Lithospheric strenght control over depositional environments and foreland accommodation in the Western USA Basin during the Early Triassic

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AGENCE NATIONALE DE LA RECHERCHE ANR

BIOGÉOSCIENCES

Laboratoire Magmas & Volcans

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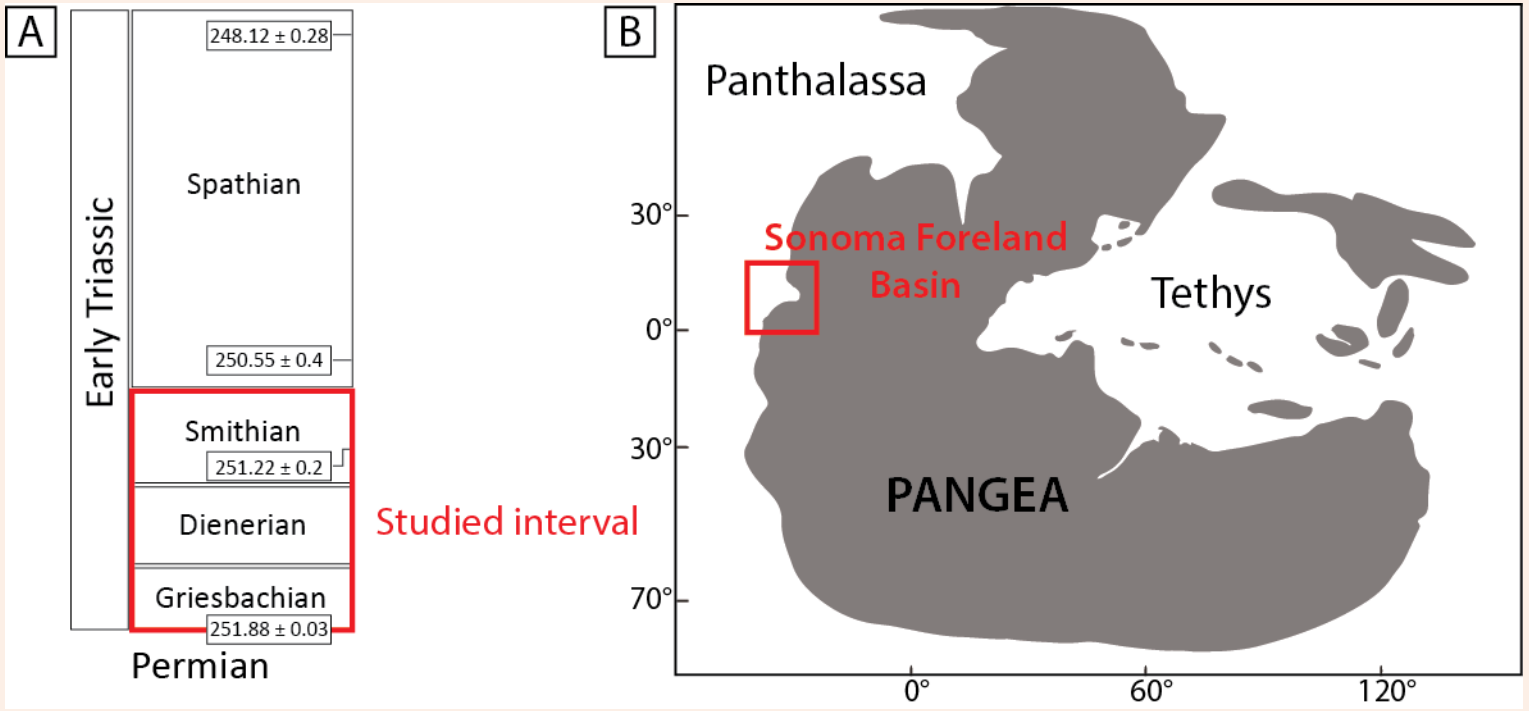
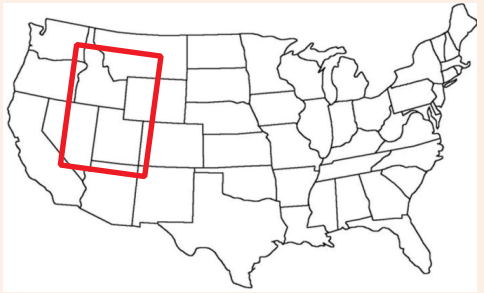
Context of the study



