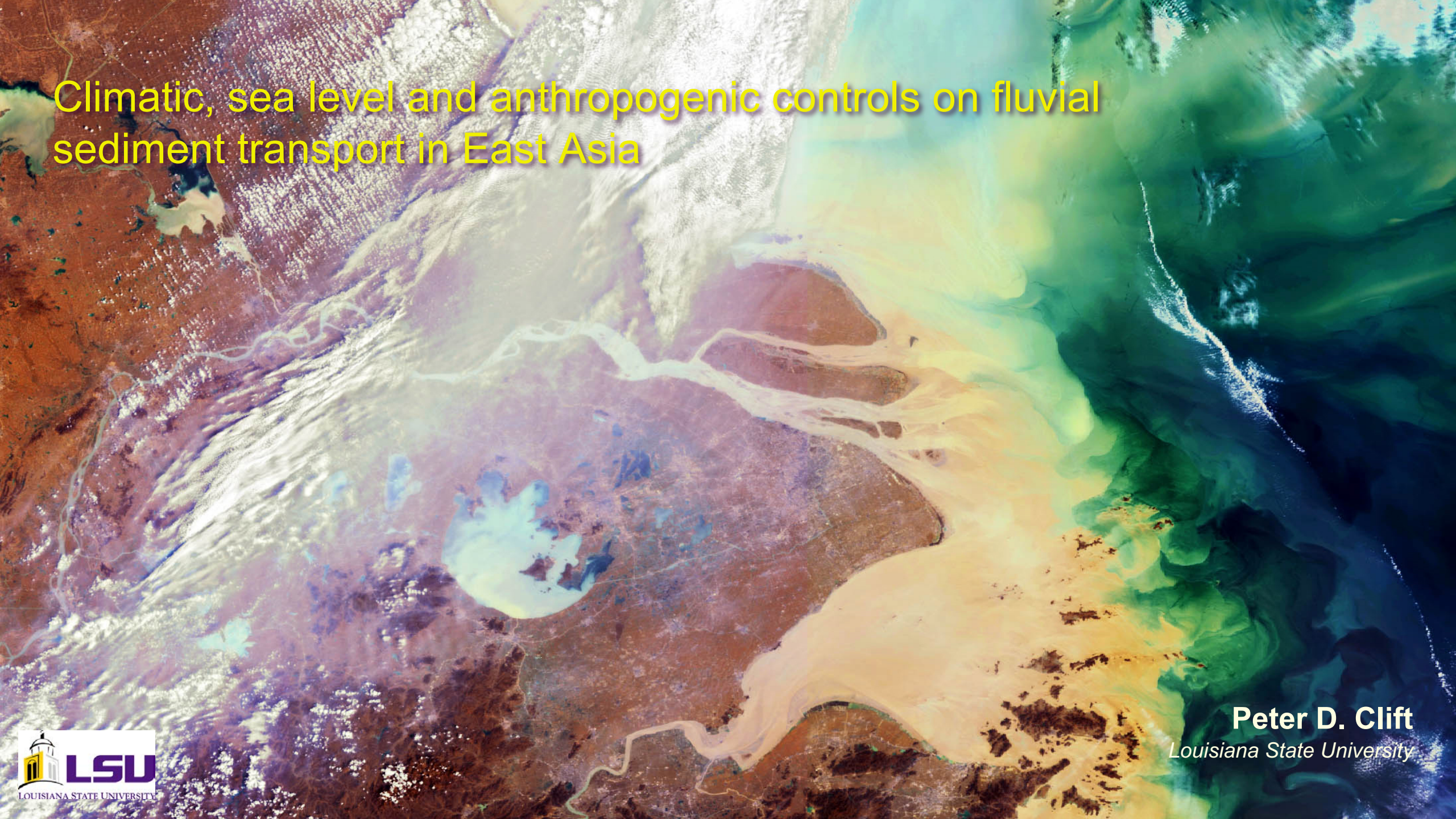
Climatic, sea level and anthropogenic controls on fluvial sediment transport in East Asia



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Research Objectives

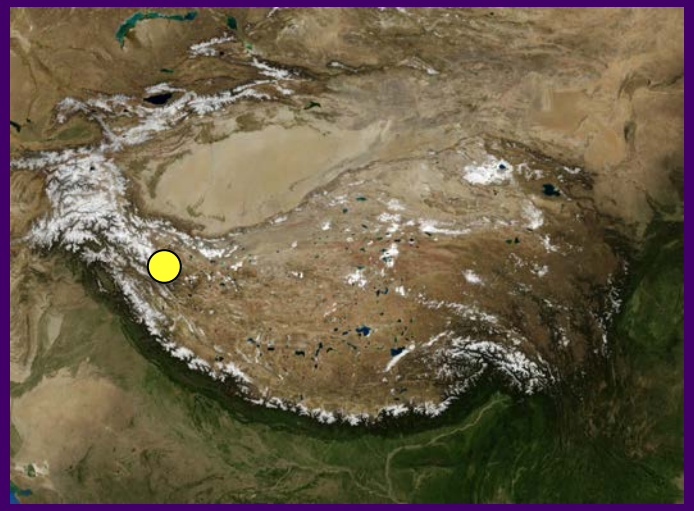
- How do changes in climate (monsoon intensity) impact erosion and the transport of sediment to the ocean?

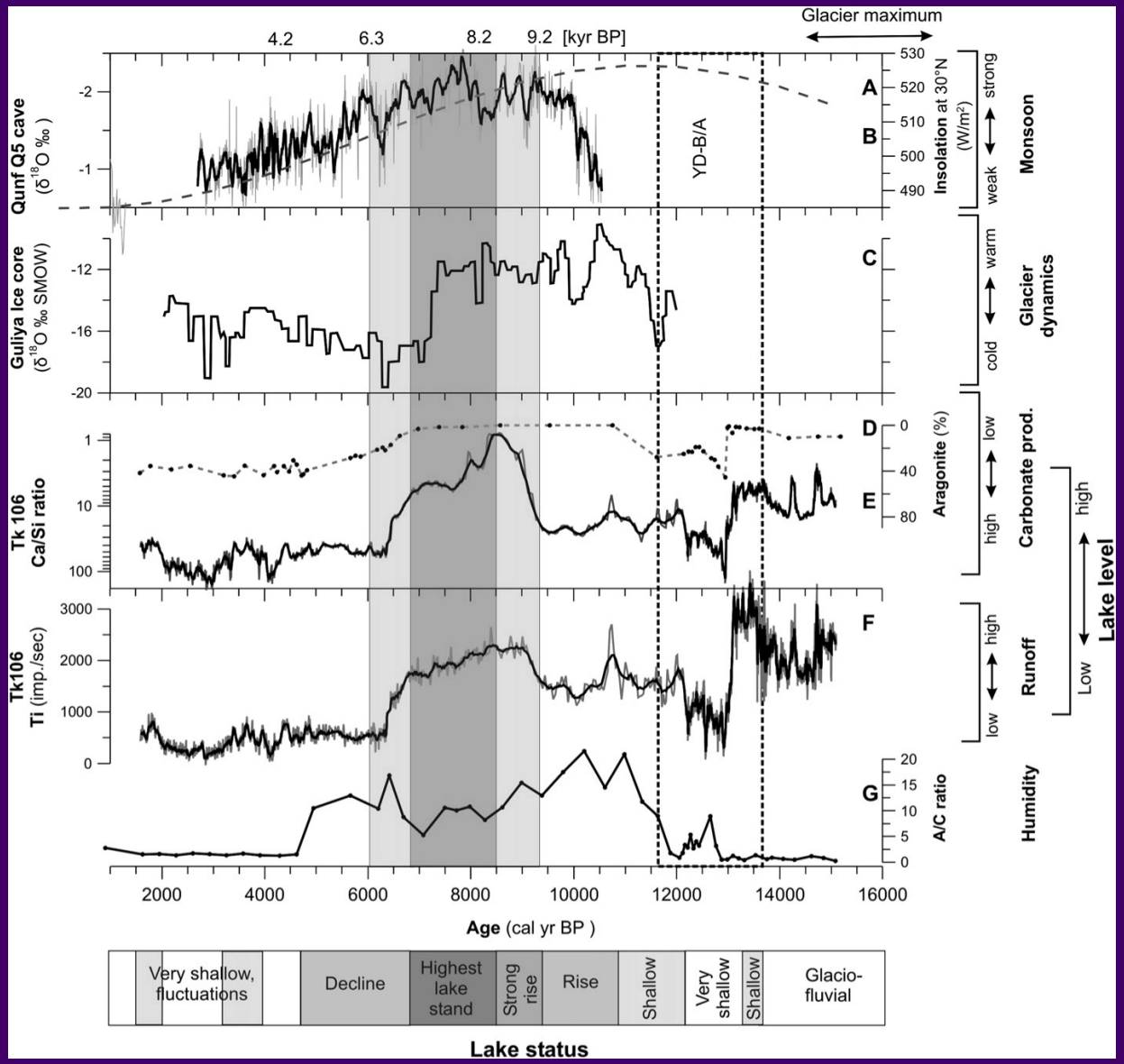
- How does human activity affect erosion and sediment transport to marginal seas?

- What are the timescales of these responses?

- Can we resolve human activity from changes driven by climate or tectonic processes?

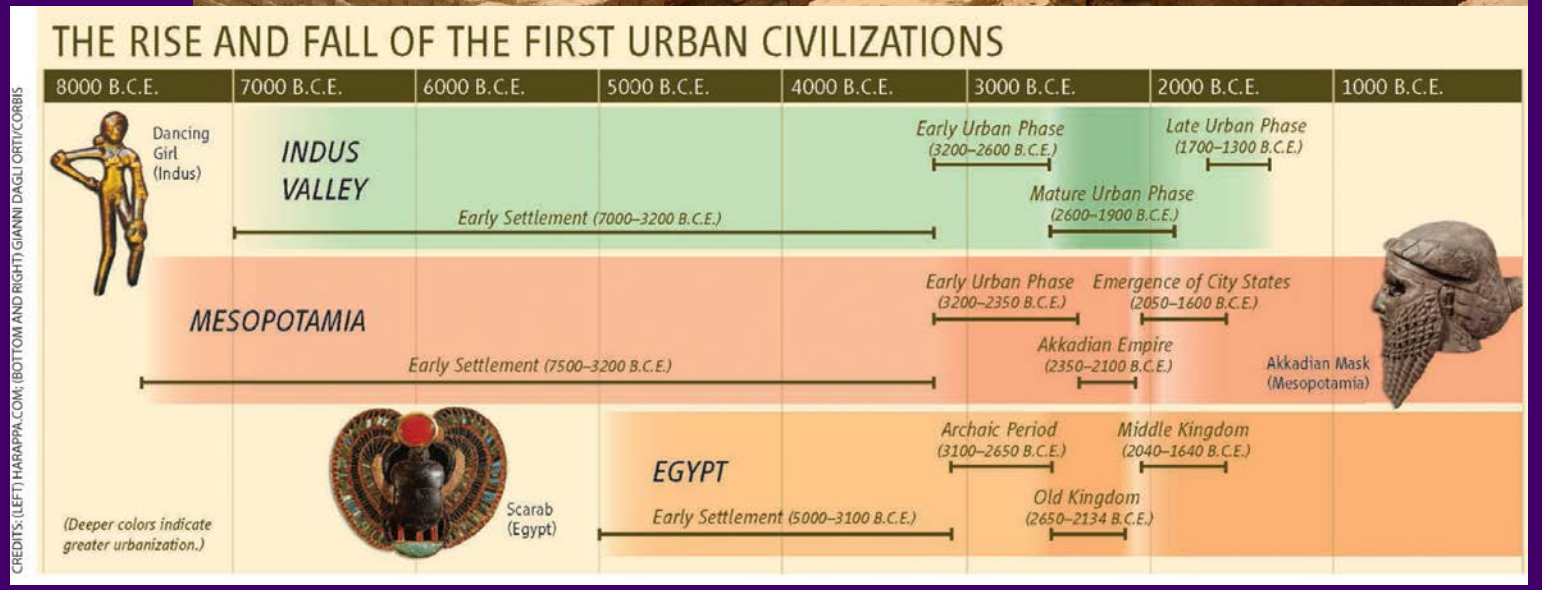
Quaternary sediment flux can be compared with the evolving monsoon intensity and sea level



