Source-to-Sink signal propagation in a coupled catchment-deep-sea fan system: the Sithas example from the Corinth Rift (Pleistocene, Greece)

Nolwenn Deiss [1,2], Sébastien Rohais [1], Vincent Regard [2]

1 - IFP Energies nouvelles, 1 et 4 avenue du Bois-Préau 92852, Rueil-Malmaison Cedex - France

2 - GET, University of Toulouse (UPS/CNRS/IRD/CNES), 14 avenue Edouard Belin 31400, Toulouse - France

*Contact: nolwenn.deiss@ifpen.fr

Introduction

WHY? - Sea level variations eroding the land-sea interface where populations are located
- Understanding of erosional processes

WHAT? - Integrated mass balance along the Source-to-Sink (S2S) profile of a **complete** system

HOW?
- Restoration of the volume of eroded sediments in the catchment
- Calculation of suspended sediment load with BQART model
- Quantification of the volume of deposited sediments deposited in the offshore
- Comparison of the 3 methods

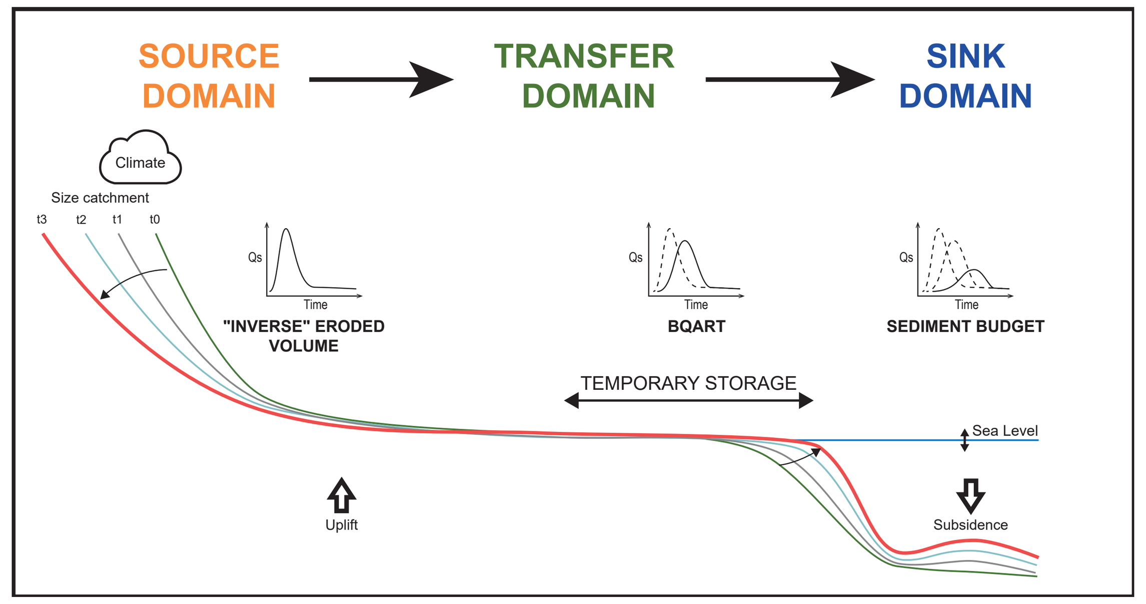

Figure 1. Theorical S2S scheme presenting the sedimentary signal propagation along a Source-to-Sink system with its controlling factors

Case study & Data

- Sithas System
  - Coupled catchment-deep-sea fan system
  - Small system: catchment ≈150 km^2
  - Marine terraces as spatial constraints
  - Extensive dataset available
  - Regional tectonics increases erosion and sedimentation processes

