# Source-to-Sink study and Grain Size and Volumetric Model of the Escanilla Sediment Routing System, South Central Pyrenees, Spain*

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## Abstract

Understanding how the tectonic controls on accommodation generation affect grain size trends, depositional facies and stratigraphic architecture remains a key challenge for sedimentologists and petroleum geologists. We tackle this issue using a case study in the Escanilla Formation an upper Eocene clastic sedimentary system, sourced primarily from the Axial Zone of the Pyrenees and deposited in wedge top basins of the South Central Pyrenees. This system consists of a variety of depositional environments from proximal fanglomerates and fluvial deposits to distal slope and deep marine turbidites. We focus on the fluvial segment of the sediment routing system. We present a source-to-sink analysis by teleconnecting mountain catchment areas, basin margin fans acting as proximal feeder systems and braided river systems of the Escanilla Formation in the Tremp-Graus and Ainsa basins.

Within the fluvial segment, distinct point sources for sediment supply to the wedge-top basins existed in the mid-late Eocene. Excellently exposed remnants of these major feeder systems are found in the Pobla de Segur-Gurb and Sis regions close to the southern edge of the Pyrenean Axial Zone. The deposits of the fluvial system are best observed in the Isabena Valley close to Lascuarre, the Viacamp region, and in the southeastern Ainsa Basin. We present new sedimentological data from the Gurb and Viacamp regions in the Tremp-Graus basin and make a correlation panel for the entire fluvial segment. Linkages within the fluvial segment are aided by a range of provenance tools (paleoflow determinations, clast composition data, detrital U/Pb zircon ages and Apatite Fission track data) and palaeomagnetic data.

The sediment budget for the Escanilla routing system can be estimated by mapping the fairway of the system and interpolating sediment thicknesses of its constituent units. We model the downsystem trends in grain size in relation to deposited sediment volumes for these time intervals. Our results demonstrate that it is now possible to derive quantitative relationships between the spatial distribution of subsidence, down-system grain size, sediment volume and stratigraphic architecture in this common type of sediment routing system.

## References


Beamud, E., M. Lopez-Blanco, J.C. Larrasoana, M. Gomez-Paccard, M. Garces, and E. Costa, 2010, Tectonic versus climatic controls on basin-margin alluvial fan/fan delta complex development, Montserrat, NE, Spain: EAGE 72nd New Spring for Geoscience/SPE EUROPEC Conference, Barcelona, Spain, June 14-17, 2010 (extended abstract), Paper no. P068, CD-ROM, 5 p.

Sutcliffe, C., and K.T. Pickering, 2009, End-signature of deep-marine basin-fill, as a structurally confined low-gradient clastic system: The Middle Eocene Guaso system, South-Central Spanish Pyrenees: Sedimentology, v. 56/6, p. 1670-1689.

# Source-to-Sink study and grain size and Volumetric model of the Escanilla sediment routing system, South Central Pyrenees, Spain.

AAPG Talk 24/04/2012

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Thanks to my co-authors: Philip A. Allen and Alexander Whittaker

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Saudi Aramco

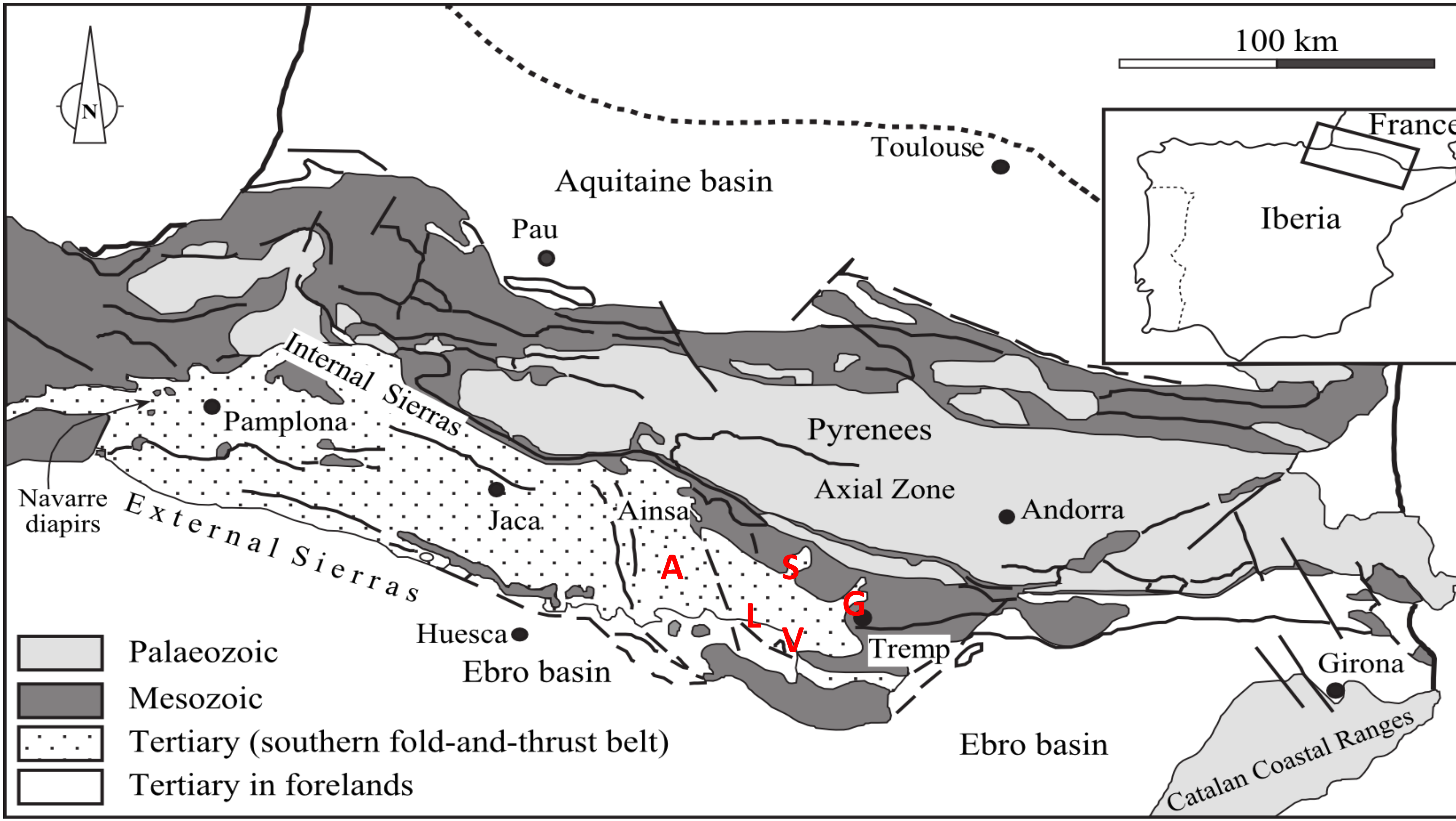
# Outline

- Motivation
- Escanilla Routing System
- Reconstructing the Sedimentary System
  - **Provenance work**
  - **Map of the sedimentary fairway**
- Sedimentological Work
  - **Sedimentary facies**
  - **Correlation Panel**
  - **Sedimentary facies versus distance**
- Calculating the sedimentary budget and sedimentary fluxes
  - **Calculation of sediment fluxes in sedimentary basins**
  - **Fluxes and sedimentary architecture**
- Conclusions