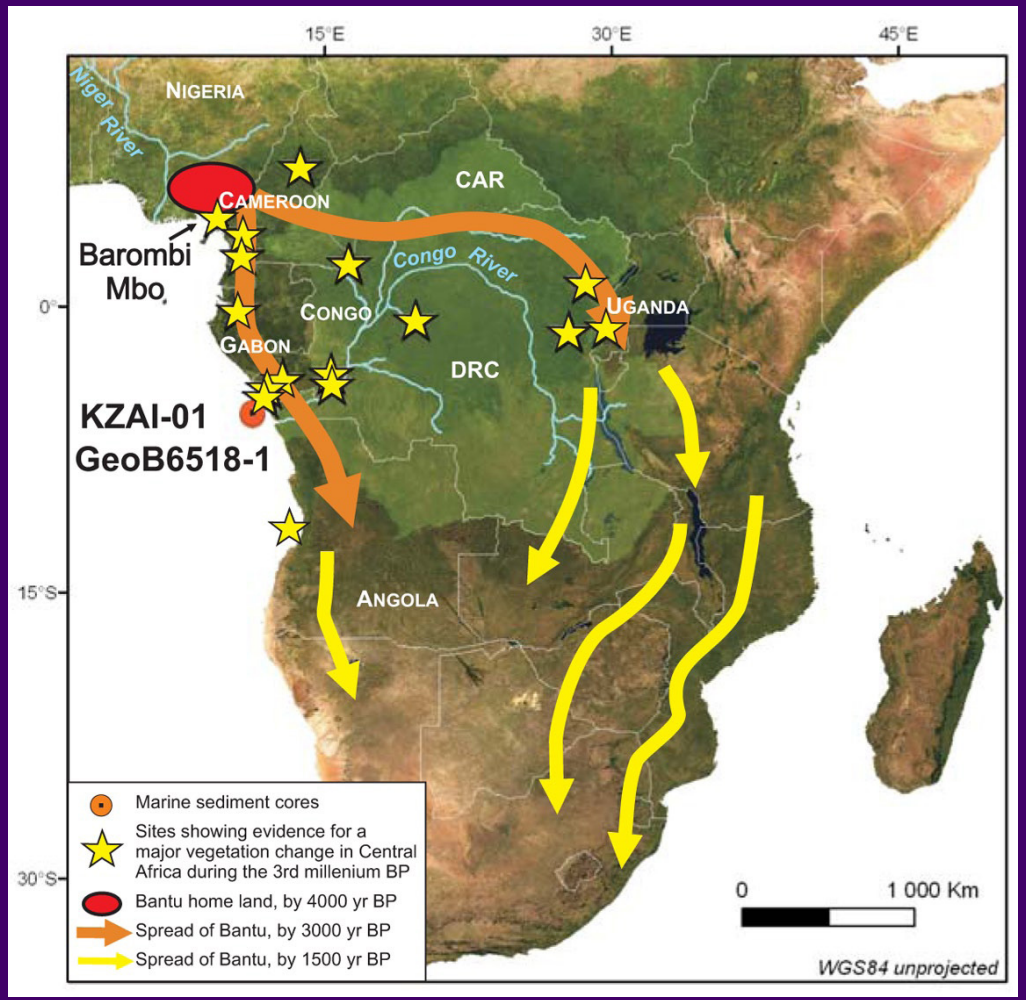


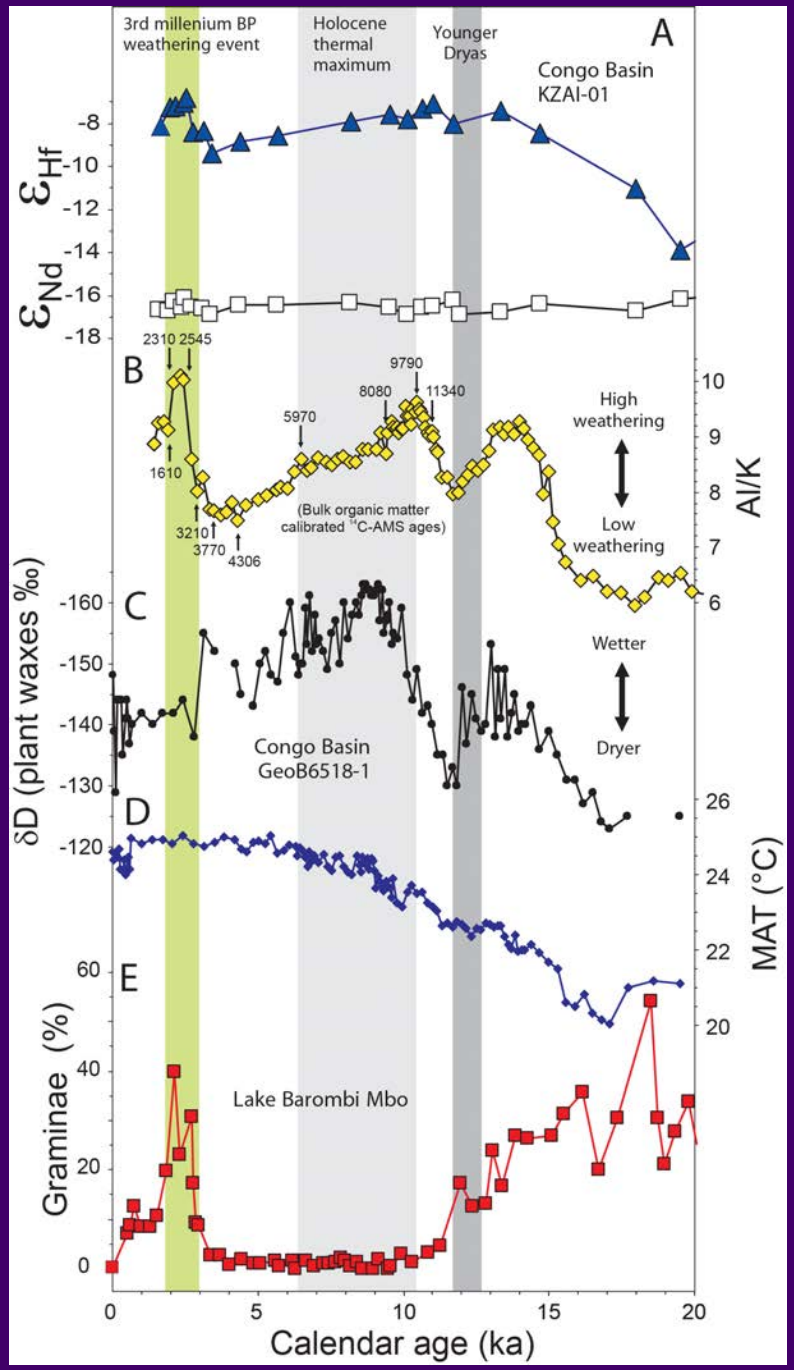
Wünneman et al. (2010)

The Harappan were established around 3200 BC with major cities supported by extensive agriculture. Did they impact the landscape?



Settlement of the Congo basin is believed to have caused sedimentation of a pulse of weathered sediment offshore, similar to that caused by Early Holocene strong monsoon

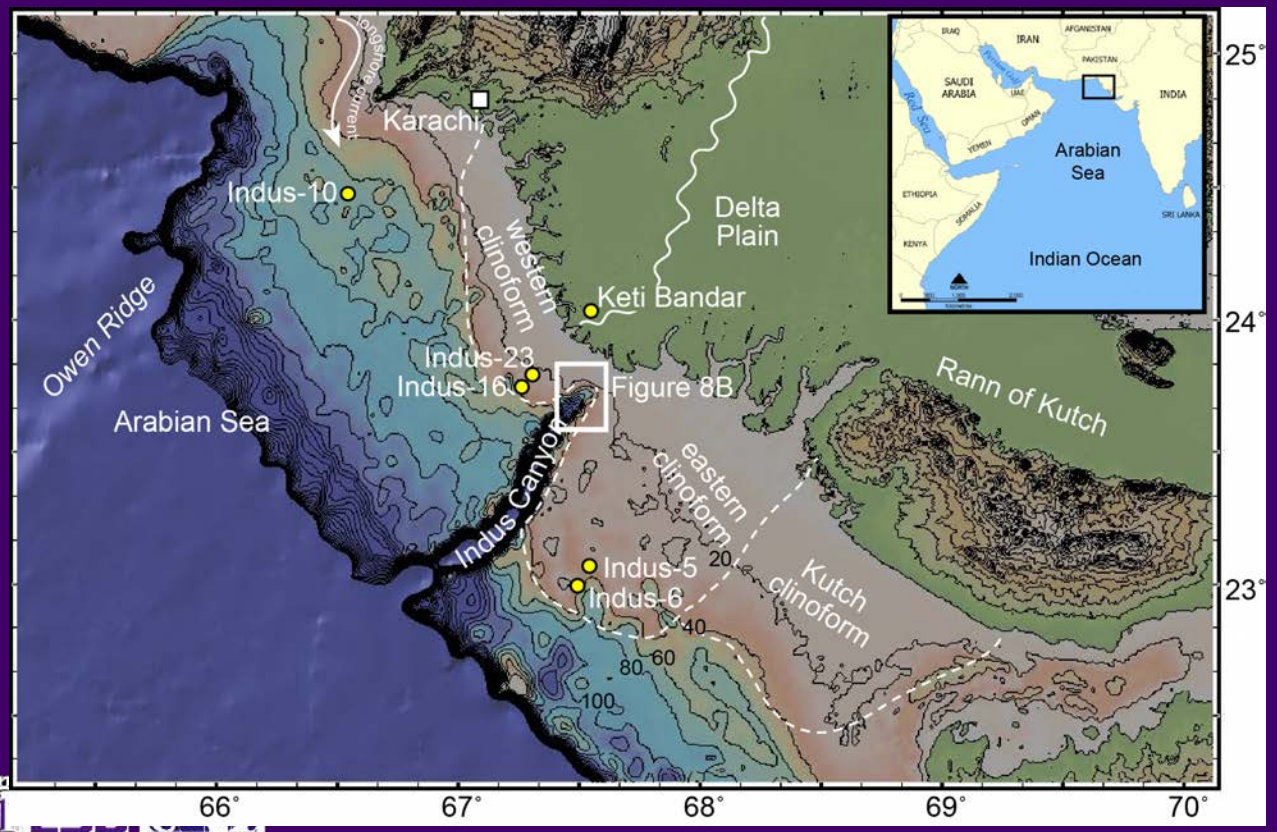


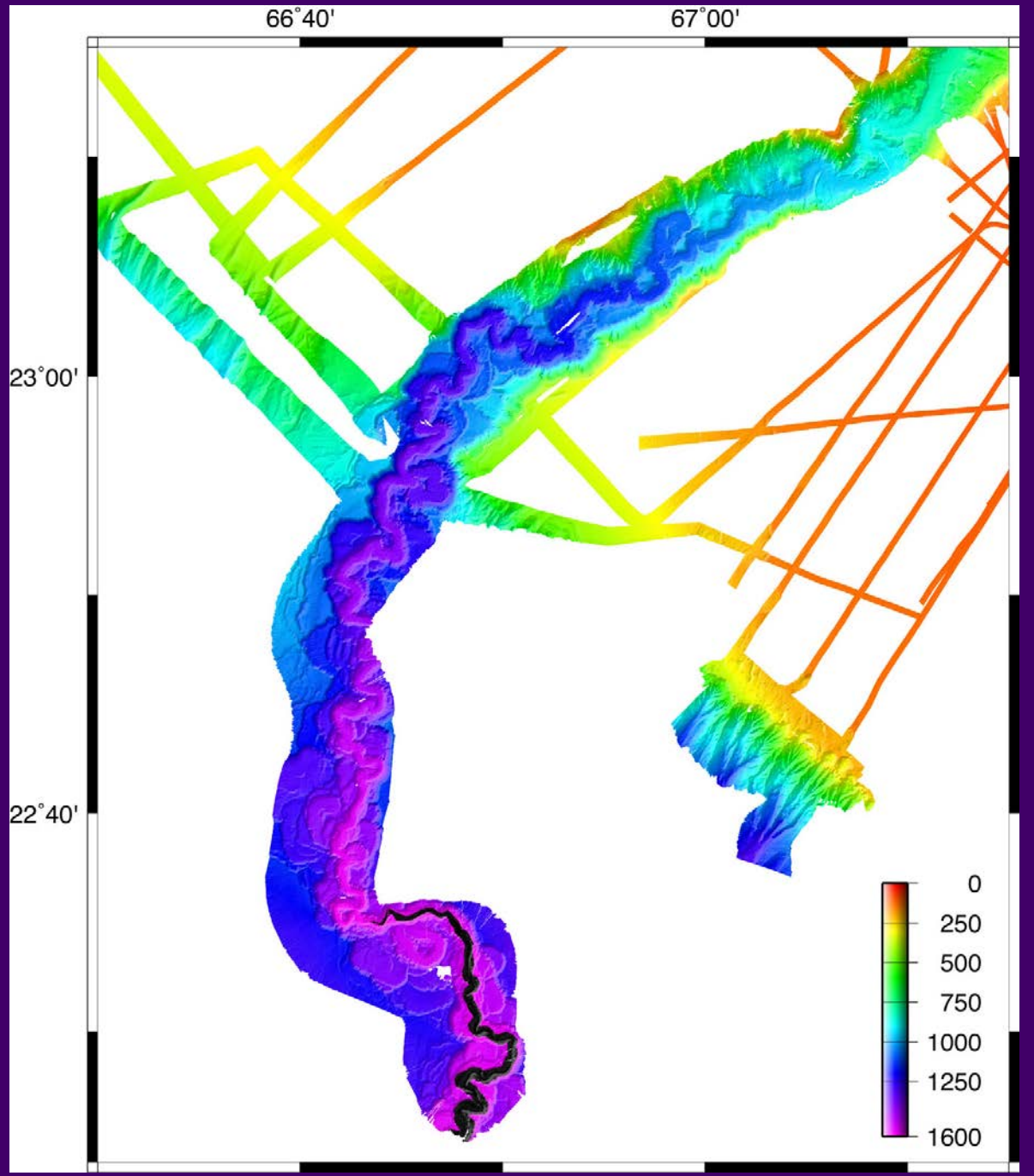


Bayon et al. (2012)