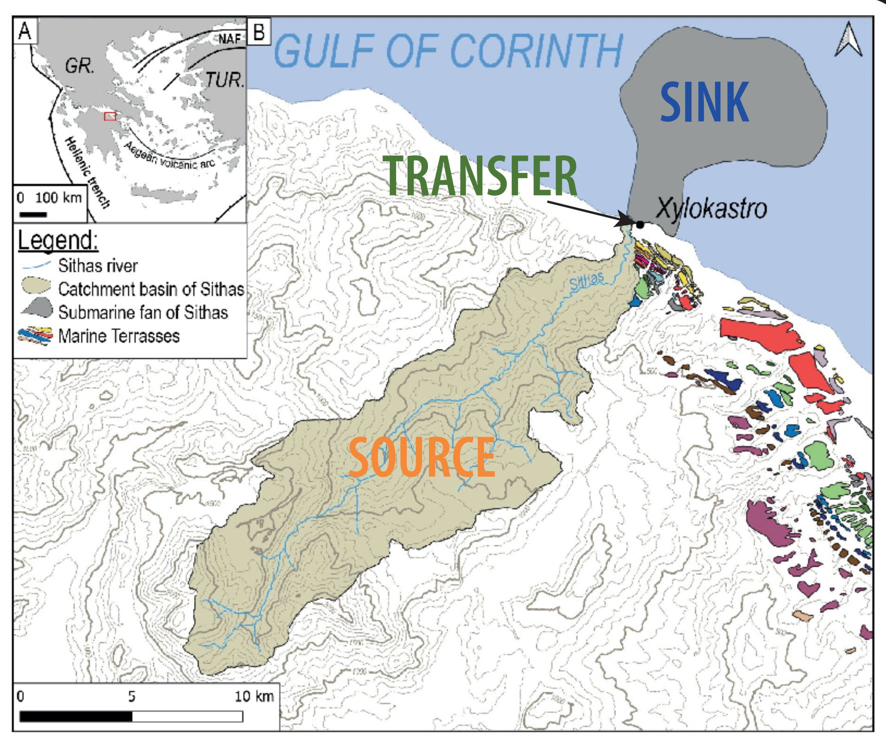

Figure 2. A. Simplified geodynamic map . NAF: North Anatolian Fault. GR: Greece. TUR: Turkey. B. Map of the study area. Marine terraces from Armijo et al. (1996) and Gelder et al. (2019)

- Age model
  - Onshore part
    - 18 markers: marine terraces
    - 3 absolute ages
    - MIS + eustatic curve correlation
  - Offshore part
    - 13 markers: bio- and magneto-stratigraphy, glacio-eustatic cycles...
    - Seismic data
    - Highstand correlations