# Motivation

- Calculate sedimentary budget within a sedimentary system and characteristic grain-size mix released from catchments.
- A pre-requisite for stratigraphic prediction.
- How the mass balance between the sediment fluxes and spatial distribution of accommodation influence stratigraphic architecture.

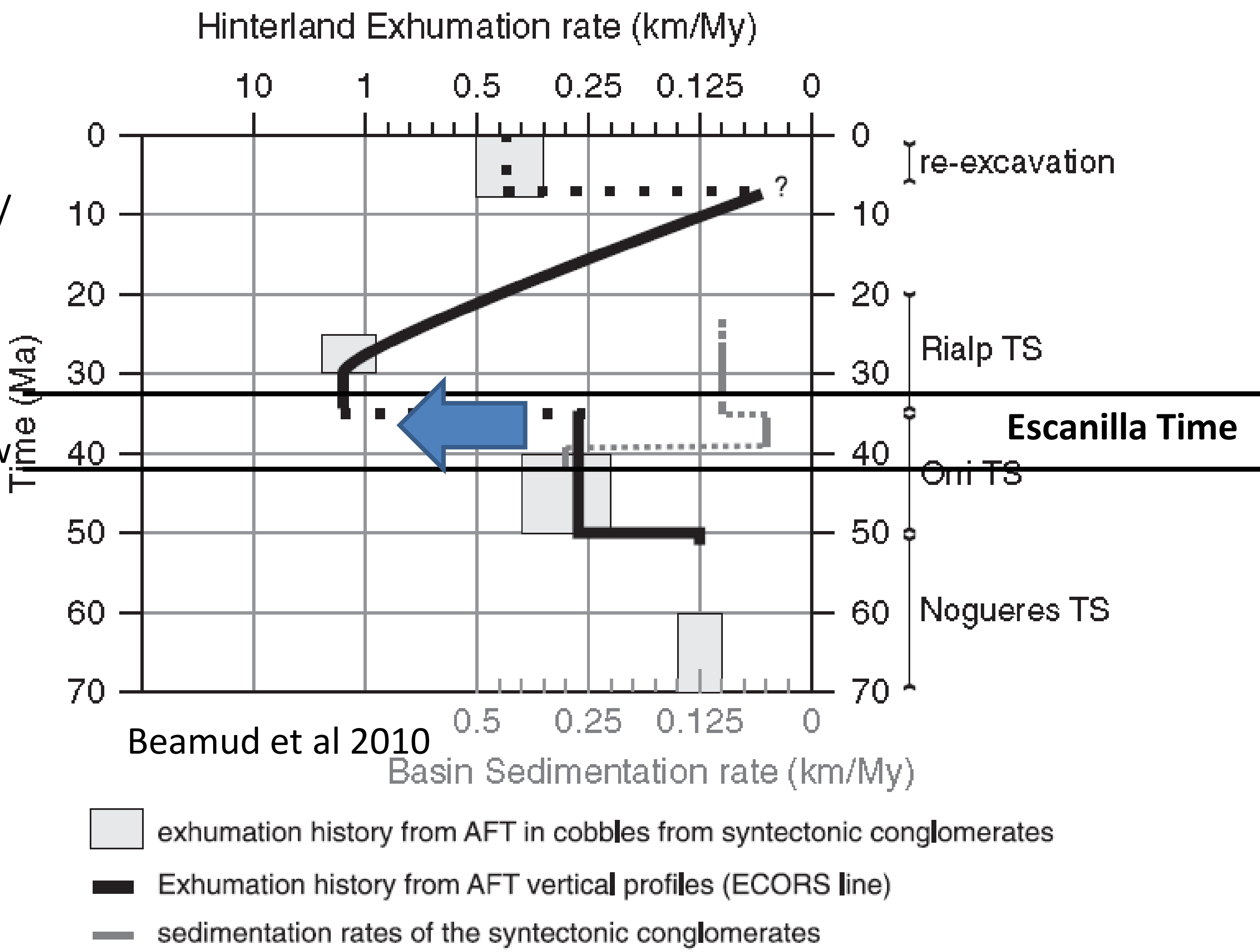
# The Escanilla Routing System




Sutcliffe & Pickering 2009

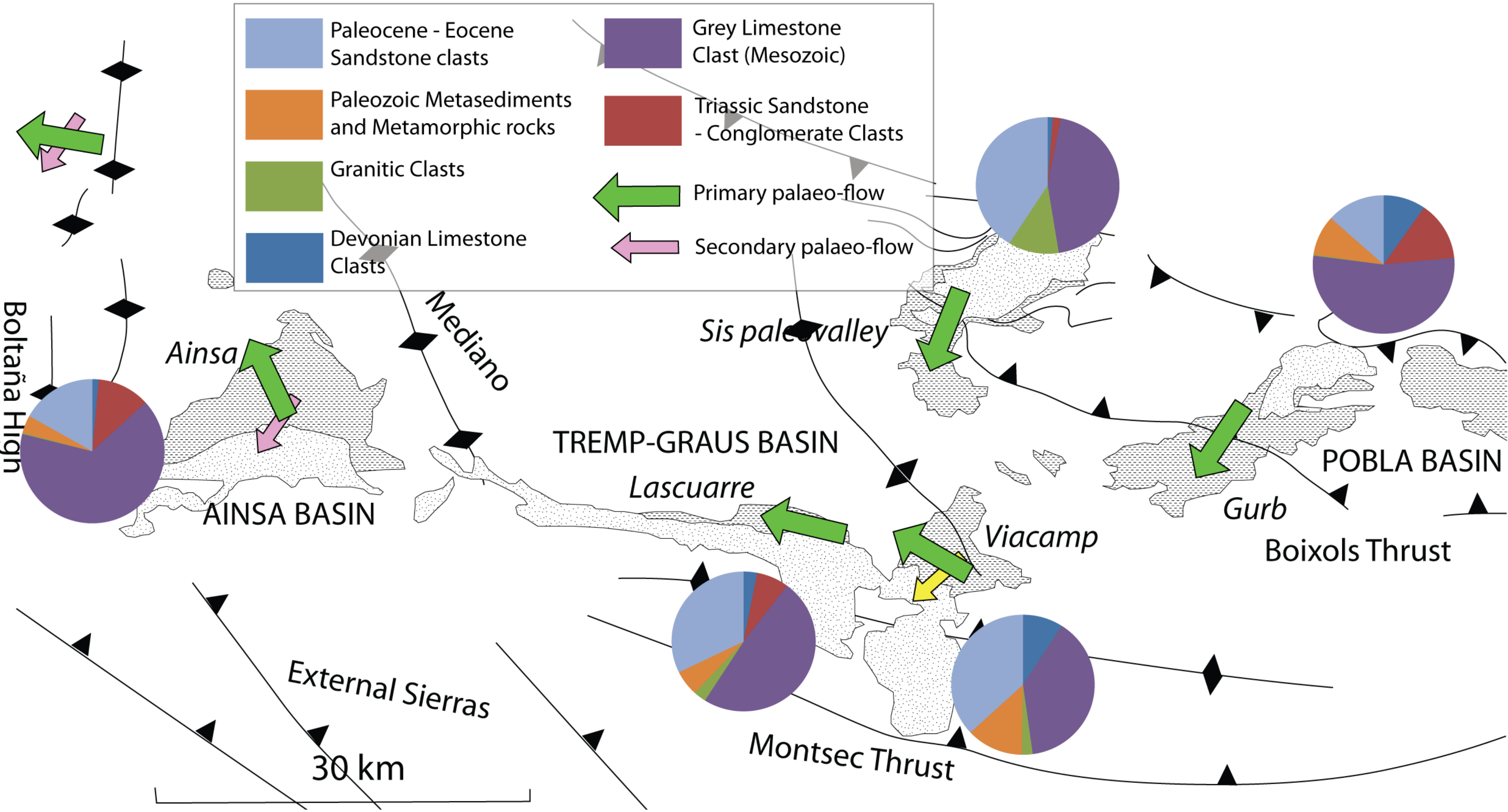
# Catchment erosion rates

We see a step Increase in Bedrock/ Catchment erosion rates from 0.25km/ Myrs to a 1-2 km/ Myr.
We want to see how this translates to stratigraphy.