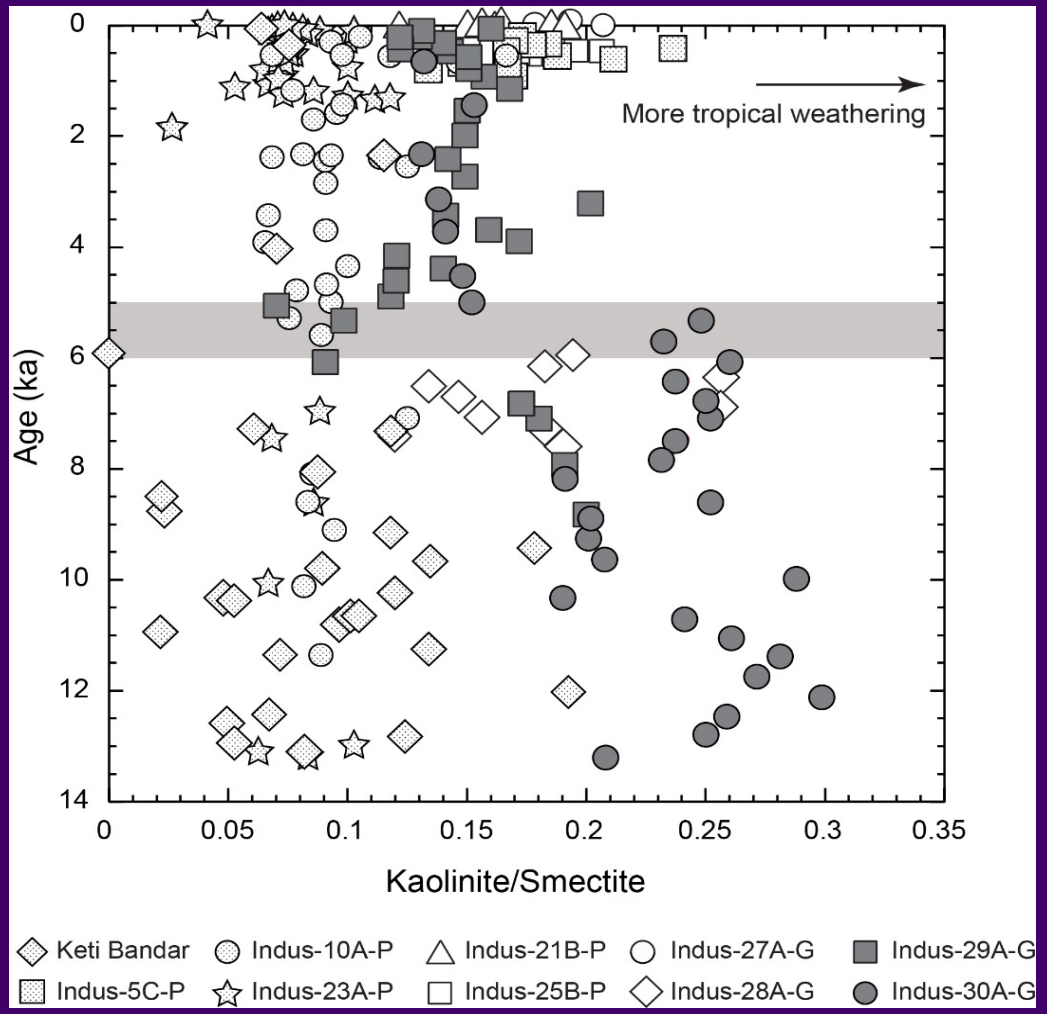
Coring in the Indus canyon and shelf now allows the weathering response to monsoon changes and human settlement to be assessed

The Indus is the home of one of the oldest urban civilizations

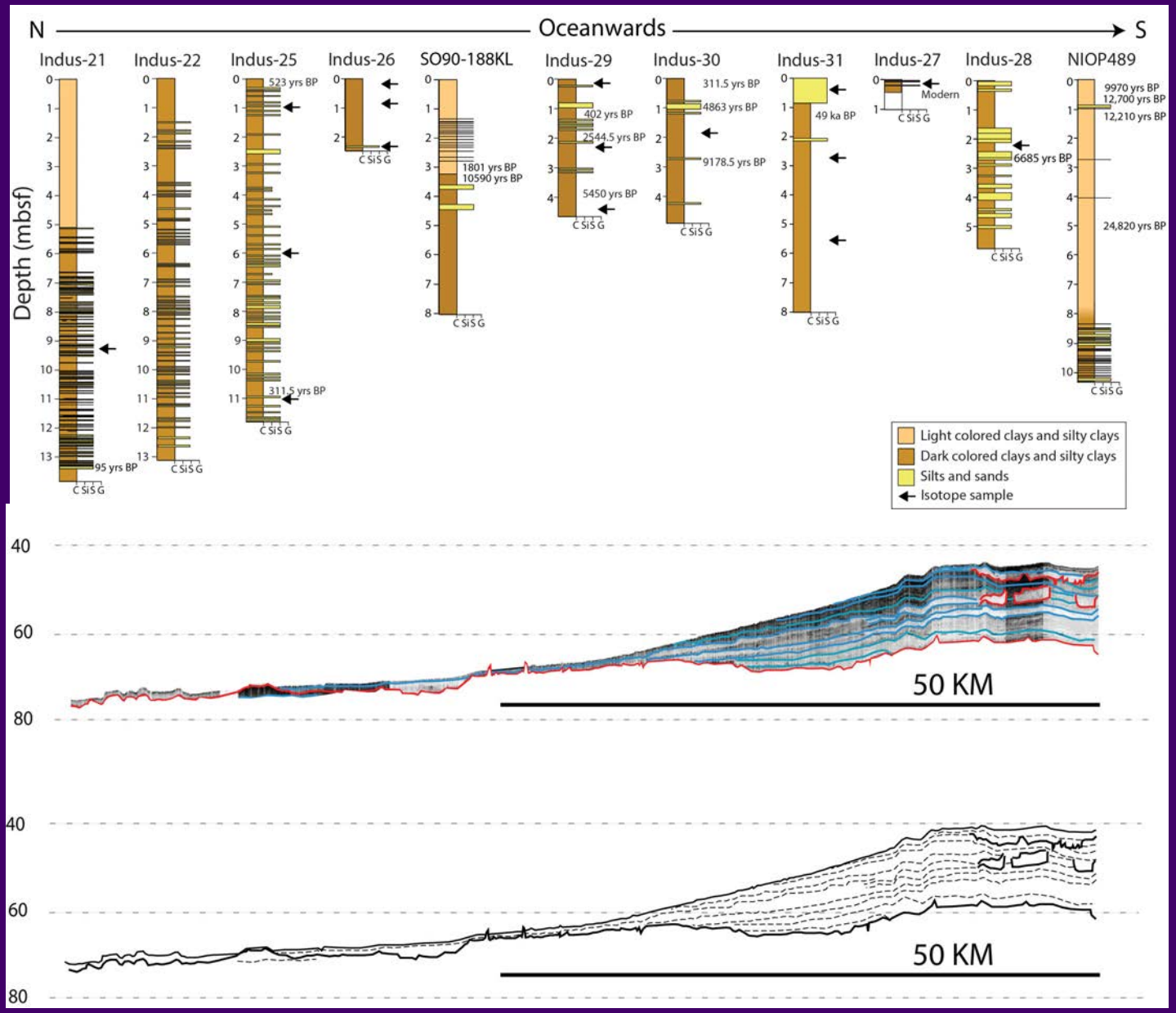




Kaolinite/smectite in the canyon and eastern clinoform falls through the Holocene

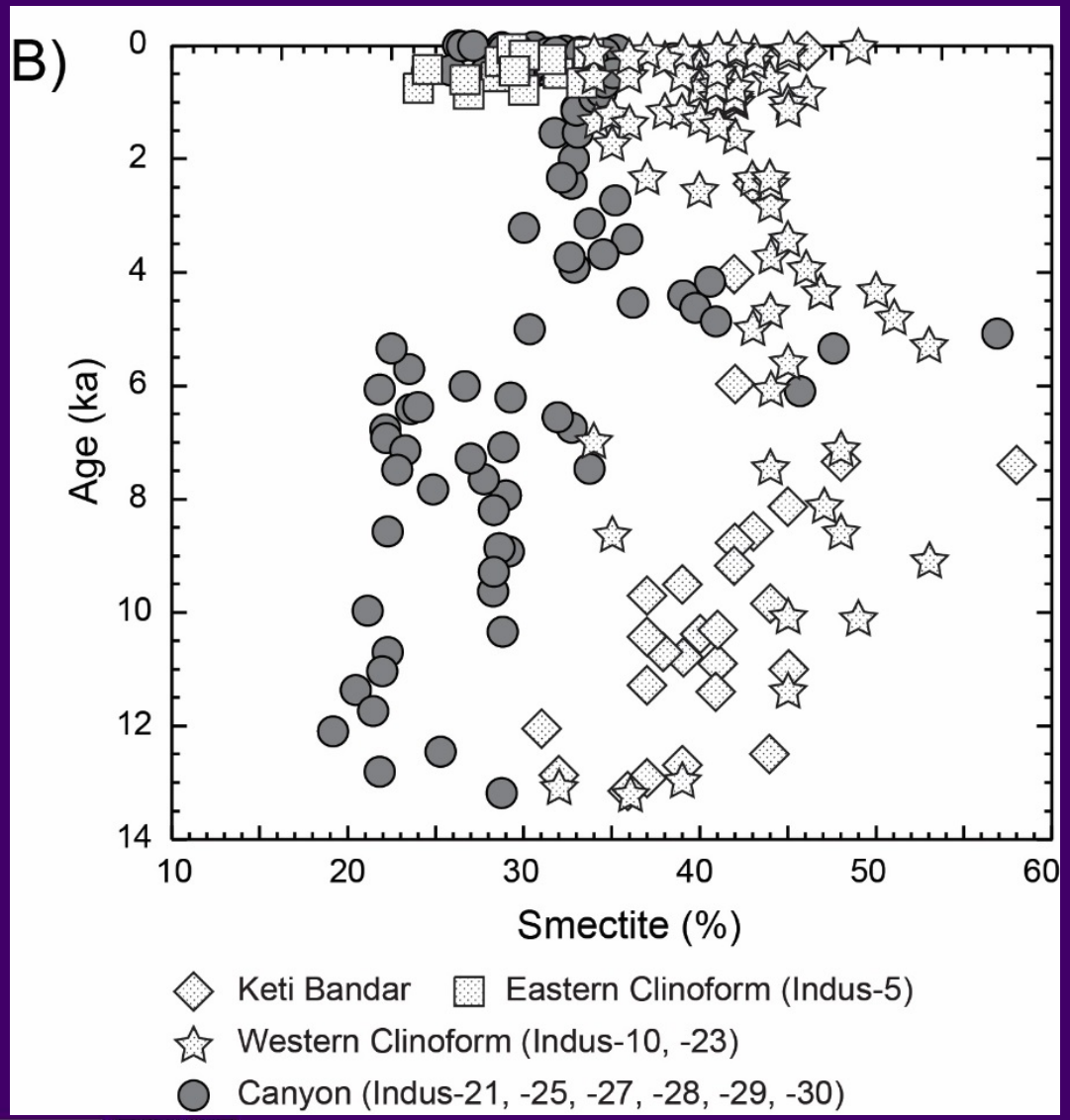


Li et al. (2019), QSR

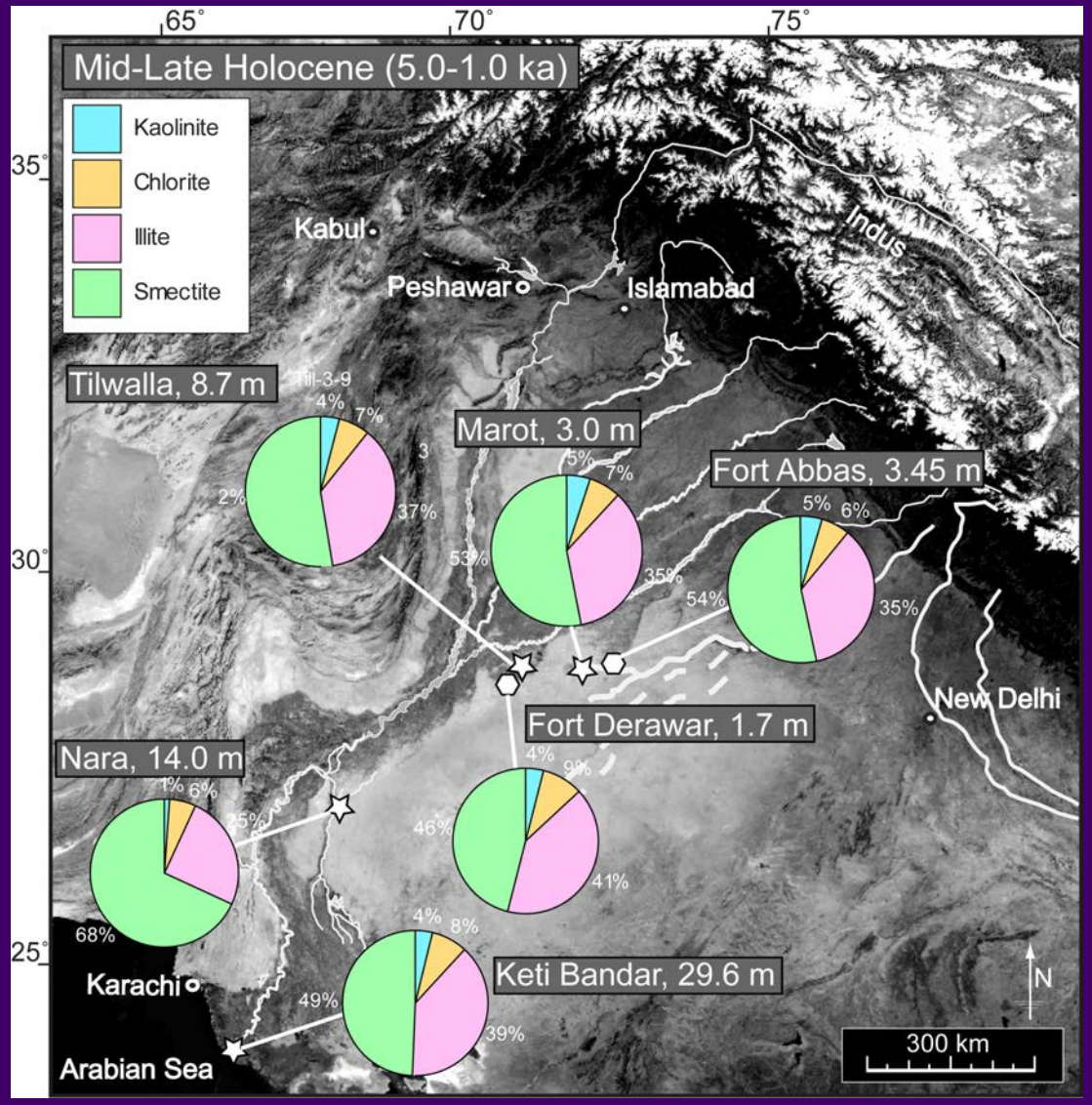


Clift et al. (2014), Basin Research

The temporal change is largely drive by an increase in smectite after 3000 BC
Smectite is very abundant on the flood plains