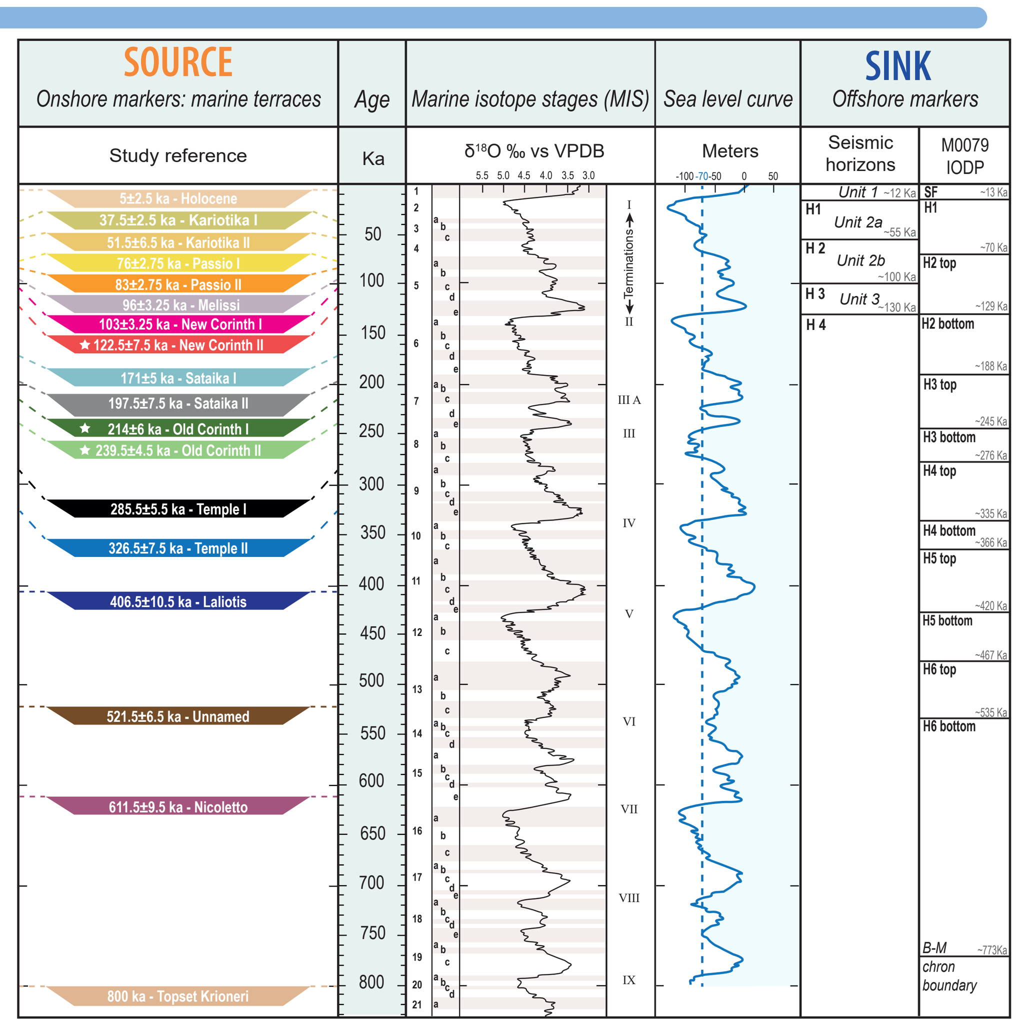

Figure 3. Proposed age model of the Sithas system

Results

- Gradual increase of the fluxes since 800 ka and more specifically since 400 ka in all 3 methods (described below)
- $Qs_{BQART} > Qs_{EROSION} > Qs_{DEPOSITION}$
- Sedimentary cycles of ~100-120 ka
- Flux peaks during interglacial periods
- Sediment export during transgression and high sea-levels
- Erosion and deposition fluxes **not fully** in phase

