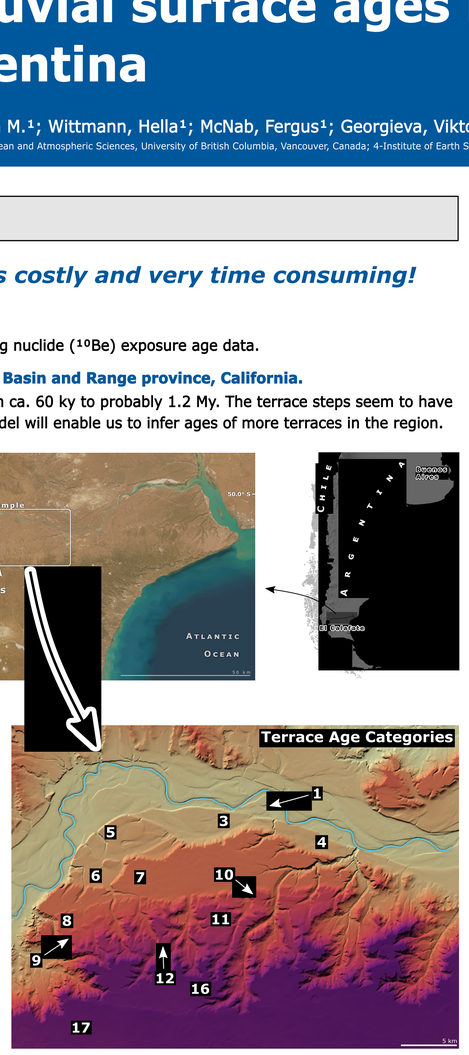
Río Santa Cruz

Ca. 300 km long. No bigger tributaries.
Anthropogenic impact is still very low.

20 different surfaces.
6 of them might not be individual steps.
4 of them difficult to correlate.

Lithology: quartzitic, granitic or sandstone.
Surface cover: (cobbles) pebbles, sand, silt/loess and low shrub vegetation.

Main driver: Westerlies (50°S)
Temperature: 7°C yearly average
Precipitation: 100 - 300 mm/yr



Working Questions:

? Can we align and correlate in-situ and satellite data? And can the latter extend the results spatially?

? How can the Contact Probe data be combined with the spatially averaged Footprint data?

? What do the spectra of the pure materials tell us exactly about weathering and age?

Spectral Data:

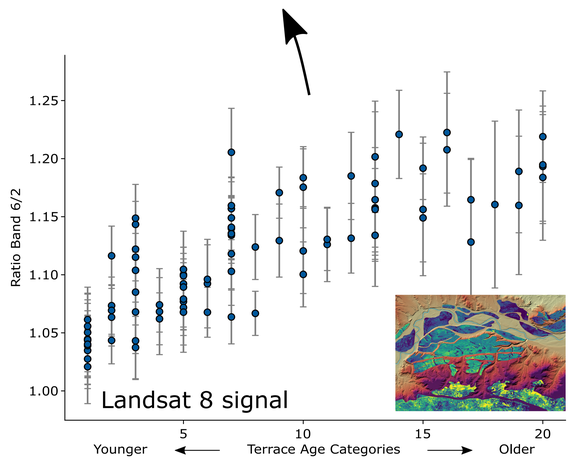
Landsat 8 and EnMAP
multi-/hyperspectral, 30x30m pixel, atmospheric correction (BCET) for L8, spectral point sampling

PSR+ (fieldspectrometer)
hyperspectral, Continuum Removal
- **1m footprints:** mixed signal
- **Contact Probe:** "Endmembers"

Results:

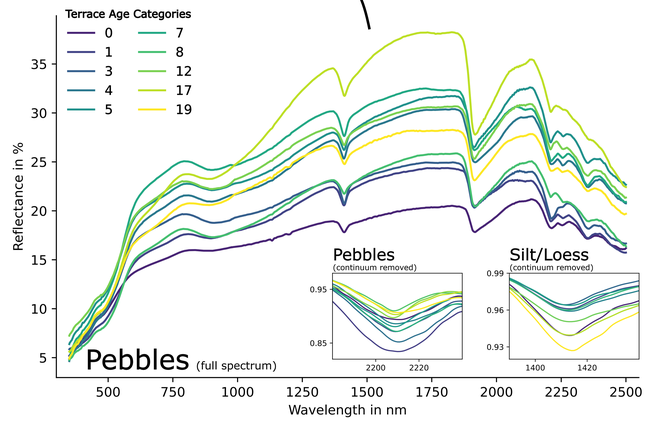
Satellite

Landsat 8 data shows strongest age correlation in **band 6** (SWIR1, 1570-1650 nm). The ratio to stable band 2 (BLUE, 450-510 nm) increases by **~20%** through the whole age range.
(EnMAP work in progress.)



PSR+ (fieldspectrometer)

Contact Probe data shows e.g strong increase in **overall** pebble **spectrum** reflectance, but also specifically in the range 1500-1800 nm. Continuum Removed data shows decreasing **absorption features** for pebbles and deepening absorption features for silt/loess with age.
(Footprint work in progress.)



Interpretation:

Spectral

Spectral in-situ data identifies weathering with time that can be tracked via satellite.

The Contact Probe data shows changing absorption features that are related to **iron oxides** like hematite and goethite or to **clay minerals** due to their water absorption bands. These signs of weathering are supported by Landsat 8 data that picks up the overall reflectance increase.

Geomorphic

The Río Santa Cruz setting allows a spectral-age model ranging up to 1 My.

Linking the terrace chronology with the spectral data results in a age model that spans up to **~ 1 My**. This means **weathering rates** in dry and cold Patagonia are **much slower** compared to other regions with less stable and warmer climate conditions or different lithologies. Spectral data tends to saturate there more quickly.

Outlook:

Next steps:
- mineral identification
- question of different sensor scales

Spectral-Age Model:
→ robust calibration
- applying to undated terraces

Spectral Differences:
→ weathering & age differences
→ incision signal migrating through channel

Model transfer:
- application to different climates, lithologies and channel topologies

GFZ Helmholtz Centre Potsdam
erc European Research Council
GyroSCoPe Geomorphic and Sedimentary responses to Climate Periodicity