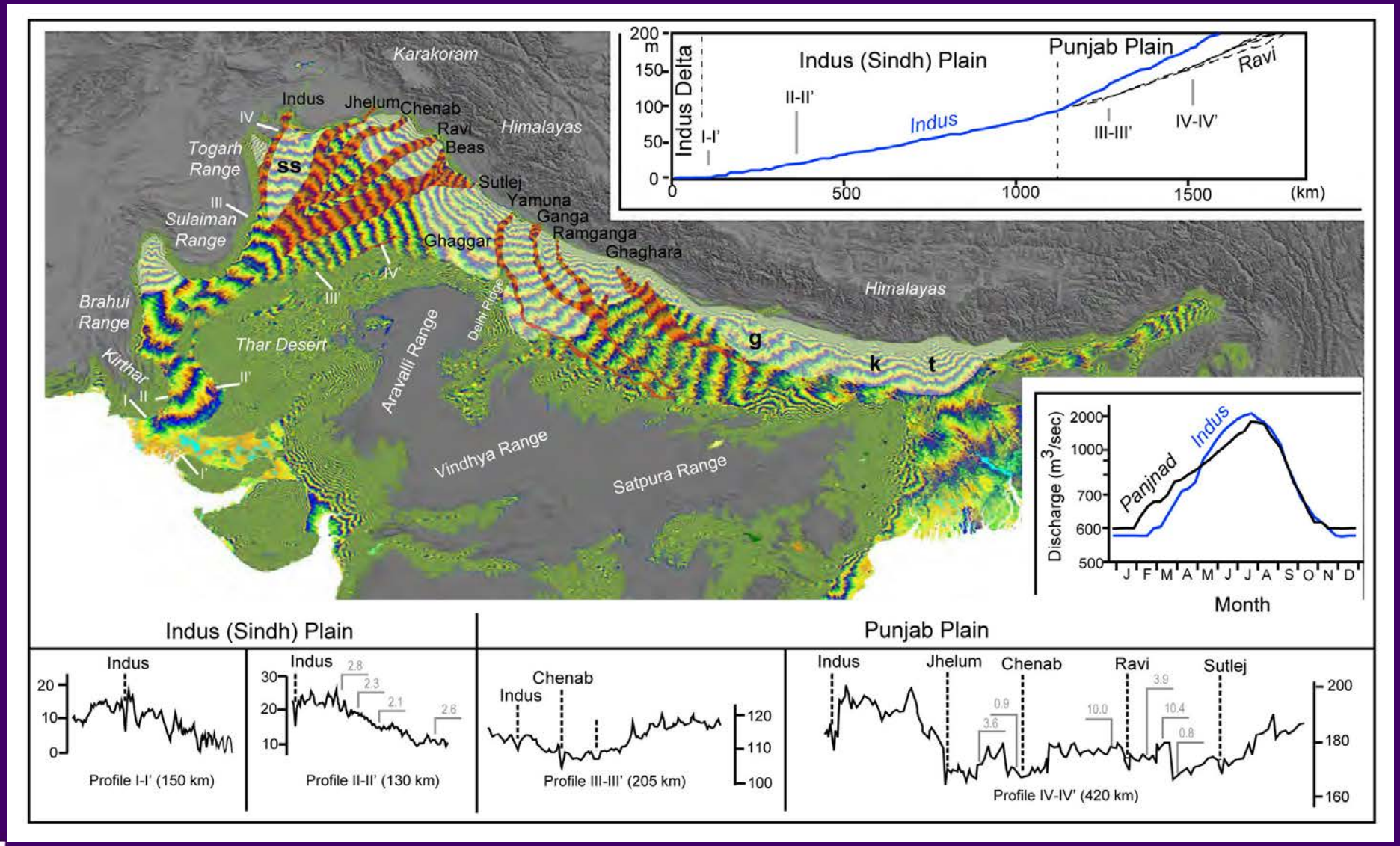


Li et al. (2019), QSR



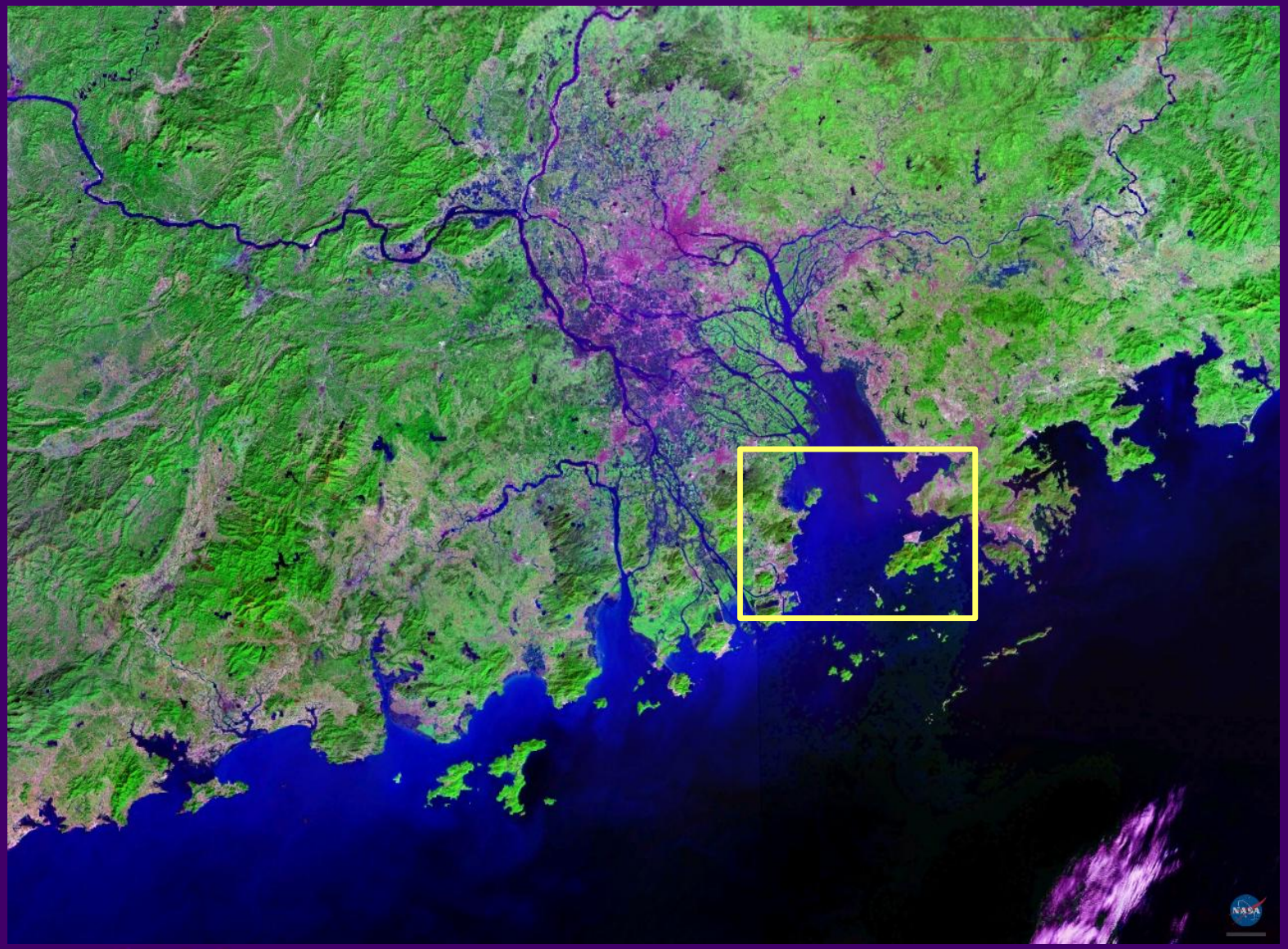
Alizai et al. (2012), QR

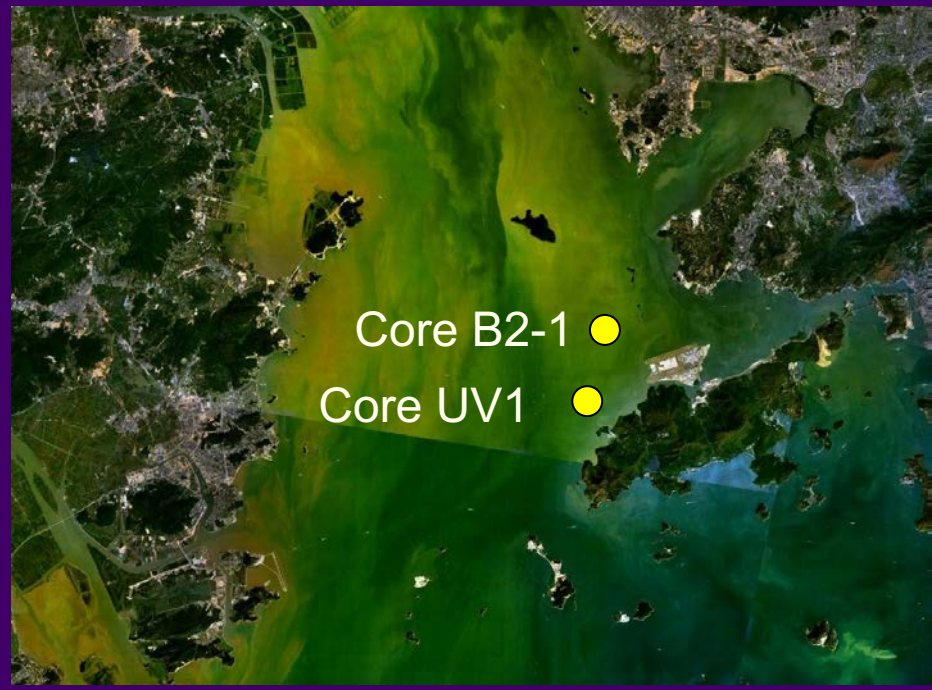
Some of the smectite pulse may also reflect incision of the river valleys of the upper Indus but this occurred more gradually since 10,000 year ago