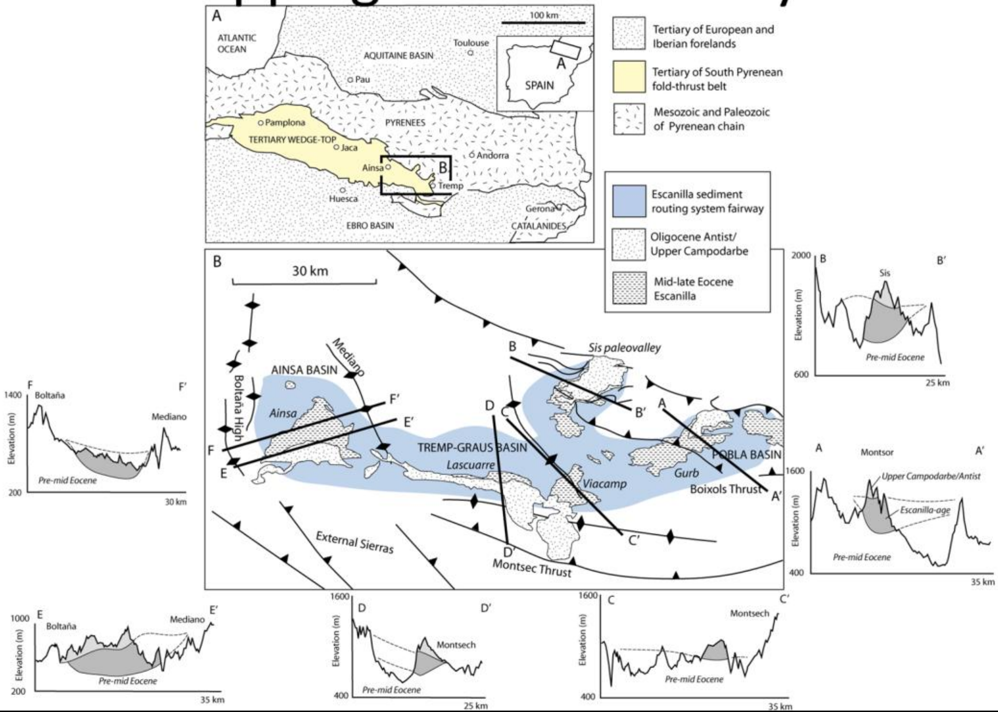



Beamud et al 2010

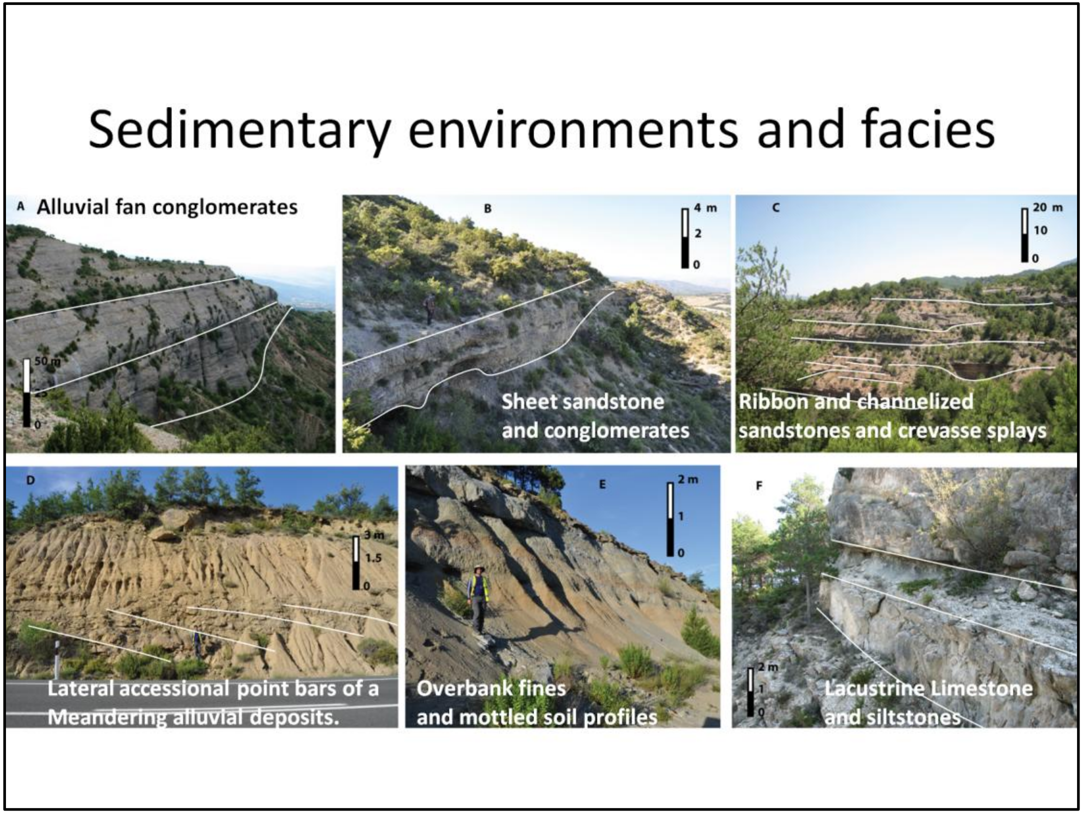
# Provenance Study



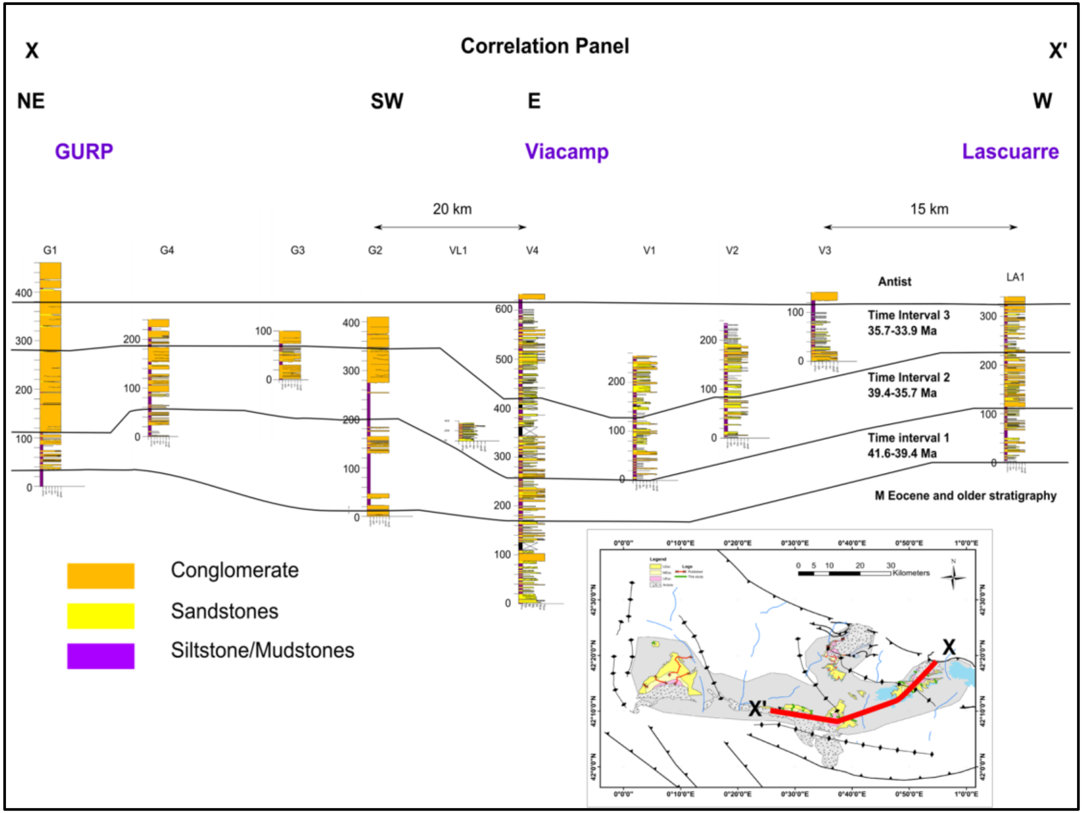
# Mapping the Escanilla System




Presenter's notes: After reconstructing the system, we had to map the sedimentary fairway, which is the spatial distribution of the system, and an interpretation of the maximum extent of the system. We have used DEM's, published geological maps, our own field observations and seismic data to map the sedimentary fairway and examples of cross-sections that we get are shown in this picture. Examples of structural cross-sections, which are the basis of this map and for our modelling of the system to constrain the sedimentary volumes, which we will explain later.

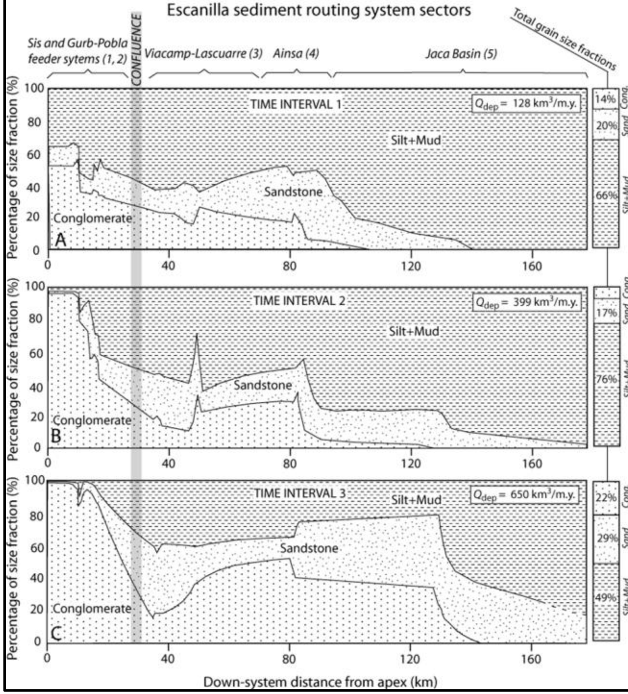



Presenter’s notes: The main sedimentary facies that we encompass in Gurp-Pobla , Sis, Lascuarre and Ainsa basins are: the Alluvial fanglomerates and braided stacked conglomeratic bars, sheet sandstones, multi-laterally stacked sandstone bars, channel fill ribbon like sandstone deposits and crevasse-levee deposits, and laterally accreted meandering point bar and various alluvial flood-plain deposits from silt-stones and mudstones to lacustrine limestone's and mature soil horizons and caliches. With increasing finer facies in the downstream parts of the system due to selective deposition.  For simplicity, we model conglomerates, sandstones and fines as groups and do not subdivide them in the model in for example ribbon sandstones and sheet like sandstones.




