

ANR *blanc* CALIMERO

The influence of **CLIM**ate on landscape
EROSion:

The Himalayan case study

Bilan d'avancement à mi-parcours

Présentation : J. Lavé (CRPG)

Project setting

Calimero's collaborators:

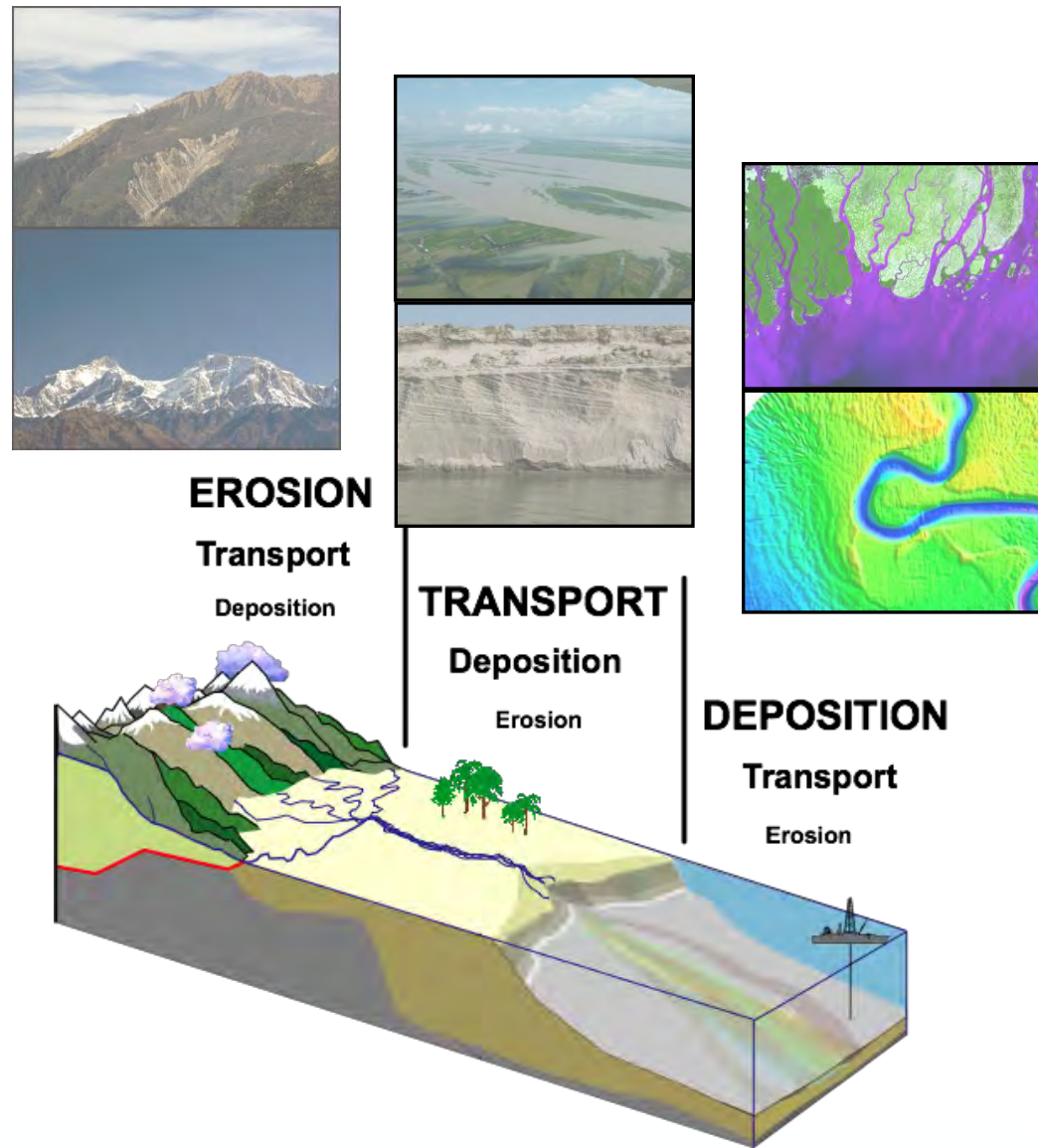
- **CRPG Nancy** : P.H. Blard, J. Charreau, C. France Lanord, J. Lavé, R. Pik
PhD students : F. Gallo (financement ANR), M. Lupker, G. Morin, N. Puchol
Collaboration : E. Dambrine (INRA)
- **CGS Strasbourg** : F. Chabaux, E. Blaes (PhD student)
- **GET Toulouse** : Y. Goddérés

Main questions:

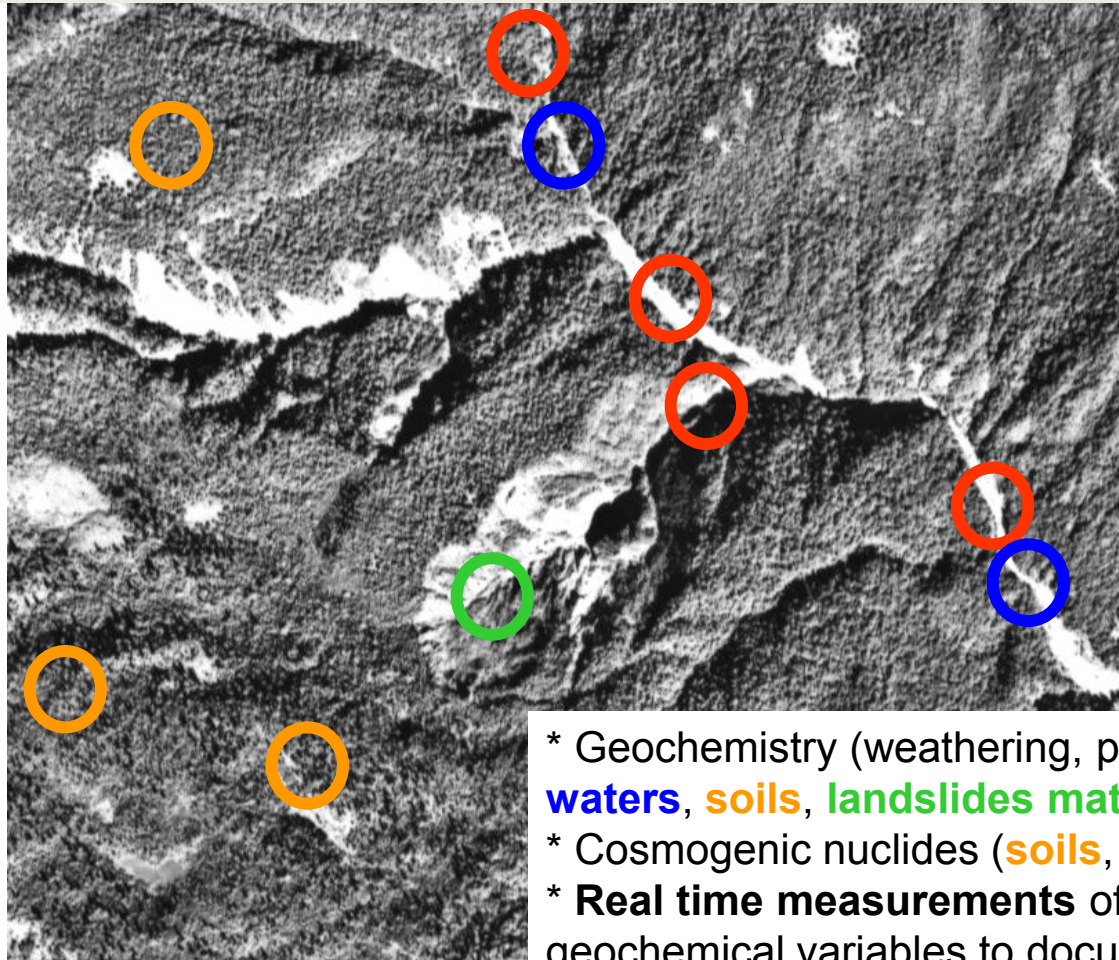
- * How the Earth surface, particularly in tectonically active orogens, responds to climatic variations in terms of weathering and physical erosion?
- * And how to identify climatic variations, and quantitatively interpret them, in old sedimentary sequences?

Several landscape elements responding to climatic forging

- * Present weathering, physical erosion and sediment transport on hillslope and rivers of the Himalayan range
- * Transfer duration, weathering, mineralogic and geochemical segregation of the sediments in the Gangetic plain
- * The Himalaya/Gangetic plain response to climatic changes at the Plio-Pleistocene transition and during the last glacial/interglacial transition



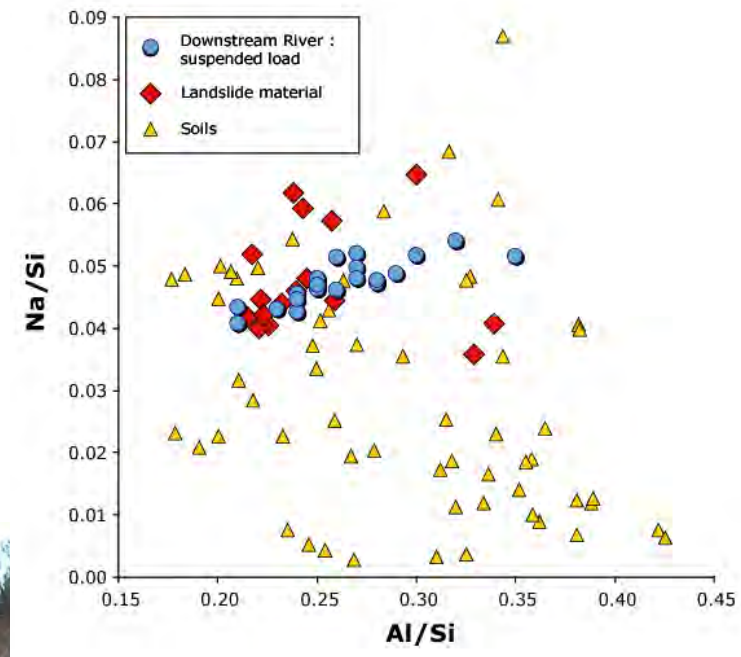
Erosion and weathering of the Himalayan range