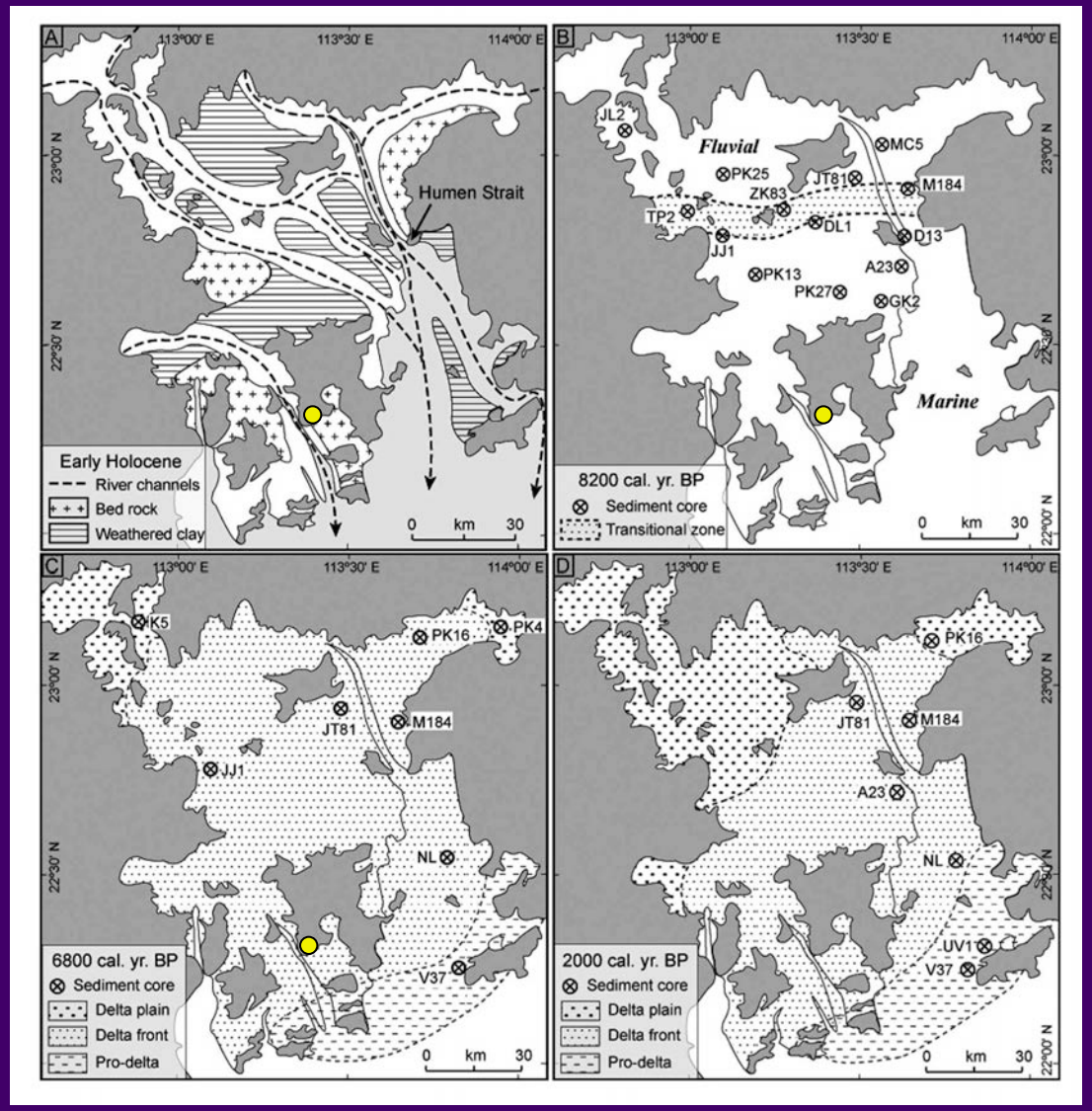
Giosan, Clift et al. (2012)

So how does the Pearl River compare over the same time interval?



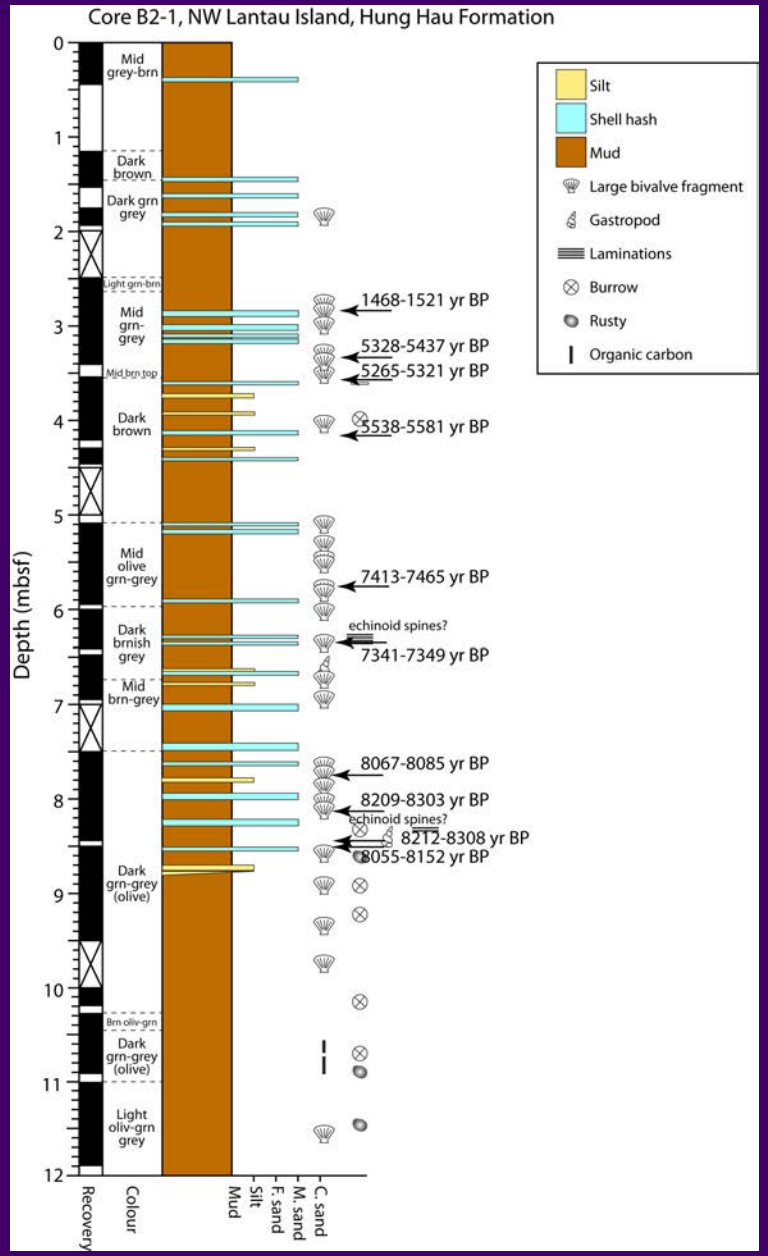


Reconstructions place the core site firmly in the mouth of the Pearl River since the Early Holocene

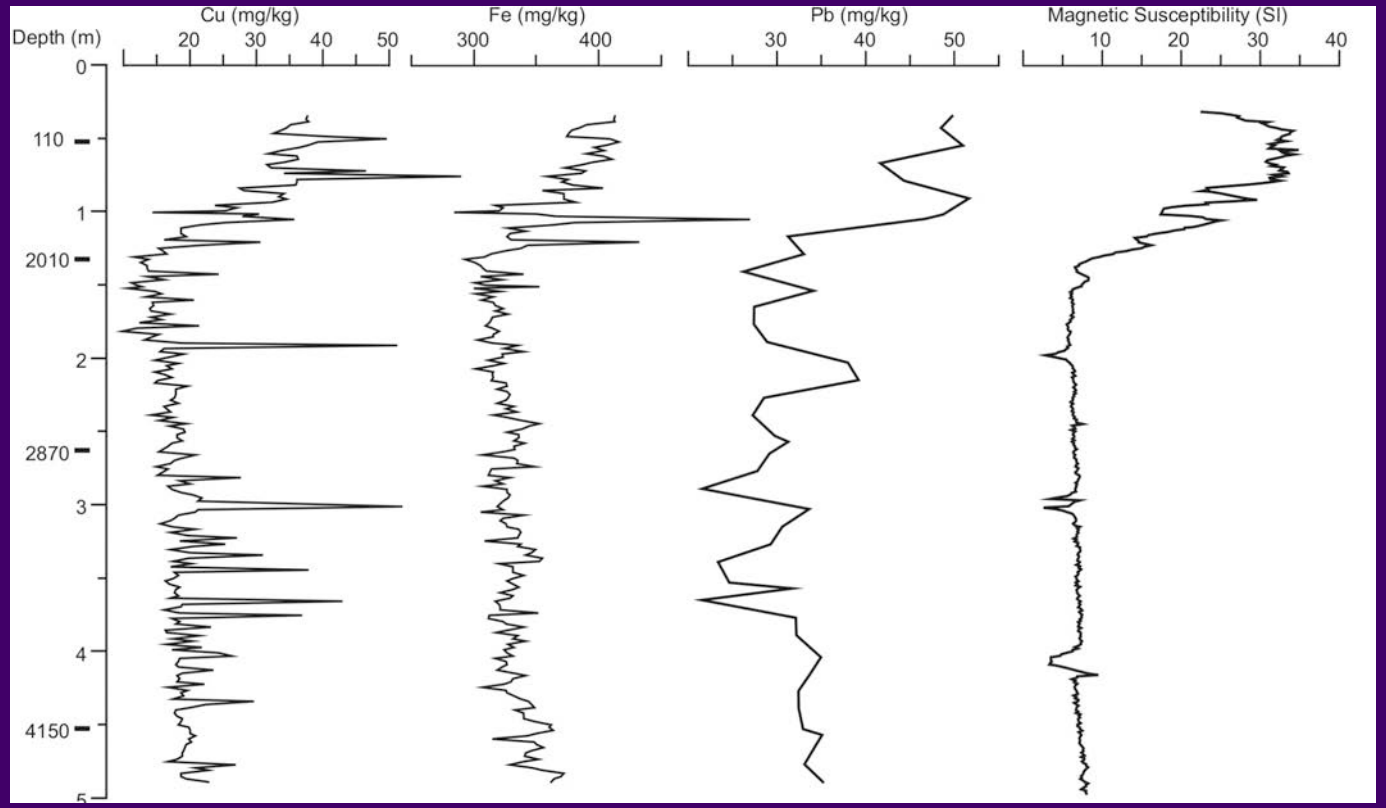


Zong et al. (2009), The Holocene

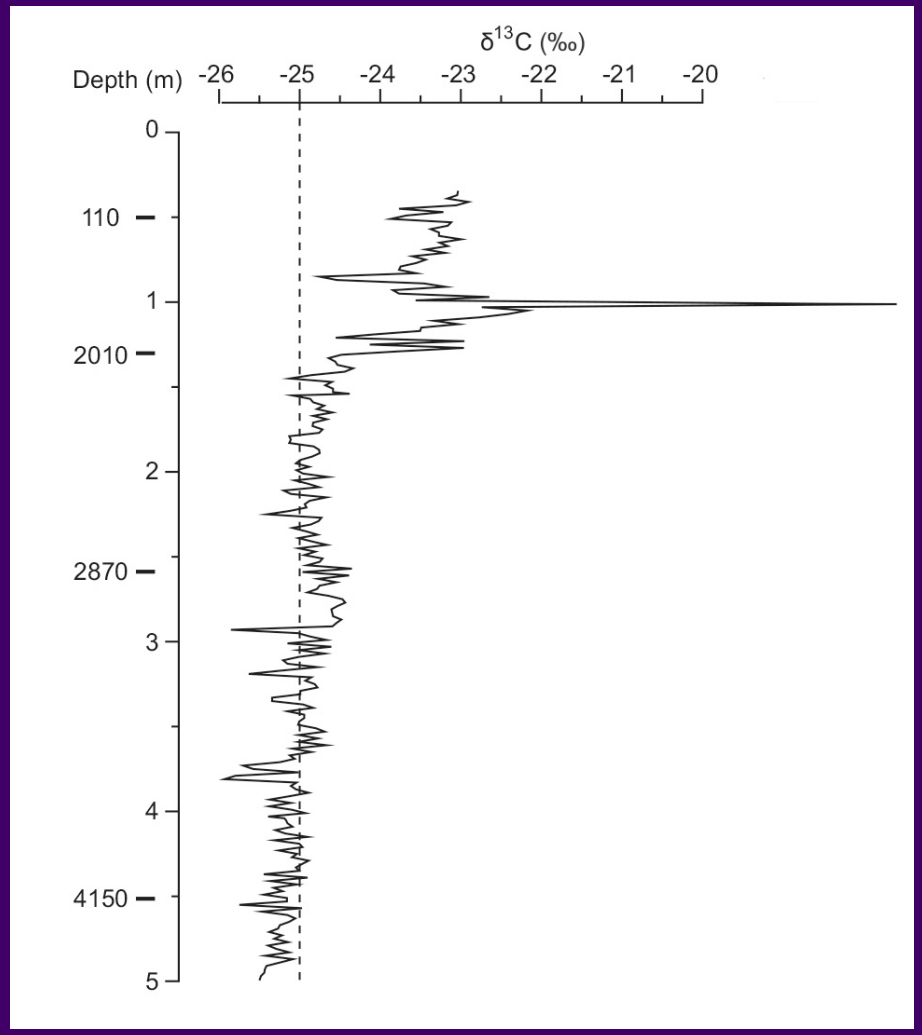
Hu et al. (2013), G-Cubed



Increasing heavy metal contamination and magnetic susceptibility towards top of HKU-1
- Human contamination



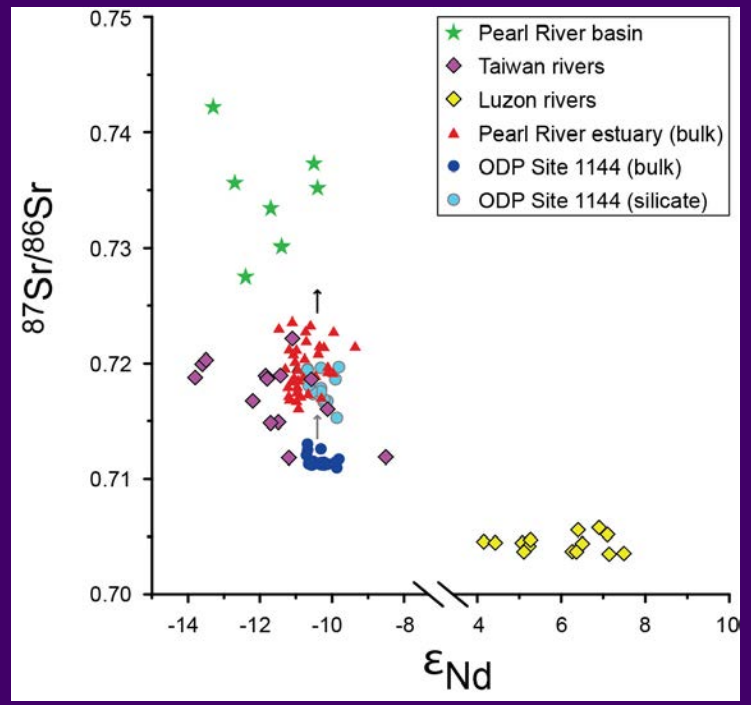
Changing carbon isotopes indicates a shift to more C4 vegetation
Spreading influence of sugarcane production