Presenter's notes: One example of our sedimentary logs and detail work on Gurp, Vicamp and Ainsa regions. The subdivision in three time intervals was possible based on dating of individual localities from other studies. We are able to define when this stratigraphic section was deposited. Our detail sedimentary logs gives as information about the thicknesses of the time intervals and the relative facies abundance in each locality.

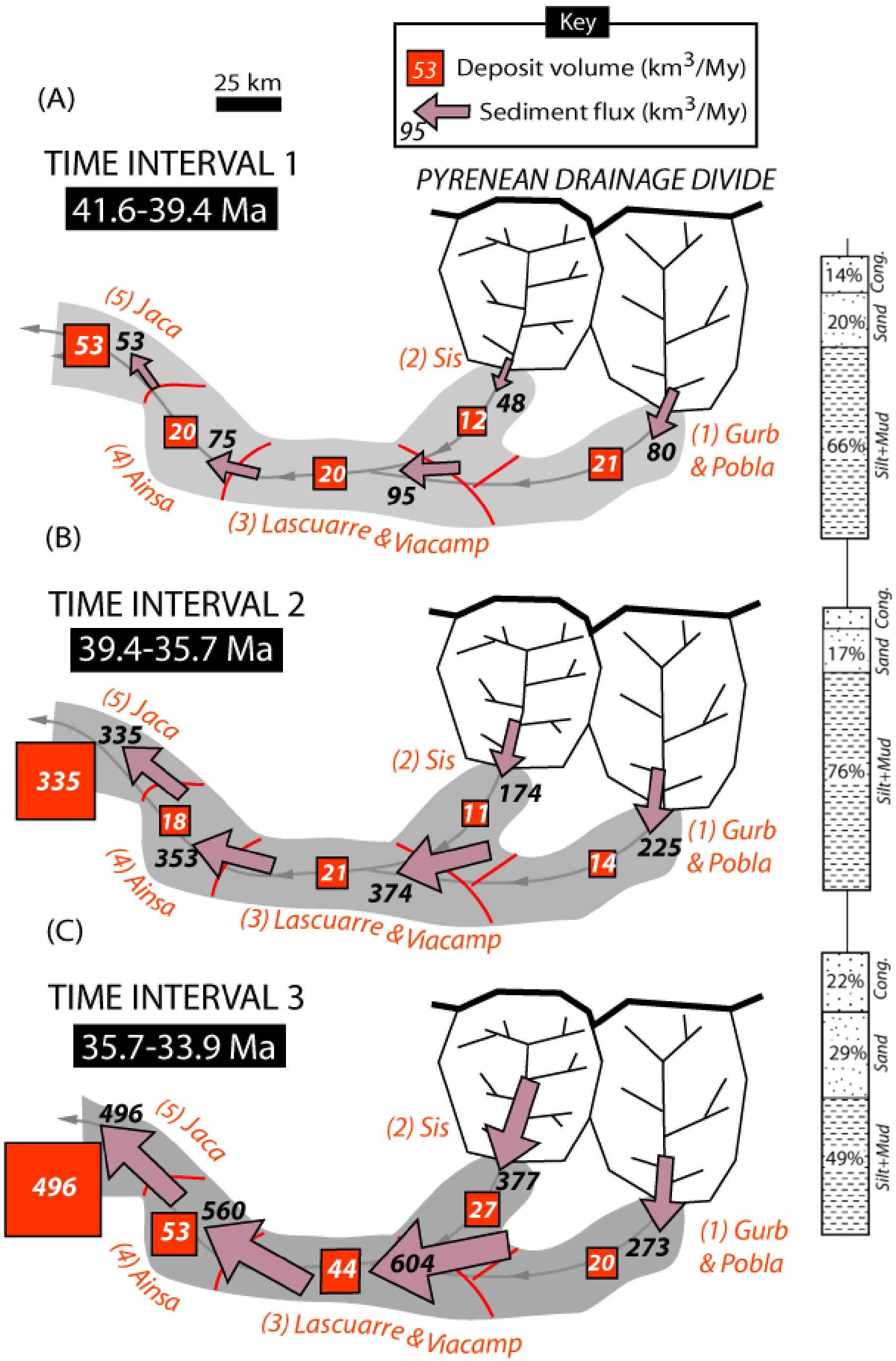
# Facies trends vs distance




- Strong progradation of facies within the basins
- Possible new tributaries from Jaca basin at time interval 3
- Interval 3 coincides with uplift of Western Pyrenees/ Lower Campodarbe