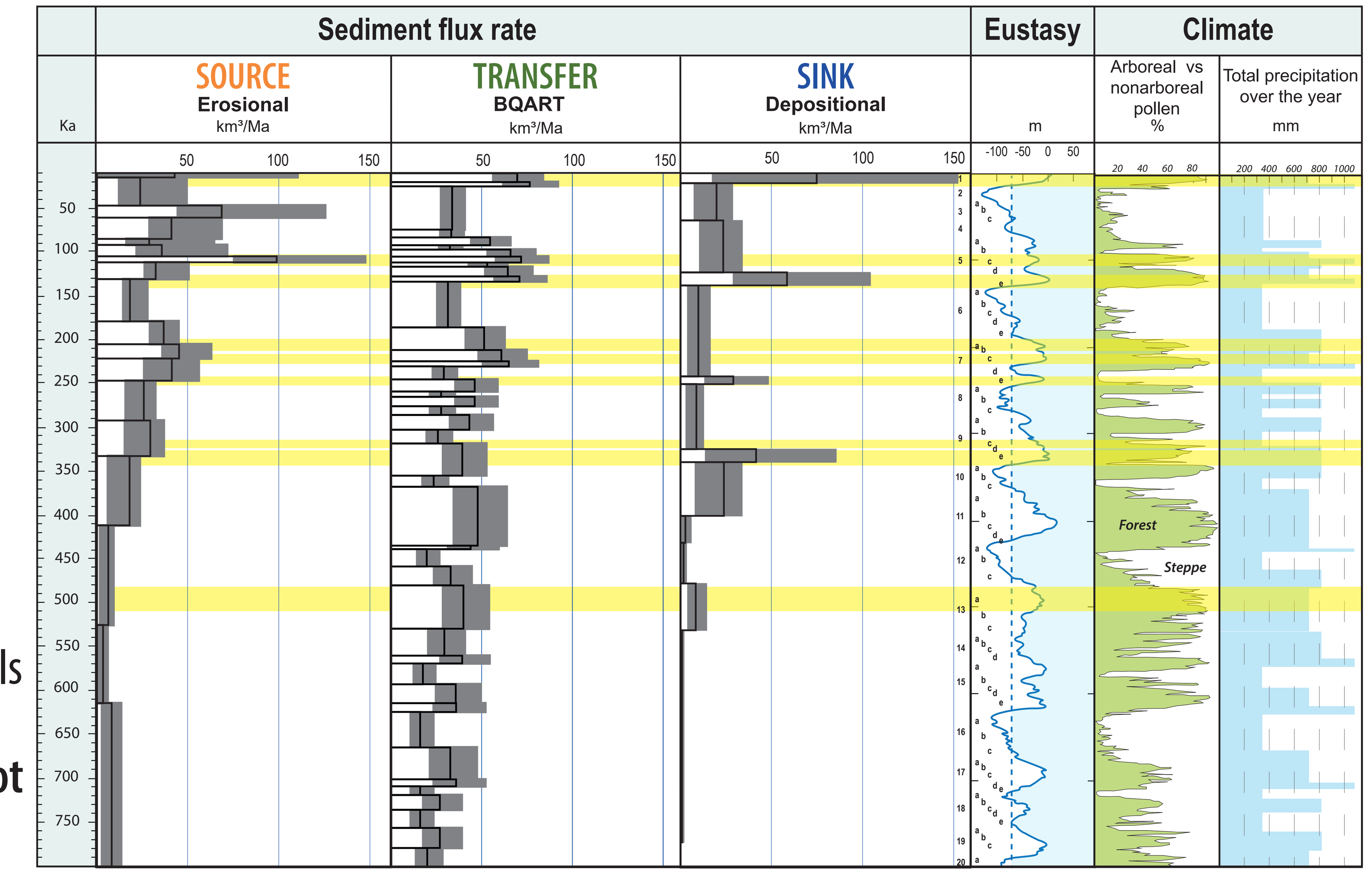

Figure 7. Comparison of BQART, erosional and depositional fluxes (km³/Ma) with eustasy and climate data

Methods: Comparison of erosional, BQART and depositional models

Erosion (estimation of eroded volumes)

For each time step:
- measuring the catchment area
- calculating average eroded thickness using 6 methods

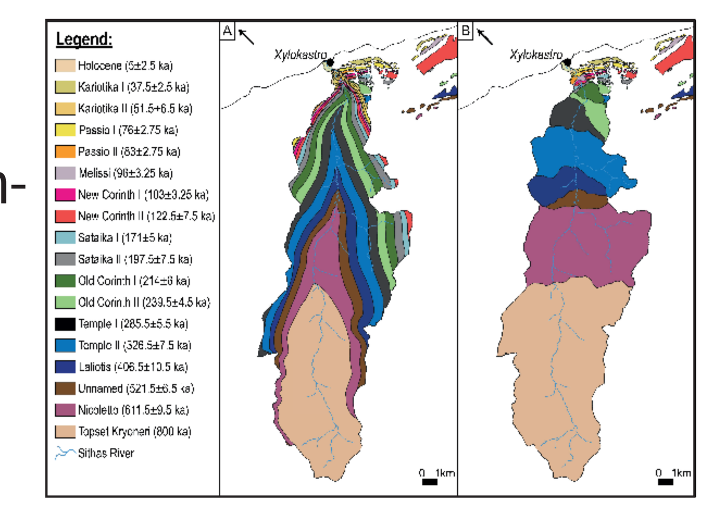

Figure 4. Paleo-catchment basin related to the marine terraces. A. "Thin" paleo-catchment. B. "Wide" paleo-catchment.