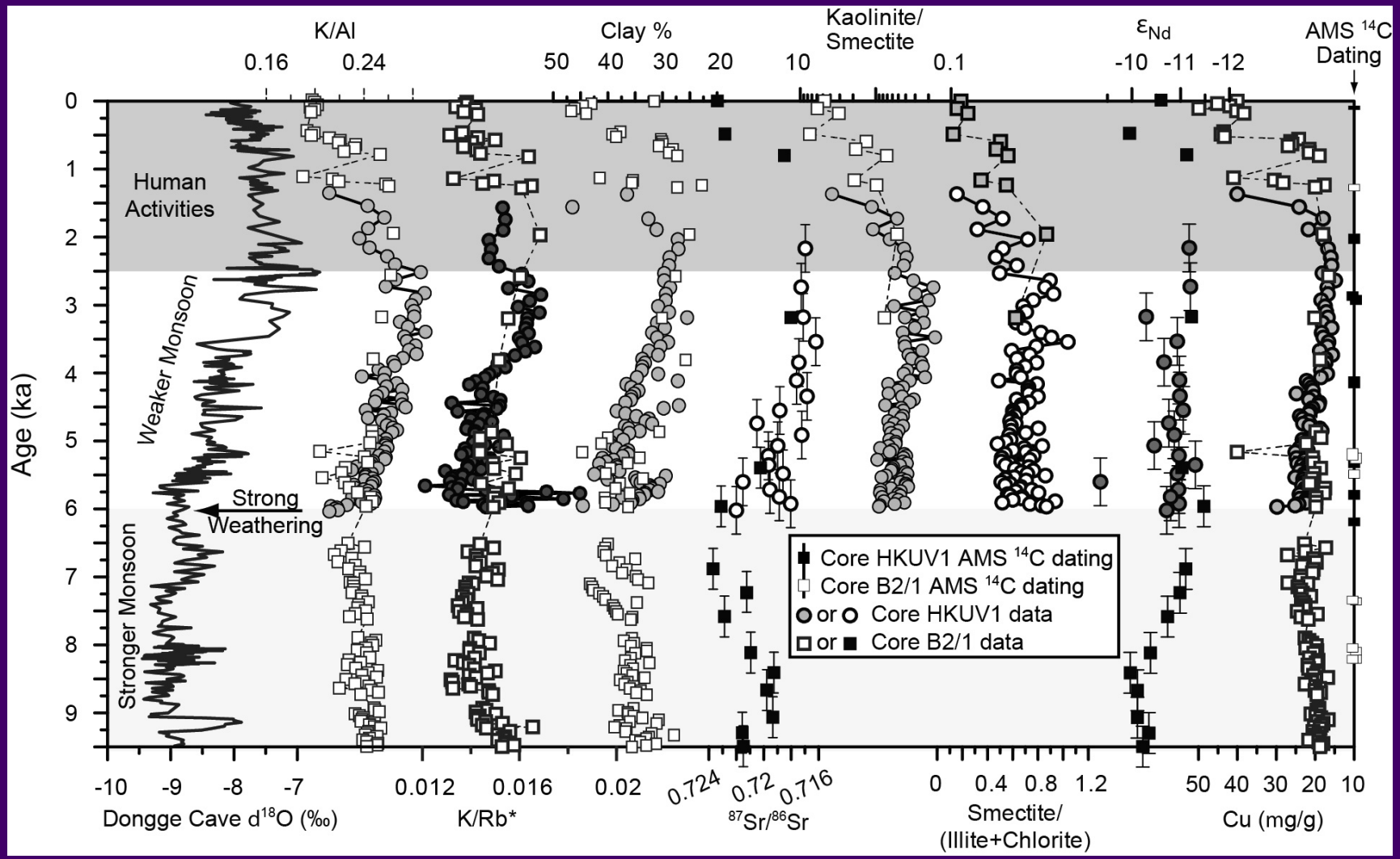


Zong et al. (2010)

Weathering tracks the monsoon intensity closely until ca. 2.5 ka

Holocene Pearl River sediments overlap with Taiwan but are quite different from the modern Pearl River

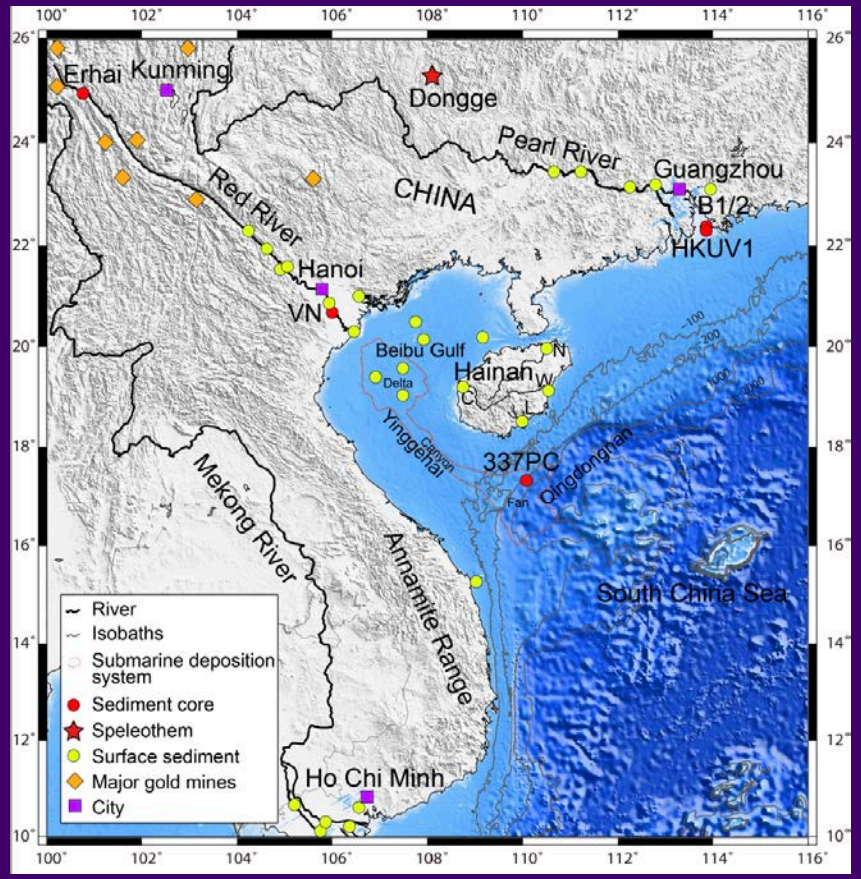


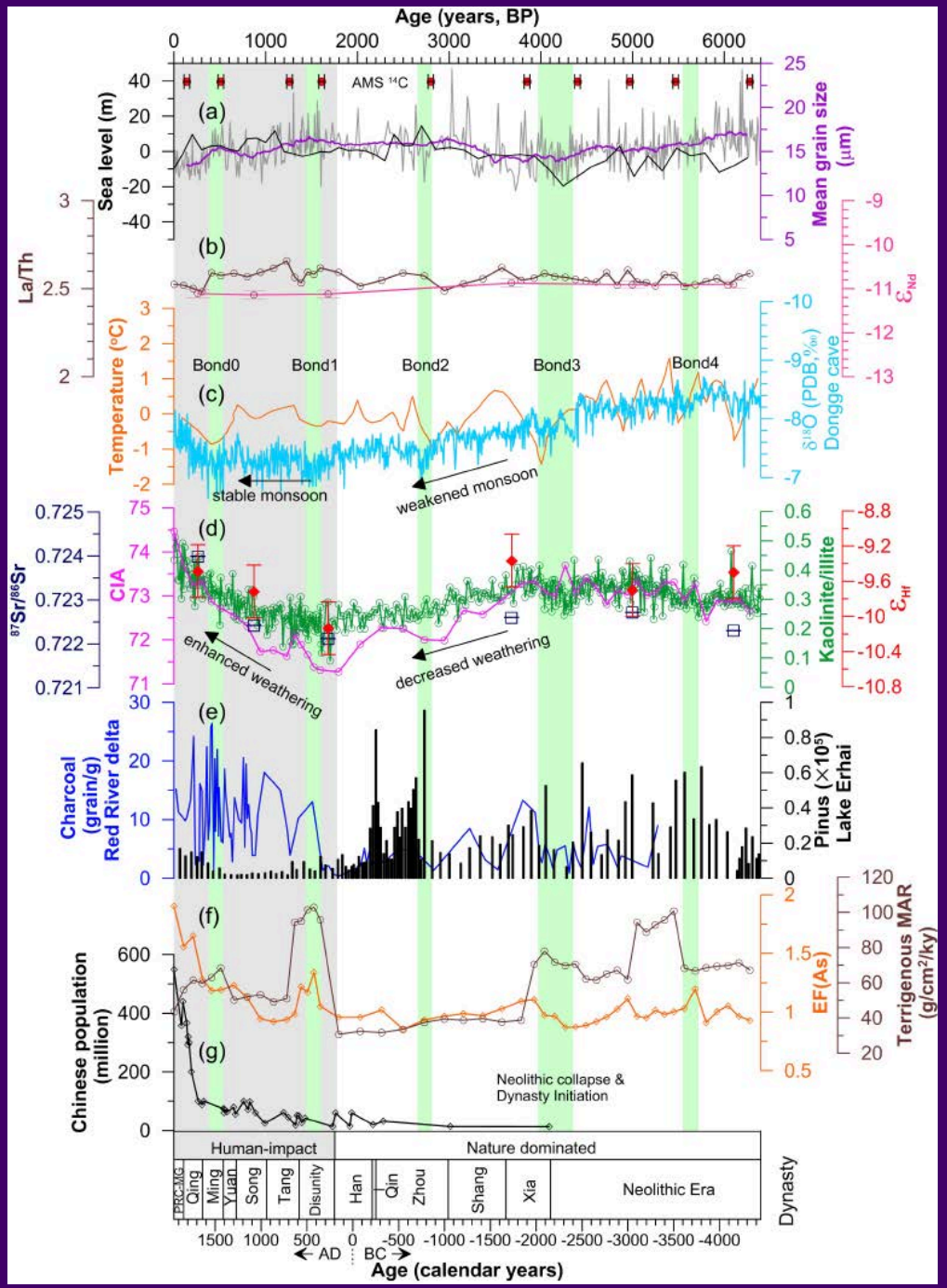


Hu et al. (2013, G-Cubed)

Weathering after 2.5 ka is linked to human settlement

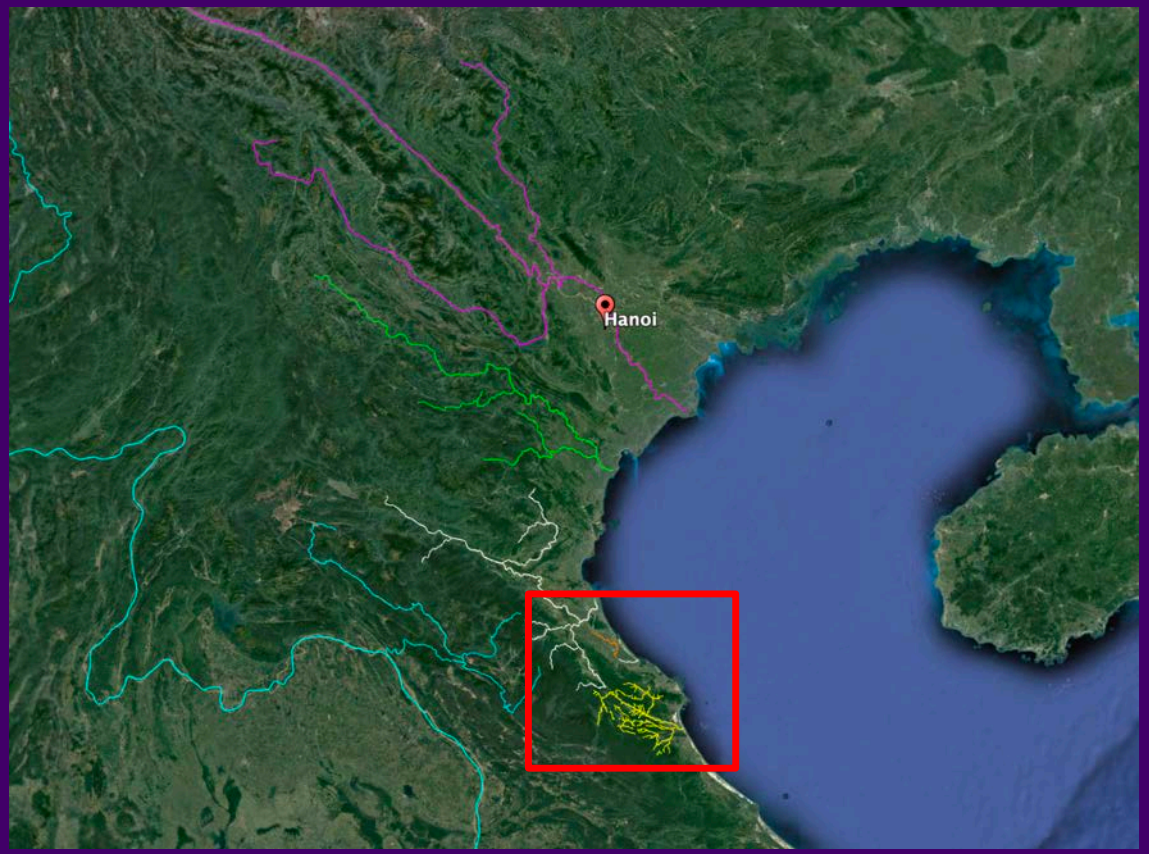
Weathering records from the NW South China Sea show a coupling between monsoon and weathering intensity until around 1800 years ago when there is a sharp rise at the same time as a population rise