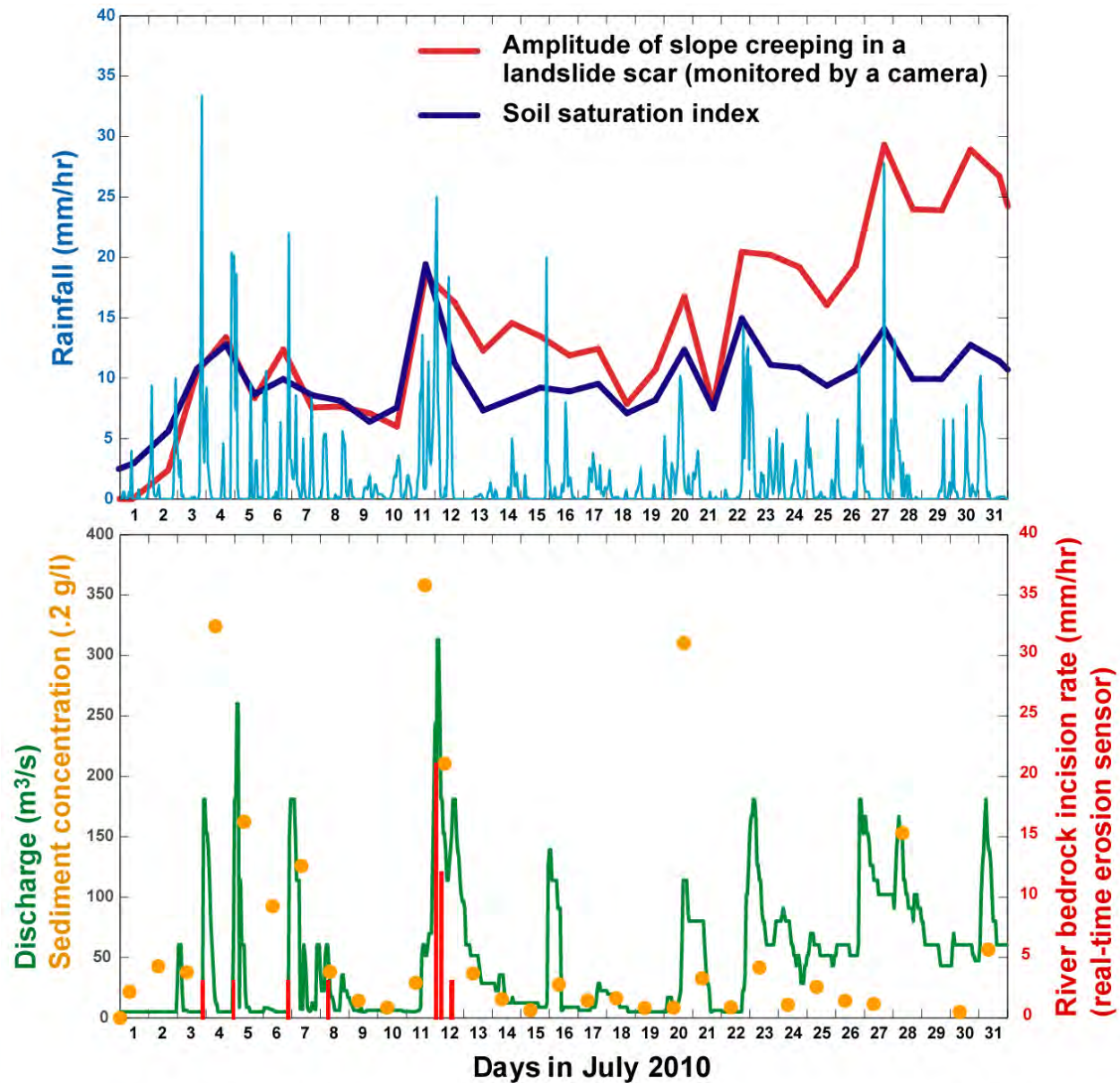
- * Geochemistry (weathering, provenance, U-series) of **waters**, **soils**, **landslides material**, **river sediments**
- * Cosmogenic nuclides (**soils**, **river sediments**)
- * **Real time measurements** of hydrologic, geophysical and geochemical variables to document hillslope and river processes and the **role of precipitation** in erosion