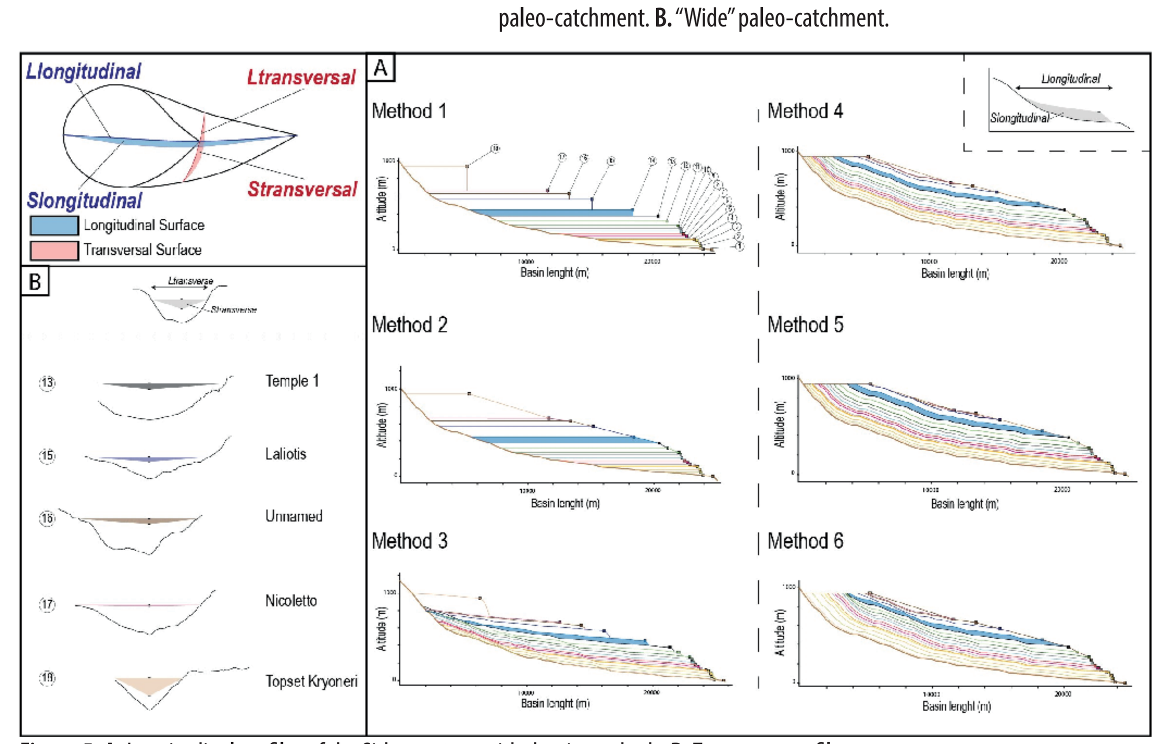

Figure 5. A. Longitudinal profiles of the Sithas system with the six methods. B. Transverse profiles.

Suspended sediment load

For each time step: using the empirical BQART model based on climatic data from Mommersteeg *et al.* (1995)

$$Qs = \omega.B.Q^{0.31}.A^{0.5}.R.T$$

Deposition (sedimentary budget)

For each time step: intersecting the fan size with the thinkness maps

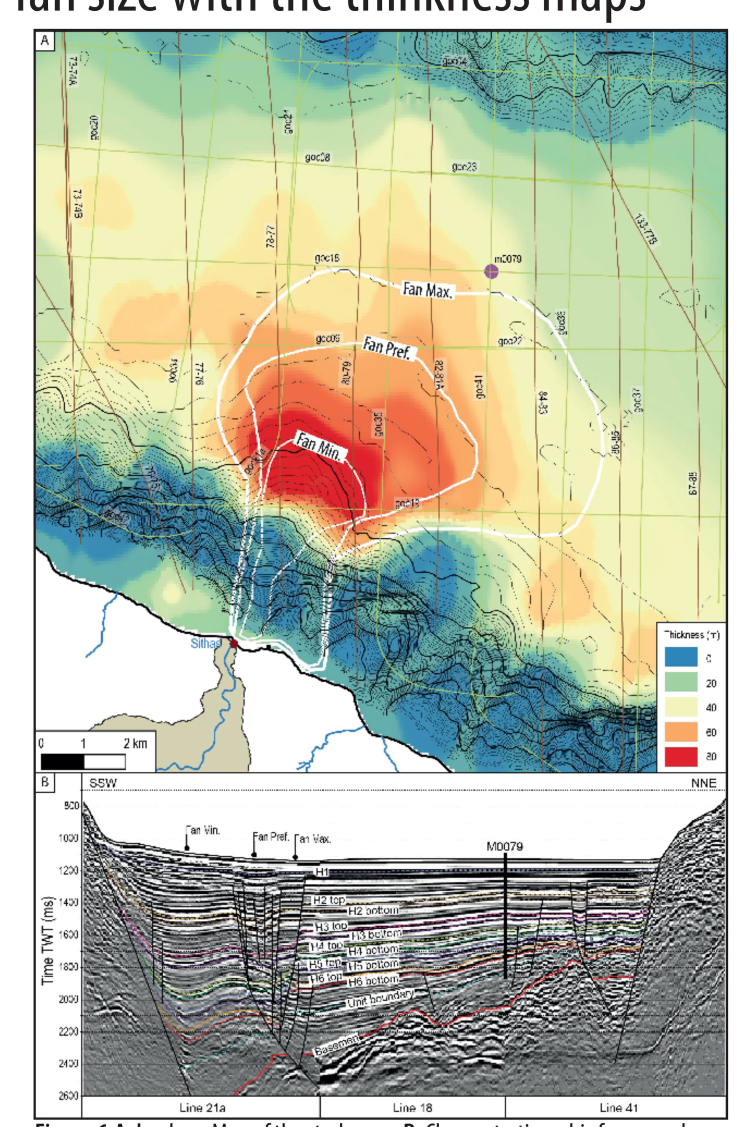

Figure 6.A. Isochore Map of the study case. B. Chronostratigraphic framework on a high-resolution seismic reflection profile from Taylor et al. (2011) and Shillington et al. (2019)

Conclusion

- Hypothetical model:
  1. strong export of previously stored sediments at the beginning of the interglacial period
  2. gradual decline in flows as sea level falls
  3. low sediment export during glacial period
  4. increase in sediment export capacity during transgression
- Controlling factors: size of the catchment, climatic cycles