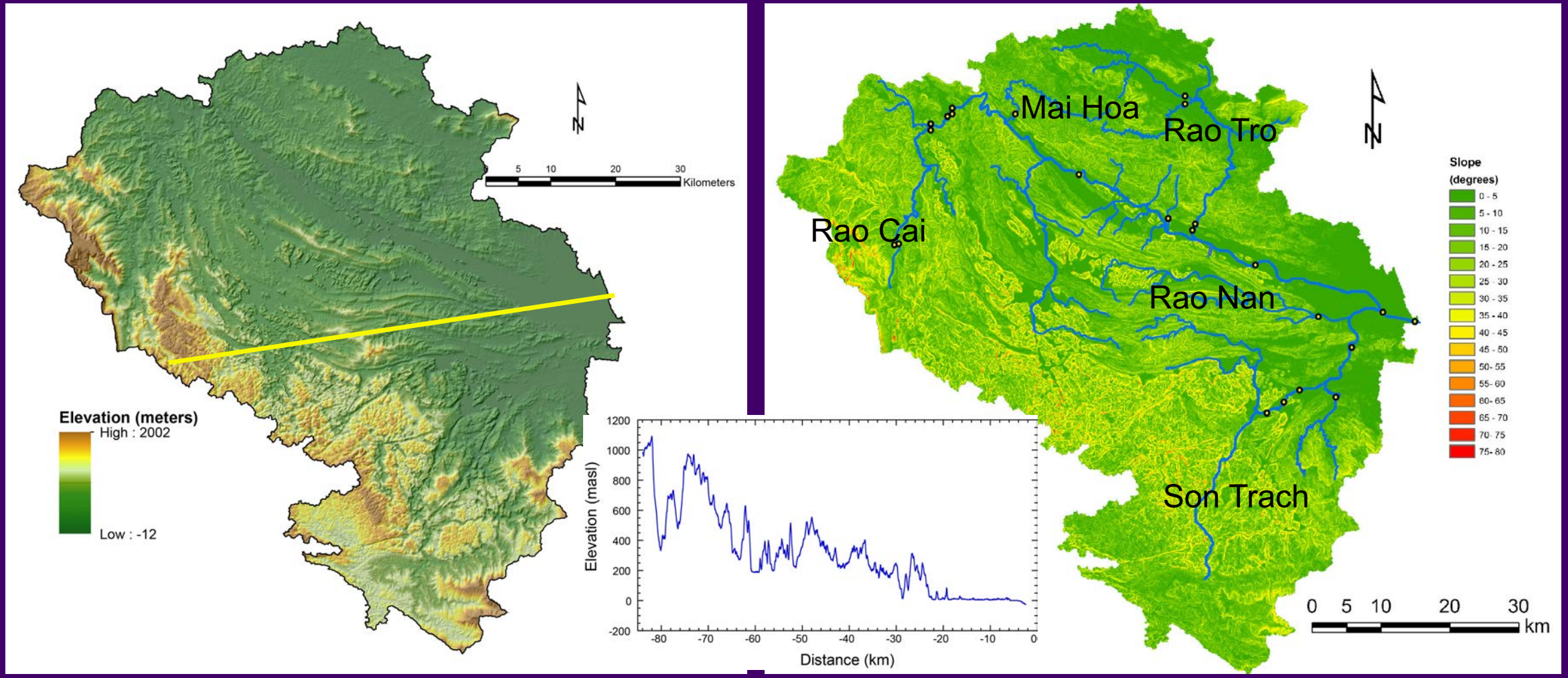


Wan et al. (2015, Geology)

The response of landscape to changing monsoon can be tested in the Song Gianh catchment of northern Vietnam



The Song Gianh has a tropical monsoonal climate and steep topography on its western boundary where the rainfall is concentrated

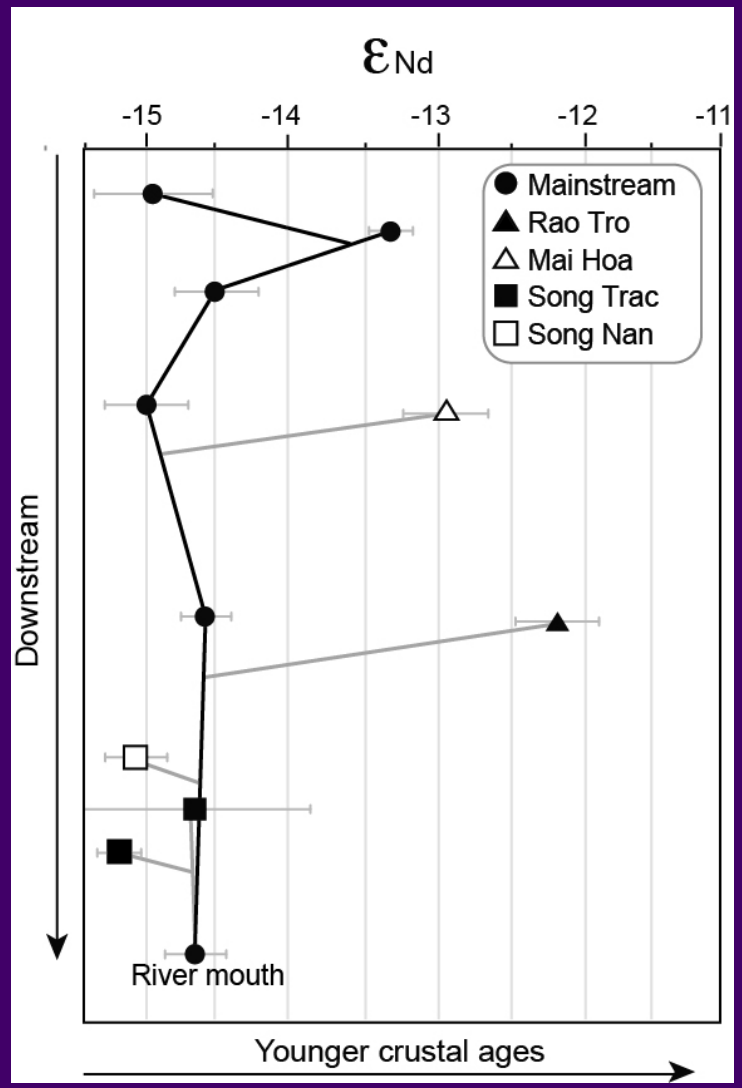


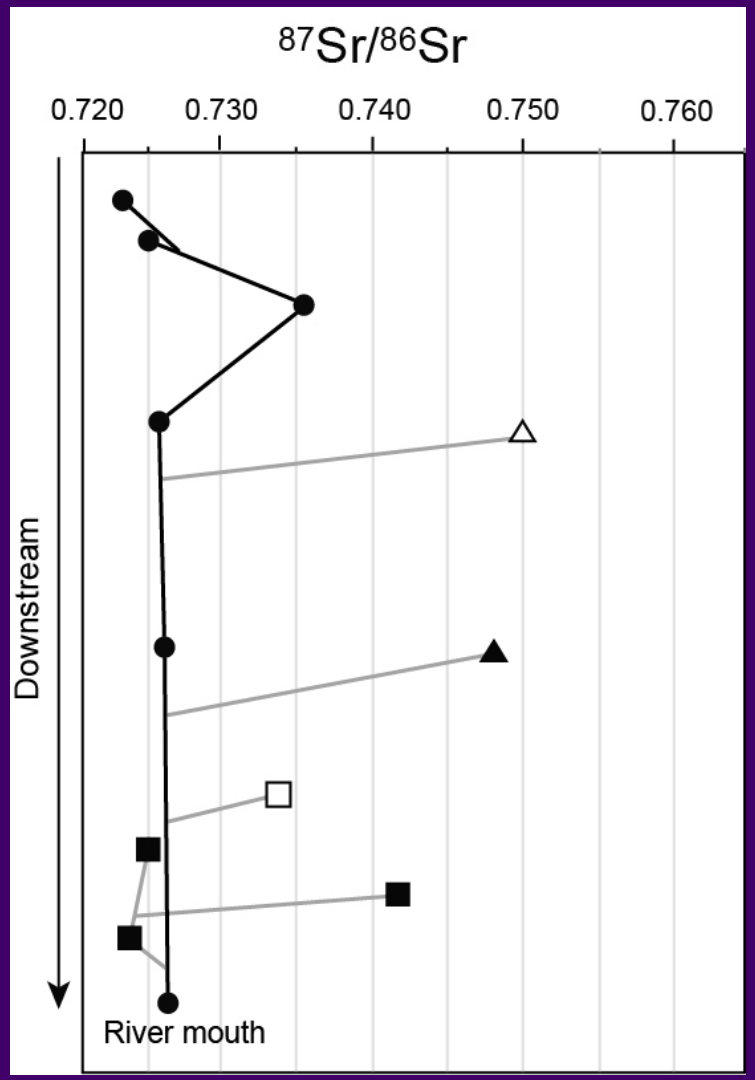
Jonell et al. (2017, Basin Research)