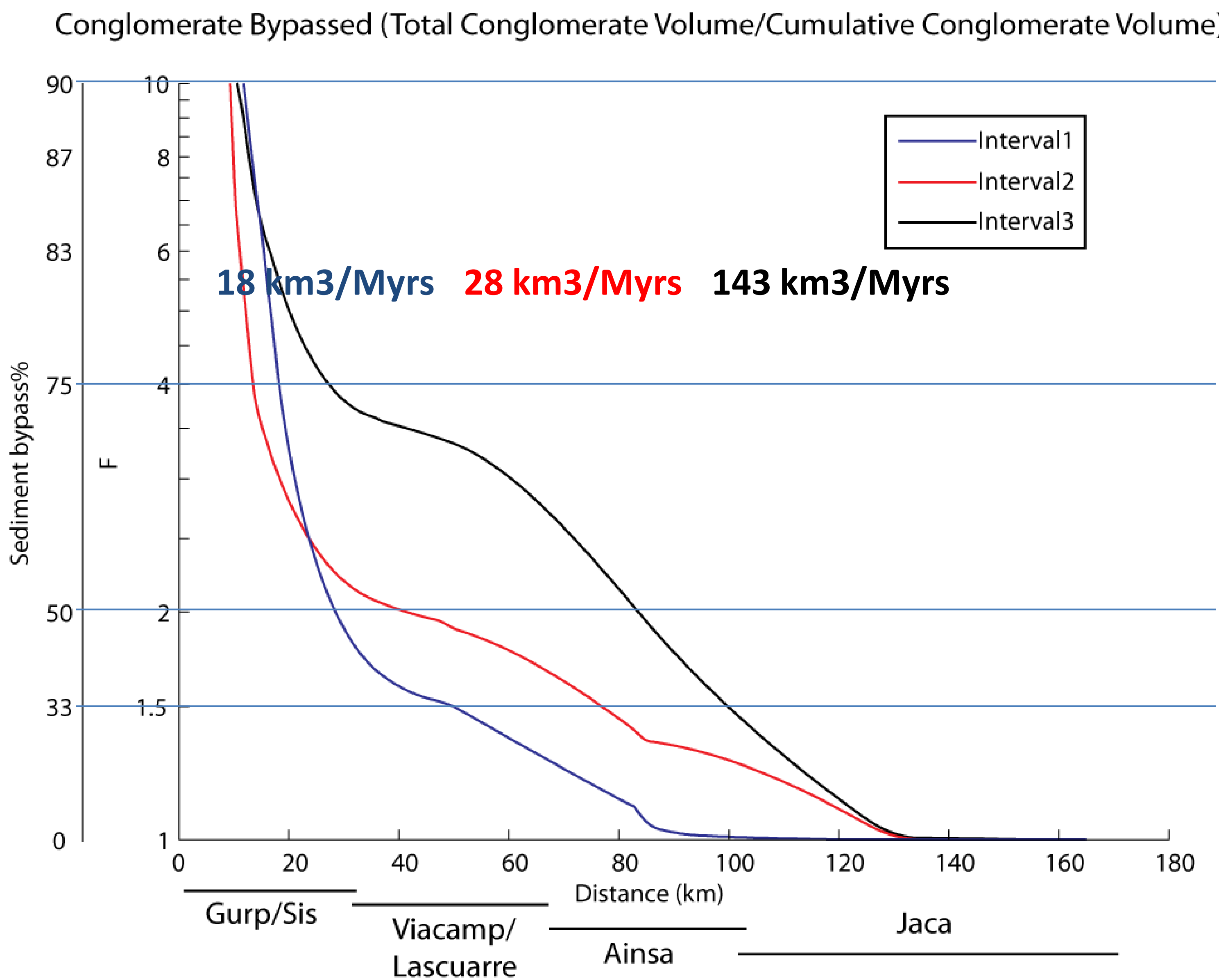
Presenter’s notes: Based on our sedimentary logs we can track facies versus distances for a very big length of the system from source to sink in Jaca basin and see how they change with distance and time. We present here the grouped facies of conglomerate, sandstone and fines and we there relative abundance in the whole system and our best guess about the sediment released from catchments in each time interval. We see a strong progradation of facies within the basins and possible new input points for Jaca basin at time interval 3 (Santa Orasia). Interval 3 coincides with uplift of Western Pyrenees

# Sedimentary budget and sediment fluxes of the system

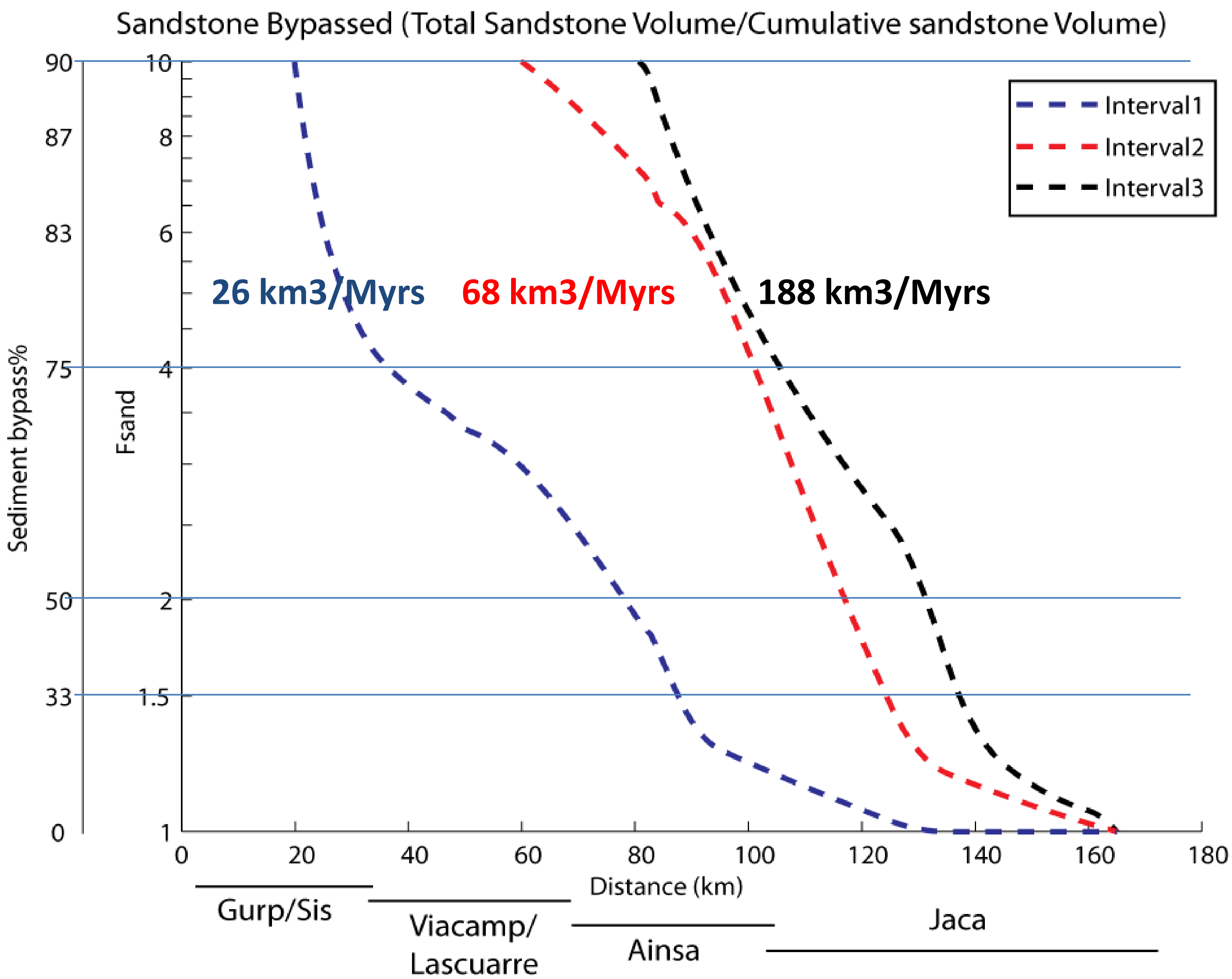



- We calculate the sediment deposited in each depozone and sediment flux through the system with time.
- We see a progressive increase in the total sediment fluxed through the system over time from 130 $km^3$/Myr in time interval 1 to a five fold increase in time interval 3 of 650 $km^3$/Myr