Sediment production on hillslopes

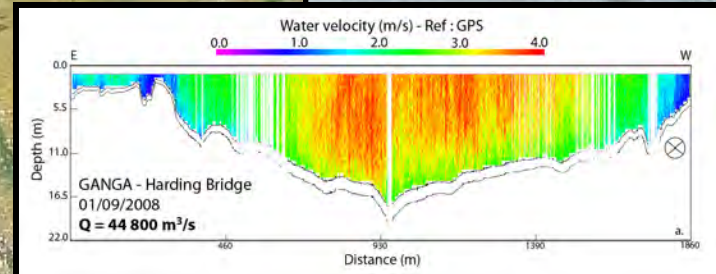
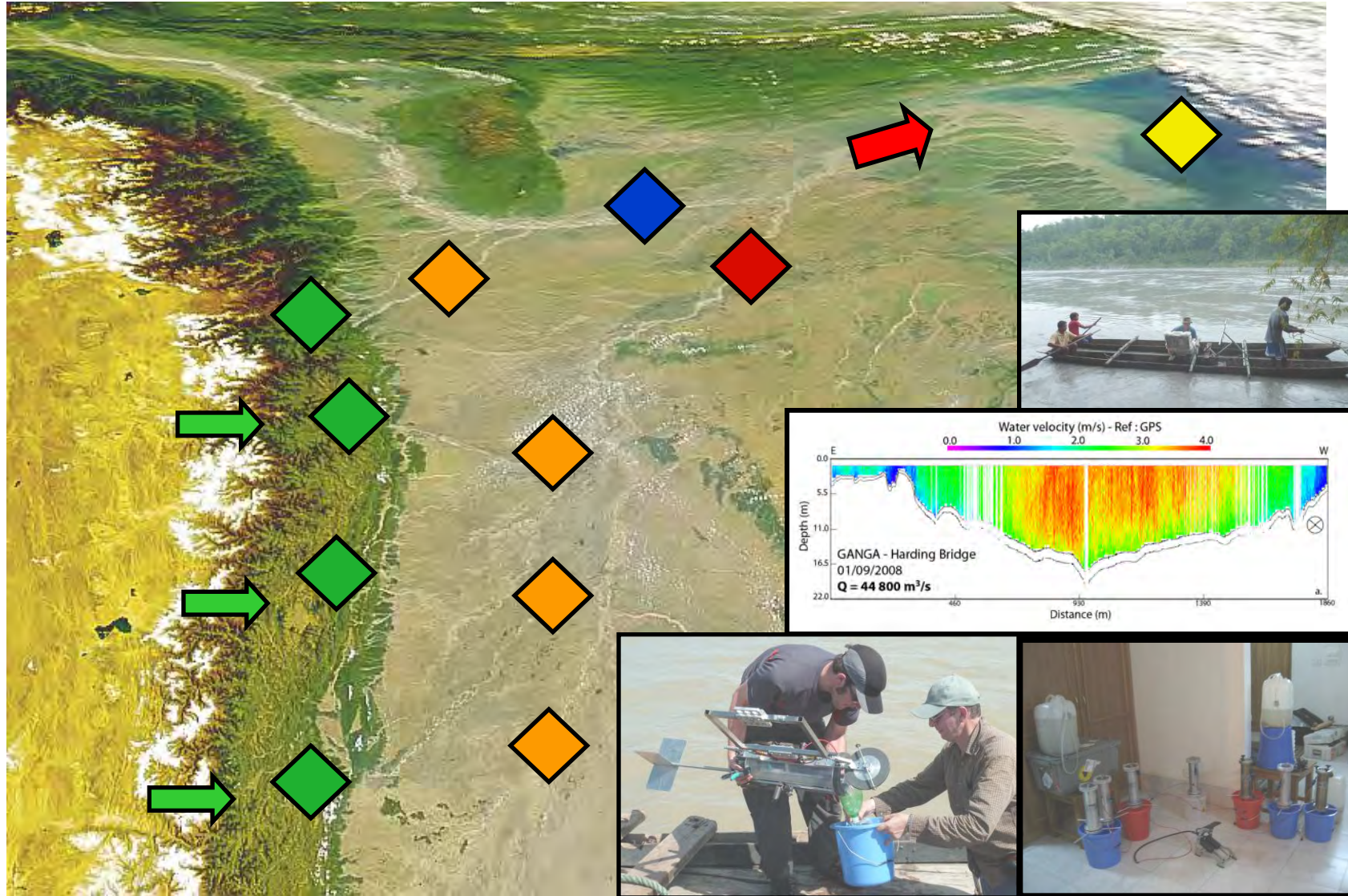
In active mountain ranges, landslides material dominates sediment production.
=> Climate impact on soils has little direct effect on sediment export out of the range.



Positive impact of rainfall on landslide instability, sediment export or river downcutting.