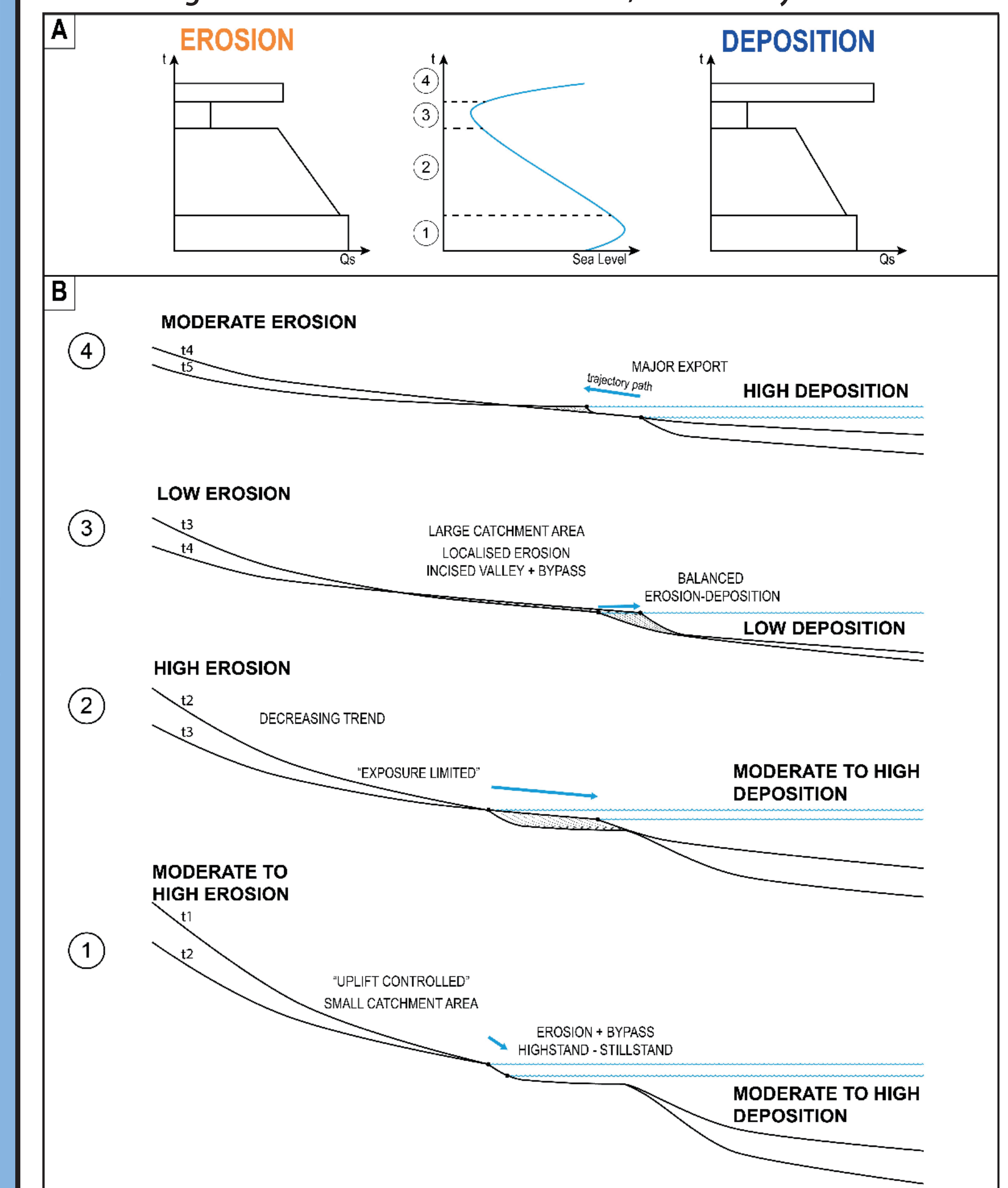

Figure 8. Synthesis figure schematically hypothesizing the evolution of a S2S system during an eustatic cycle subject to uplift following our interpretations. A. Fluxes of sediments (Qs) and sea level variation during an eustatic cycle B. Schematic cross-section of the system over time

References

- Armijo R, Meyer B, King G, Rigo A, Papanastassiou D. Quaternary evolution of the Corinth Rift and its implications for the Late Cenozoic evolution of the Aegean. Geophysical Journal International 1996;126(1). https://doi.org10.1111/j.1365-246X.1996.tb05264.x
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