# Fluxes and sedimentary architecture



# Fluxes and sedimentary architecture

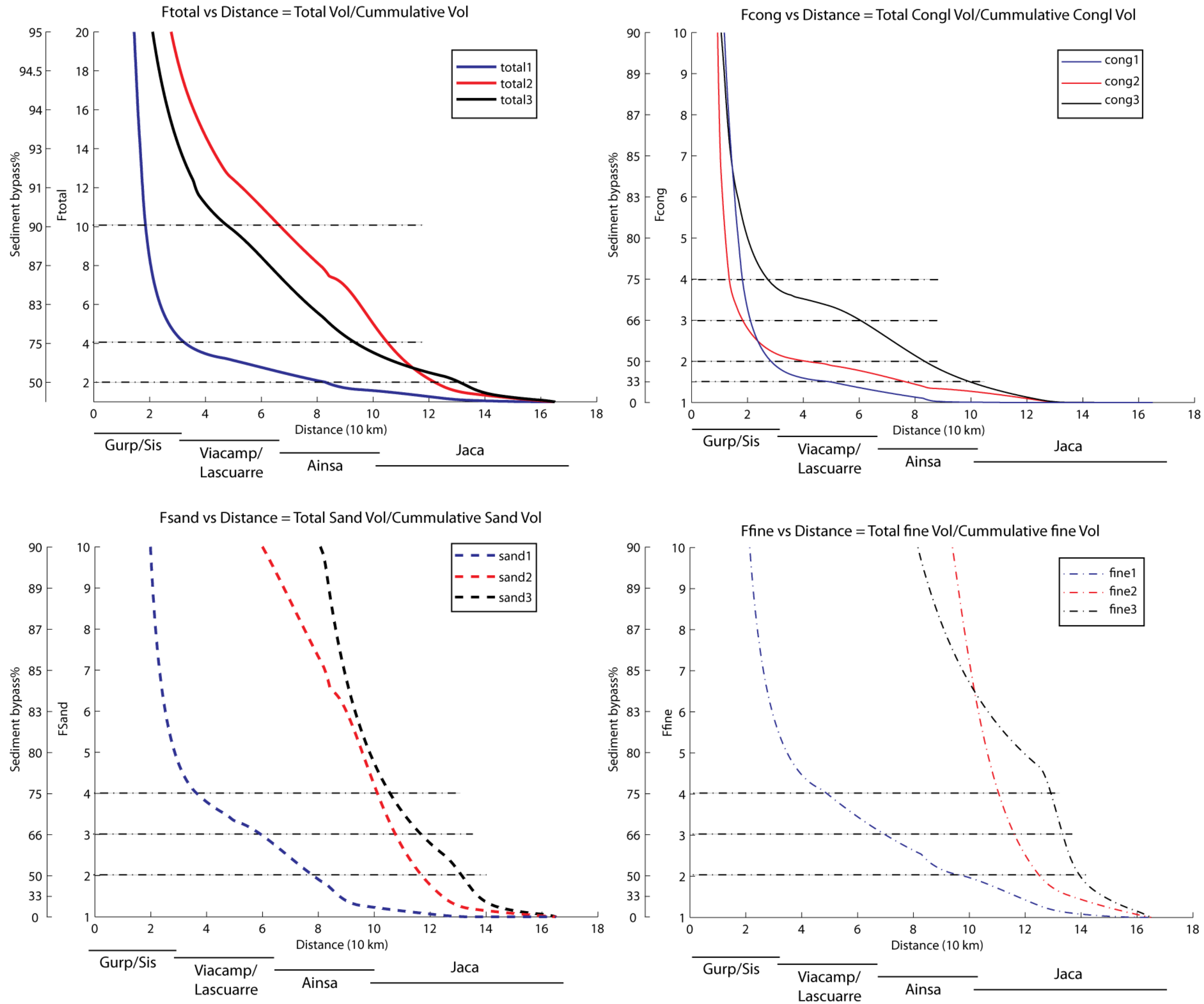


# Conclusions

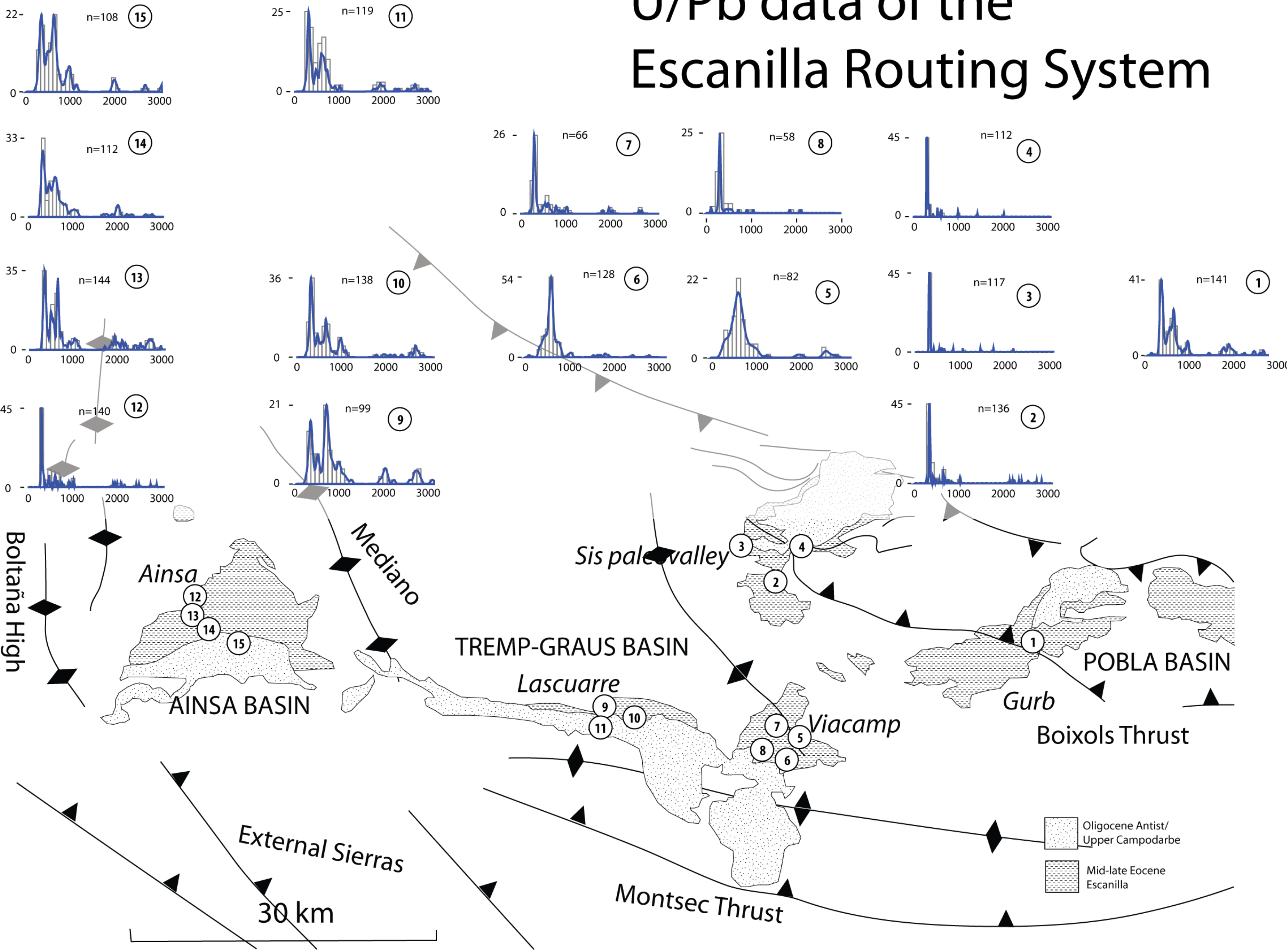
- The Escanilla Formation was primarily sourced from two mountain catchment areas - **Gurp** and **Sis** paleovalleys
- Mapping the sediment routing system **fairway** allows sediment **Volumes** and **Fluxes** to be calculated
- We track the **down-system fractionation of grain size** of sediment in three time intervals
- Within Escanilla time (Bartonian – Priabonian) from time interval 1 to 3 there was a strong progradation of facies and grain size, associated with a 5 fold increase in the sediment flux from catchment areas, leading to greater bypassing of sediment in the Ainsa and Jaca Basins.


Thank you for listening
Questions?

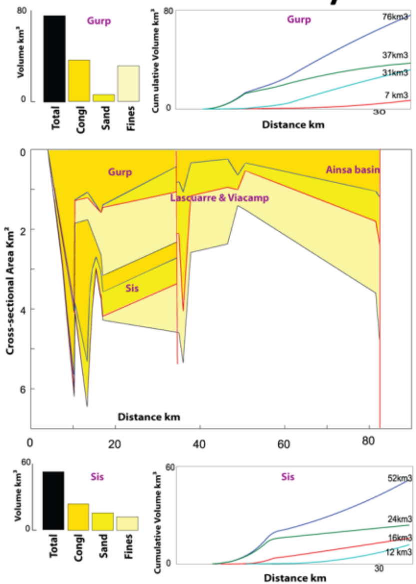
# Fluxes and sedimentary architecture

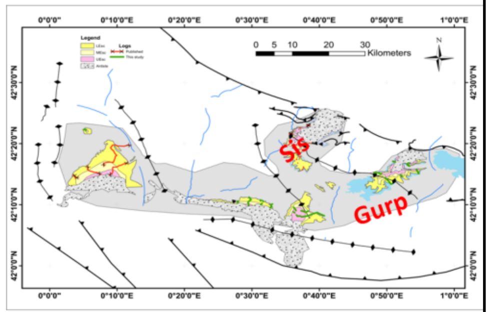


# U/Pb data of the Escanilla Routing System



# Calculating the Sedimentary budget time interval 2

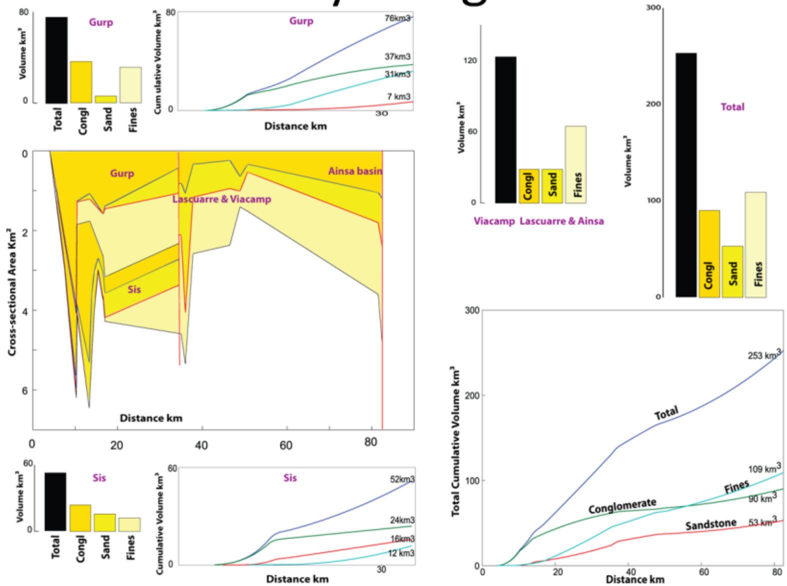



- Combination of the map of the sedimentary fairway and the sedimentary logs

Presenter's notes: This is the focus of the study and we have studied all these outcrop areas in grey, which represent Escanilla time equivalent to understand how they link together. We used of many methods in trying to understand where sediment is being produced: paleocurrent indicators, clast lithologies, Apatite Fission track analysis and U/Pb dating that we are presenting here. Our data suggest that Sis and Gurp –Pobla systems both fed the stratigraphy of the Escanilla formation in Viacamp, Lascuarre and Ainsa basin and also from evidence from (Teixel, Jolley, Puidgefabregas ) also fed the sediment into Jaca basin.

# Calculating the Sedimentary budget time interval 2




- Combination of the map of the sedimentary fairway and the sedimentary logs

Presenter's notes: Our model consists of input from our sedimentary logs and our map of the sedimentary fairway. In each locality, we try to reconstruct and calculate the cross-sectional area like the examples give in the diagram above and subdividing into conglomerate, sand, silt and fines. This diagram represents the volumetric profile and approximates the system and our best guess about the spatial distribution of subsidence. In this way, we can calculate the sedimentary and perform statistics about part of the system and the whole source to sink system.

# Grain size trends