Nd and Sr isotopes can be used as provenance proxies

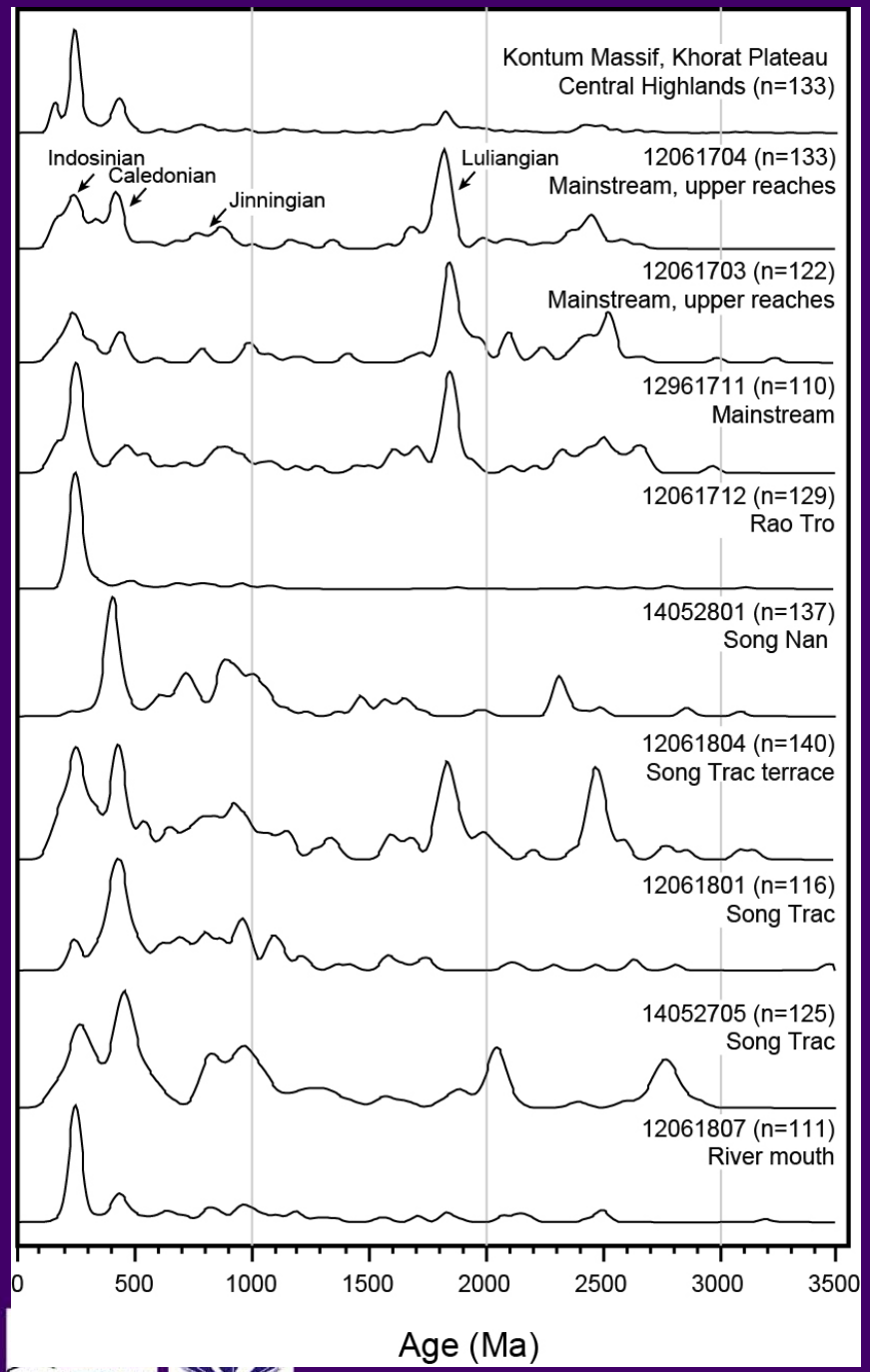
Sediment largely from upper reaches

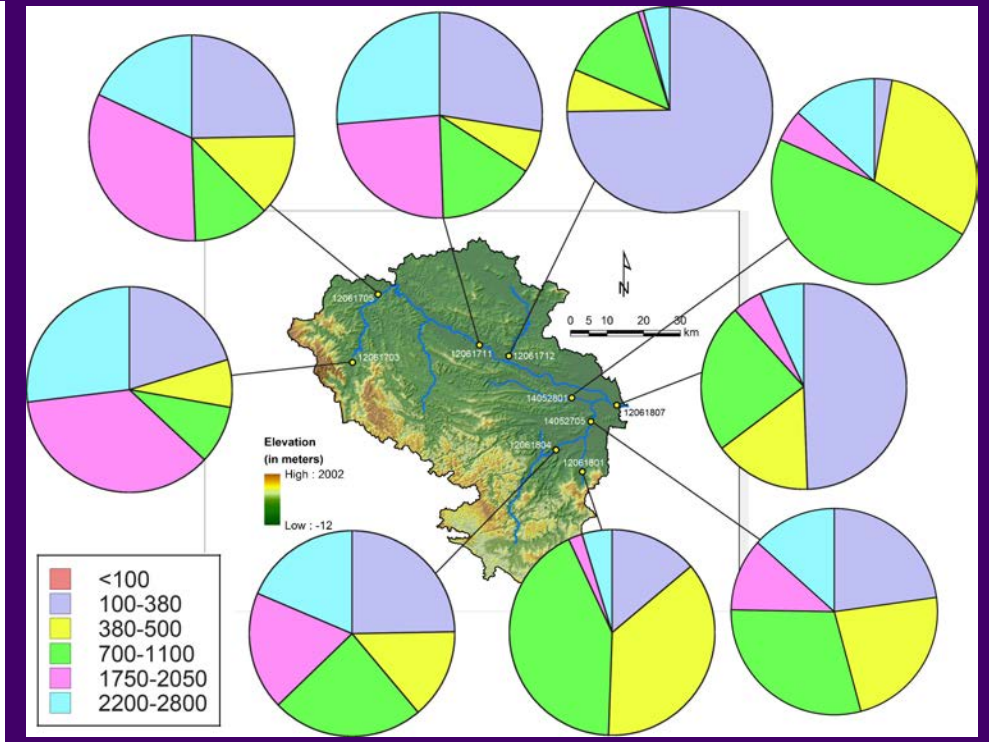
Rao Tro and Son Trach are not significant





Jonell et al. (2017, Basin Research)





Jonell et al. (2017, Basin Research)

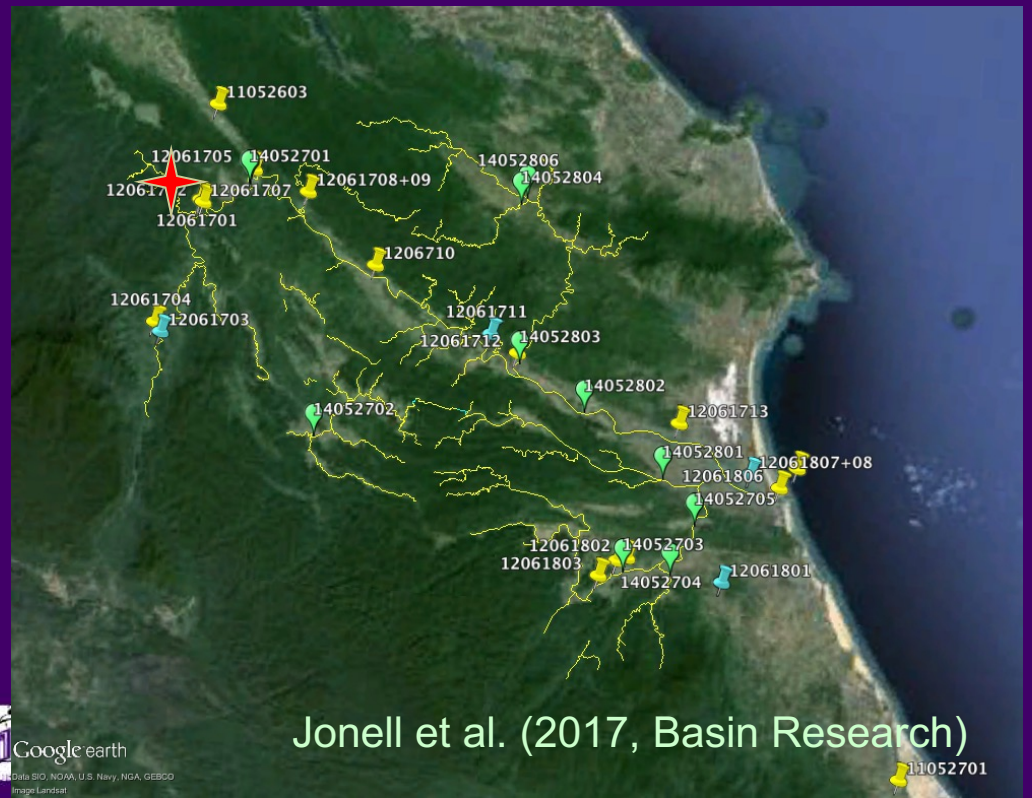
Zircon U-Pb dating does not favour erosion in the headwaters but rather in the Rao Tro

Inconsistent with the bulk sediment isotope data

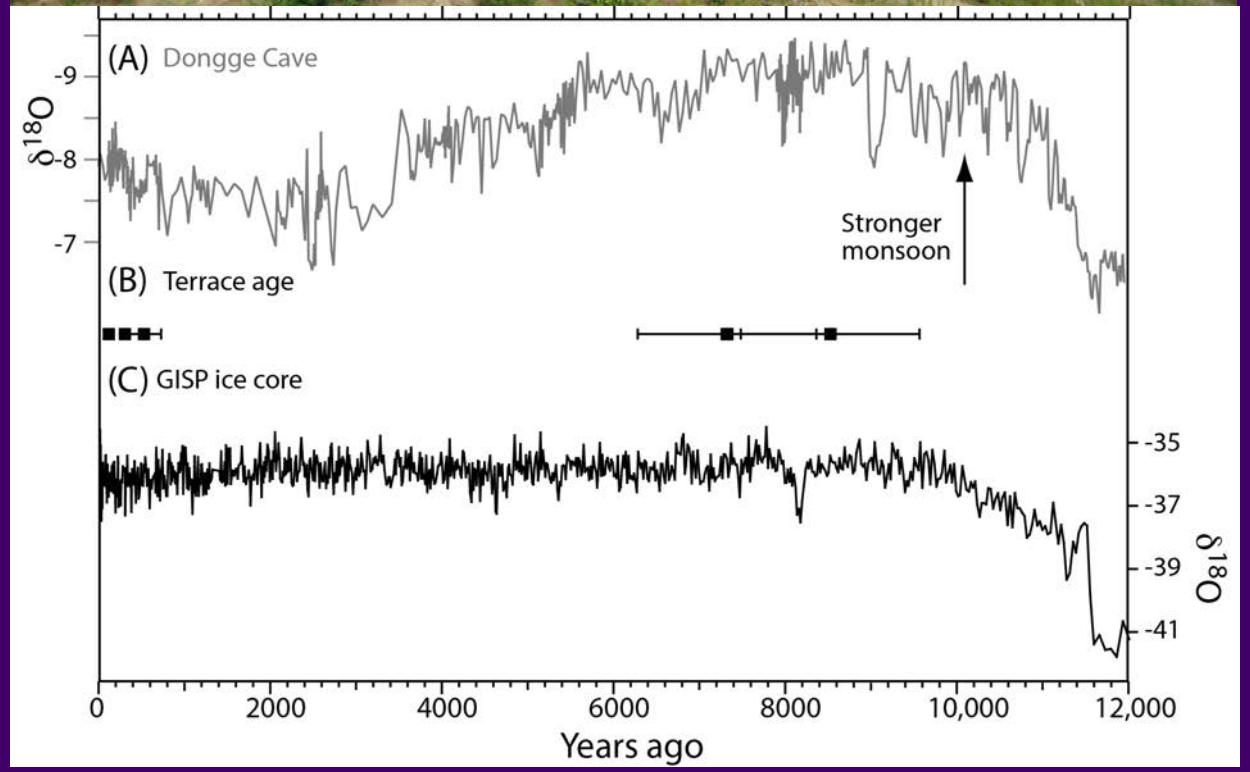
Reflects long transport time of zircon and changes in erosion linked to human settlement

Terracing in the upper Song Gianh, dated at 7360 ± 960 yrs and 8550 ± 1080 yrs ago

Time of strong monsoon = valley aggradation

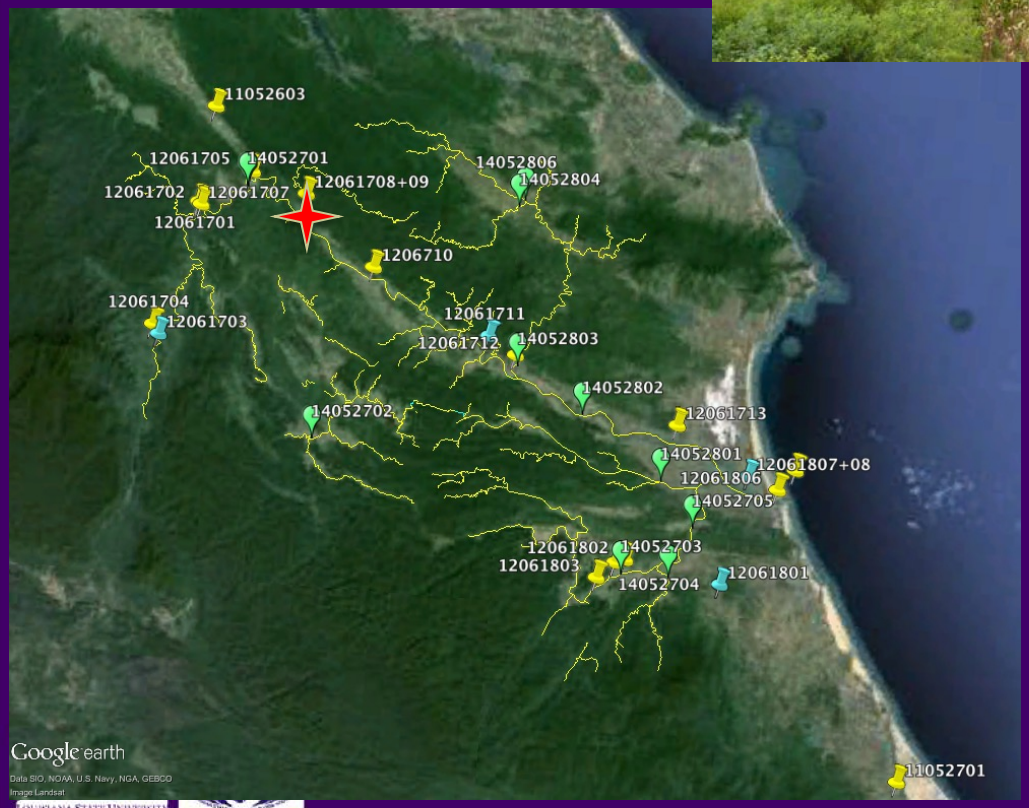


Jonell et al. (2017, Basin Research)



Terracing in the middle Song Gianh, dated at 550 ± 190 yrs

Terracing in the lower Song Gianh, dated at 150 ± 140 yrs



Conclusions

- Stronger summer monsoon rains drive increases in chemical weathering in marine sediment. Not caused by faster weathering rates but by erosion of previously weathered soils
- Onset of agriculture enhanced erosion of weathered soils mimicking climate change
- The appearance of weathered sediment is not synchronous across Asia. 500 BC in southern China, 300 AD in northern Vietnam, 3000 BC in the Indus Basin but coincides with increasing populations
- Impacts continue with changing settlement density and agriculture. <500 years in Vietnam
- Recognition of modern river disturbance is critical for provenance studies in the offshore basins, especially studies based on clays, e.g., smectite in the Indus and kaolinite in the Pearl River

Monsoon Seminars in 2021

- https://www.monsoongeoseminars.com

January 13, 2021, **Alexis Licht**, The Asian Climate during the Paleogene: Early Monsoons, Proto-monsoons, or no monsoon?

January 20, 2021, **Hongbo Zheng**, Eocene onset of monsoon in Yunnan (SE Tibetan Plateau).

January 27, 2021, **Majie Fan**, Sedimentary Record of Proto-Asian Monsoon?

February 3, 2021, **Stephen Gallagher**, From Monsoons to Desert: 50 Million Years of Australian Climate History.