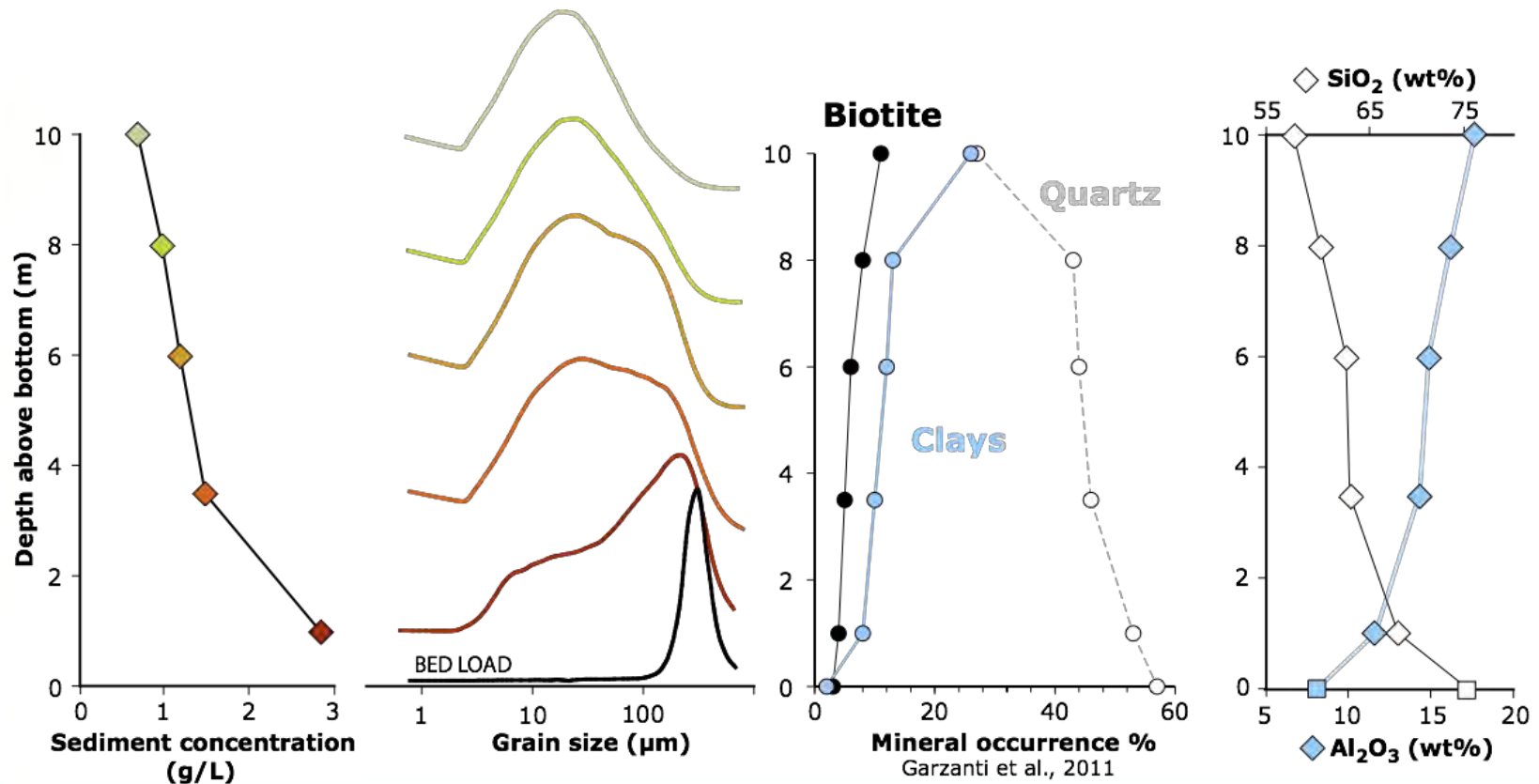


Sediment transport and weathering in the Ganga plain



Sediment transport and weathering in the Ganga plain

Spatial and temporal heterogeneity of sediment properties:
mineralogic and geochemical segregation in the water vertical section

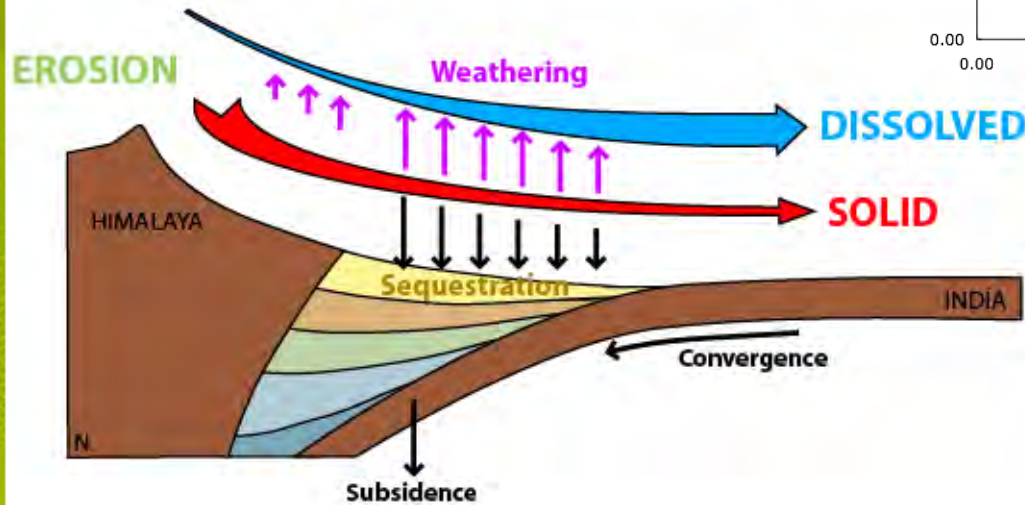


(Lupker et al., JGR, 2011)

Sediment sequestration and weathering in the Ganga plain

Main results :

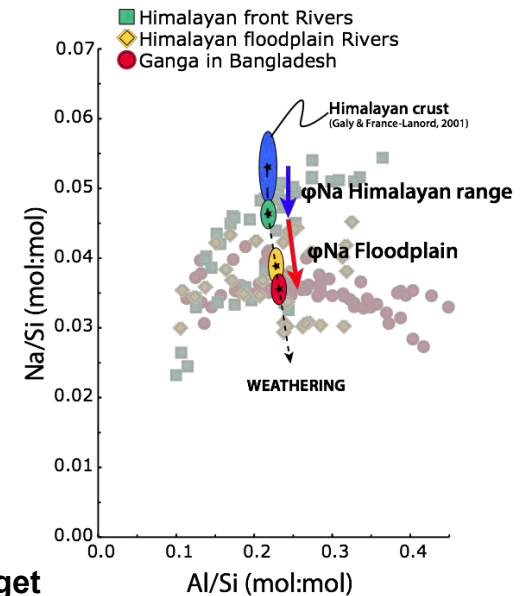
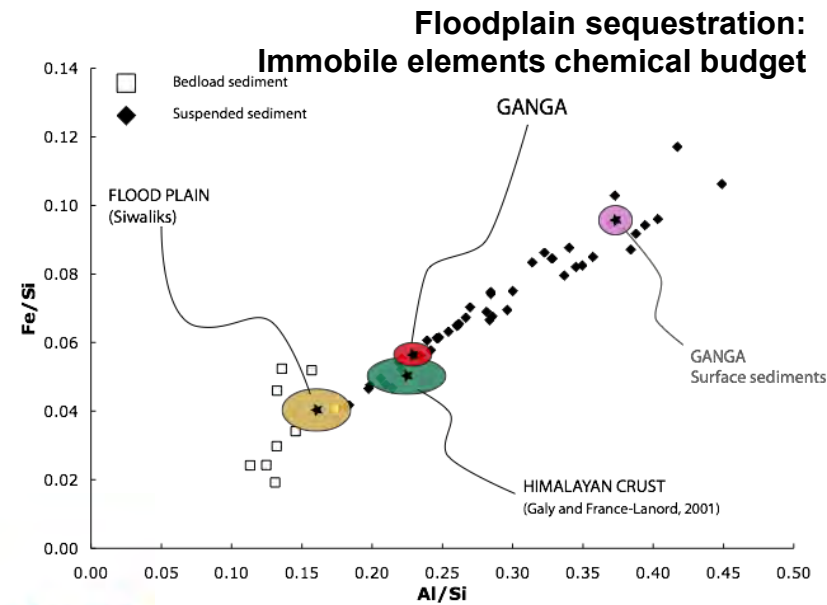
- * Comprehensive modeling of geochemical segregation during fluvial transport
- * Sediment export flux for Ganga = 400 Mt/yr
- * Floodplain sequestration = ~10%
- * Weathering (Ca, Na, K loss & clay production) occurs mainly in the plain



$$\phi_{\text{Export}} \cdot [X]_{\text{Export}} = \phi_{\text{Himal Erosion}} \cdot [X]_{\text{Himal Crust}} - \phi_{\text{Sequestration}} \cdot [X]_{\text{Floodplain}} - \phi_{\text{Weathering}} \cdot [X]_{\text{Weath}}$$

(Lupker et al., 2011, 2012)

Floodplain sequestration: Mobile elements chemical budget



Sediment transfer time

U-series in the Ganga plain
(Granet et al., 2010)

- Transfer of **suspended silty material** < 20-25kyr
- but several 100's kyr for the transfer of **sandy coarse** sediments

Cosmogenic nuclides in the Ganga plain:

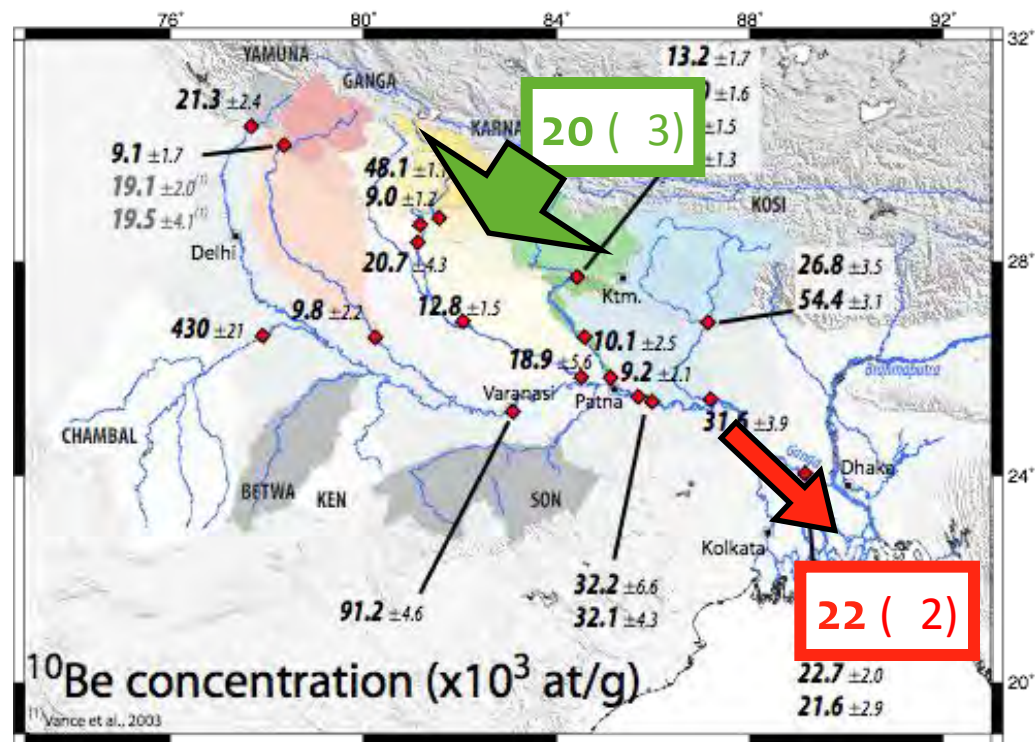
- [10Be] on coarse grained quartz (125-250 μm) from bed load sediments

$$\Delta C = \left(\frac{1}{H} \int_0^H P_{10Be}(z) dz \right) \cdot \bar{T}$$

$$\Delta C_{\text{mean}} = 2 \cdot 10^3 \quad 4 \cdot 10^3 \text{ at.g}^{-1}$$

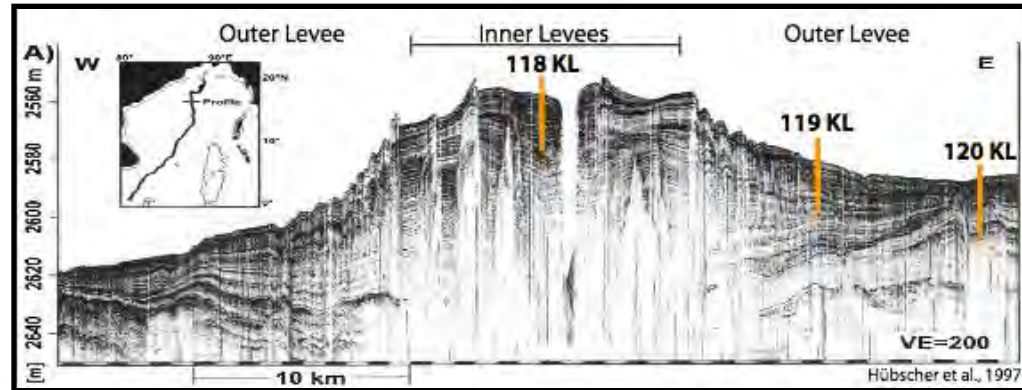
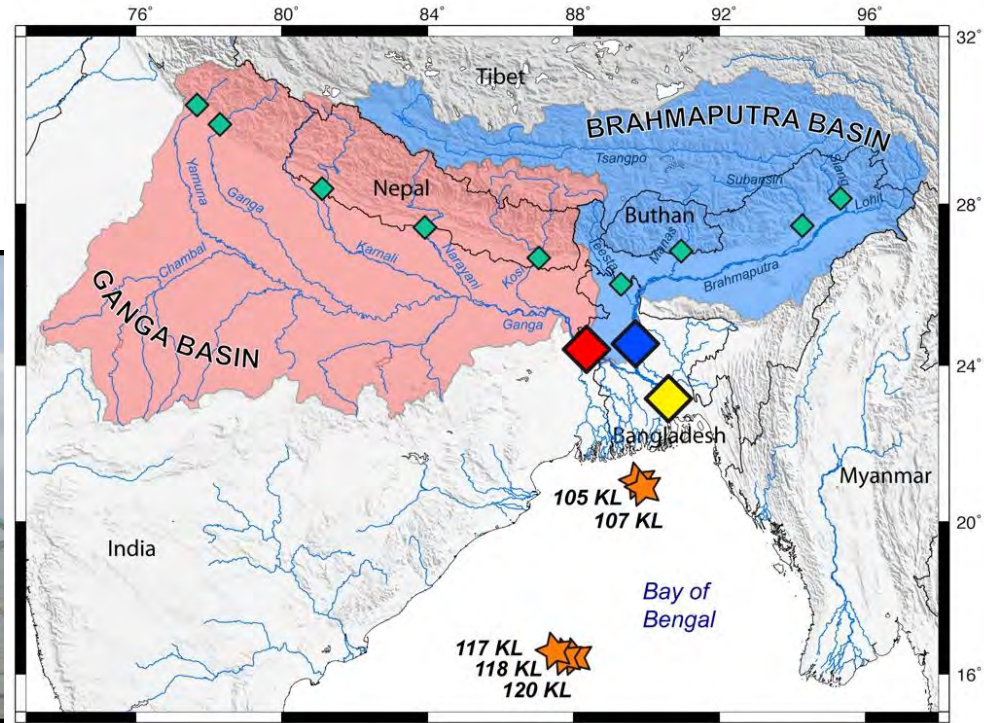
⇒ $T \approx 0-10$ kyr for coarse sand fraction at the Ganga plain outlet

≠ **U-series results (?)**

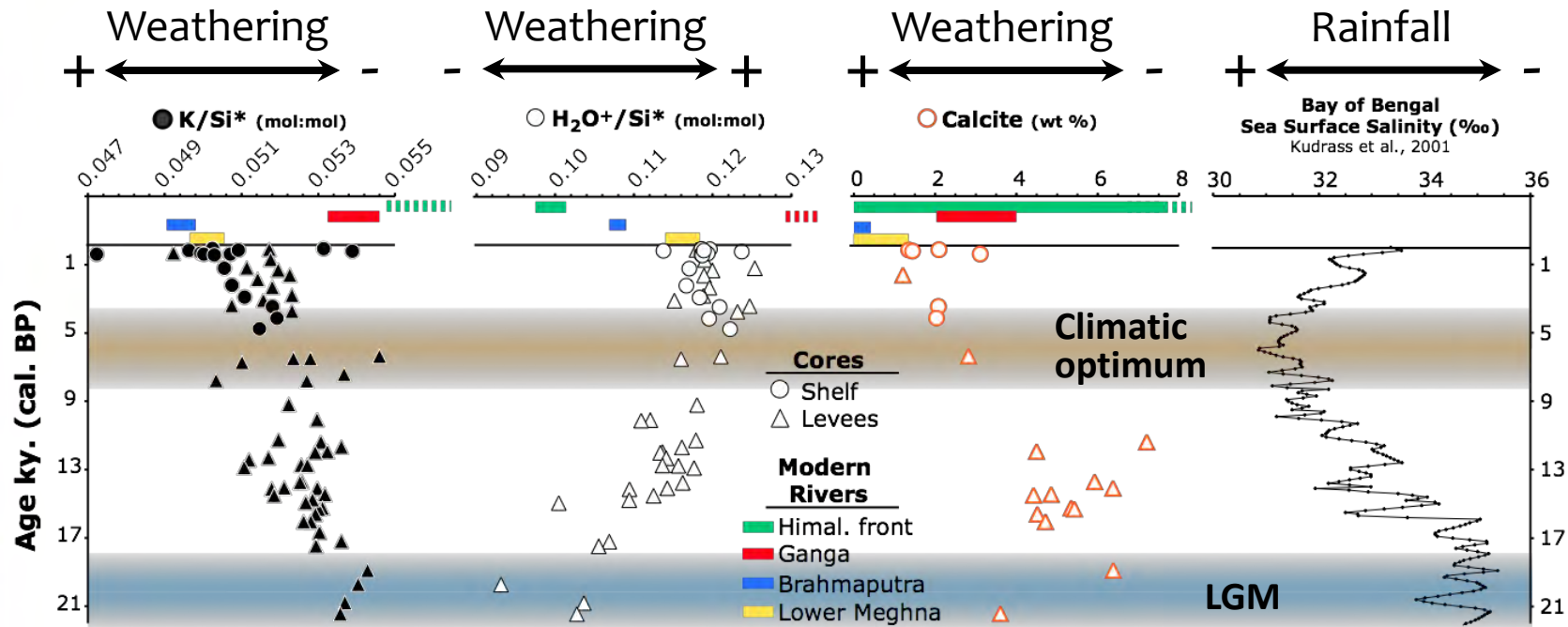


(Lupker et al., EPSL, 2012)

Himalayan system response since LGM



Himalayan system response since LGM



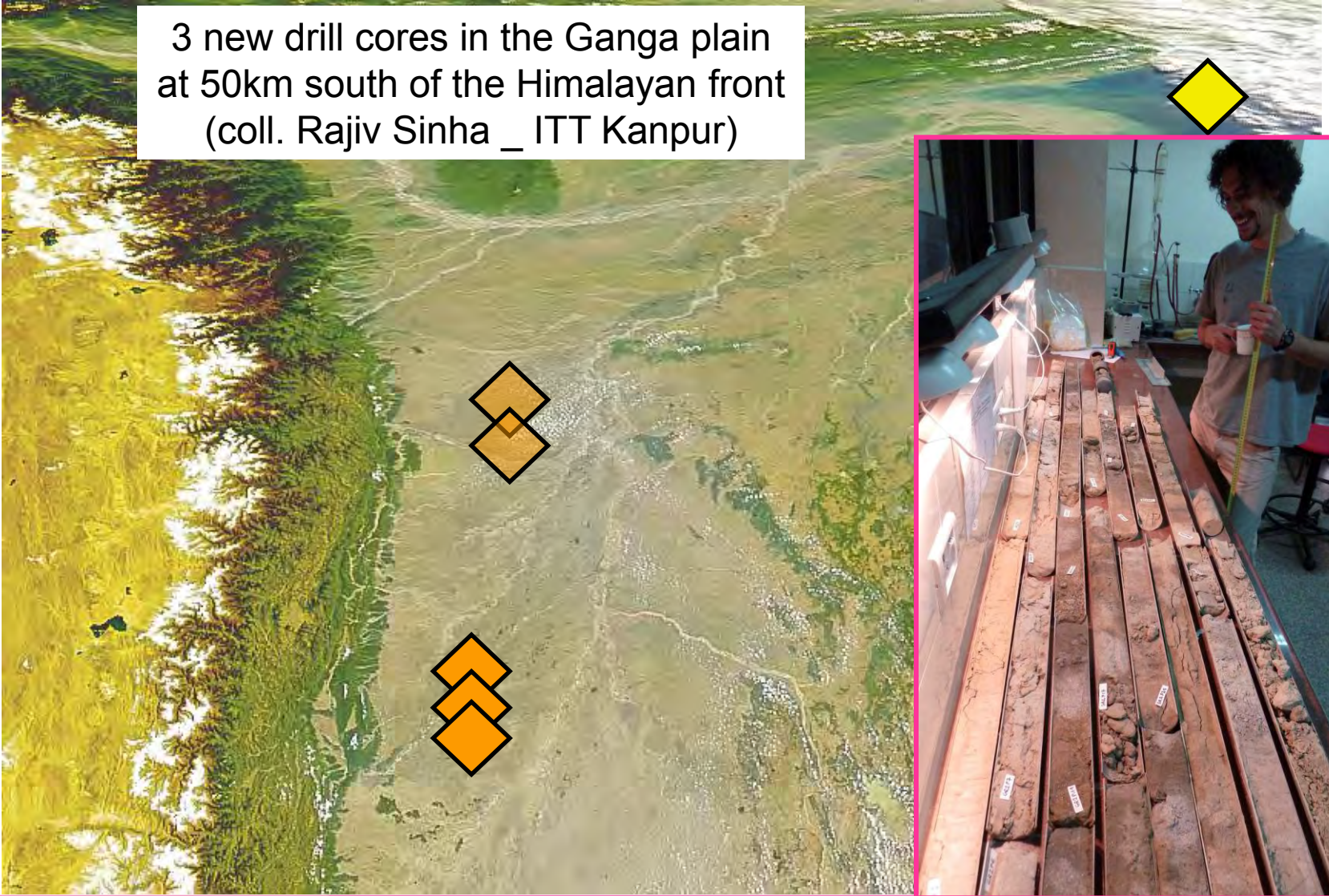
(Lupker et al., in prep)

Weathering intensity in the Himalaya/Ganga system during LGM was lower than at present.

Apparent phase shift during the Holocene consistent with the buffering role of the Ganga plain and sediment transfer time of 2 to 5 kyr.

Himalayan system response since LGM

3 new drill cores in the Ganga plain
at 50km south of the Himalayan front
(coll. Rajiv Sinha _ ITT Kanpur)



Project results

Task 1 : Erosion, weathering and sediment transport processes in the mountain range and their sensitivity to climatic variables

*Work in progress _ Large dataset now available
1 paper in prep.*

Task 2 : Transfer duration and segregation in the Ganga plain

4 published papers

Task 3 : Coupling physical and chemical erosion in a numerical model

*Work recently in progress
1 submitted paper*

Task 4 : The Himalaya/Ganga erosion response to past climatic changes

*3 new drill cores
1 magnetostratigraphic section sampling planed for the fall 2012
1 submitted paper*