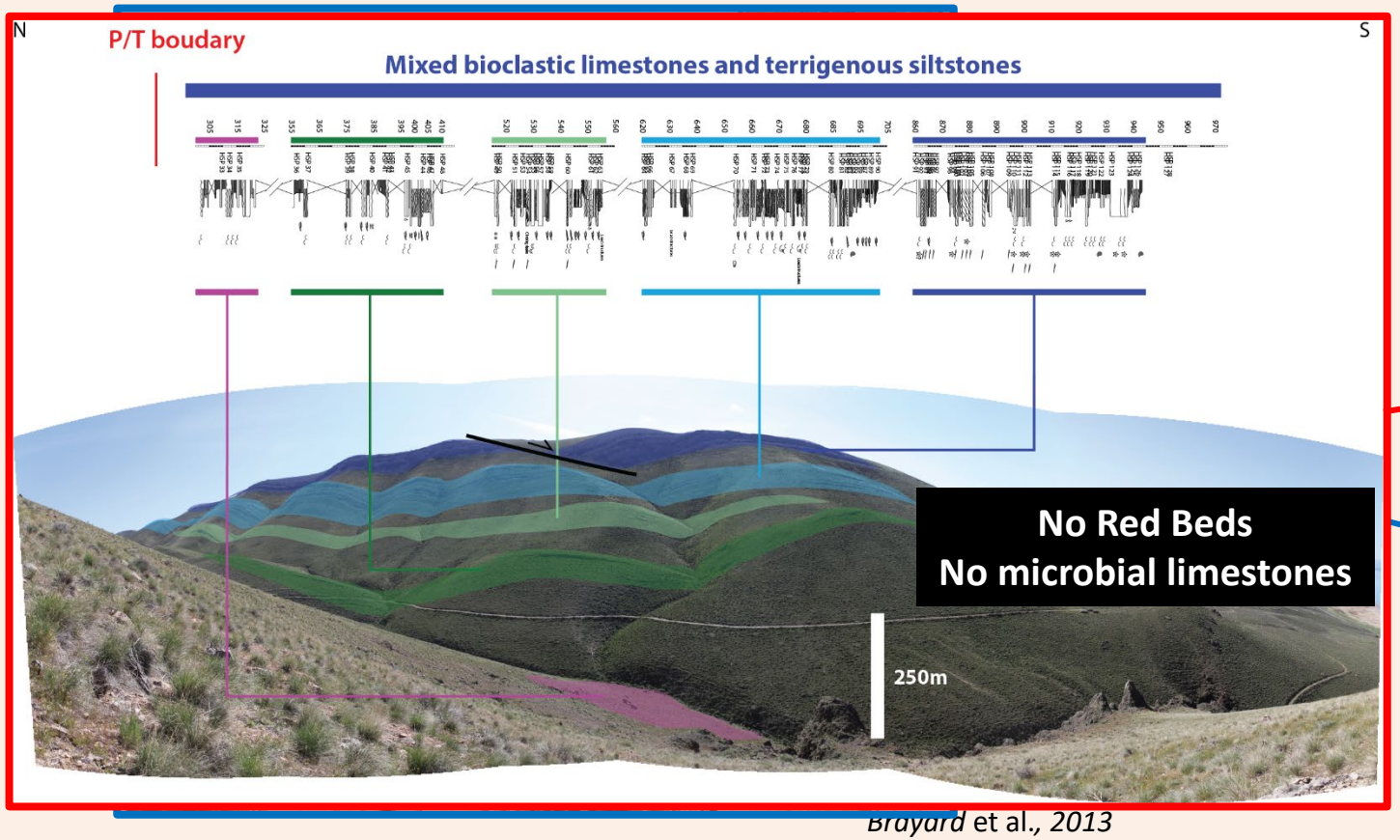


Caravaca et al., in prep.

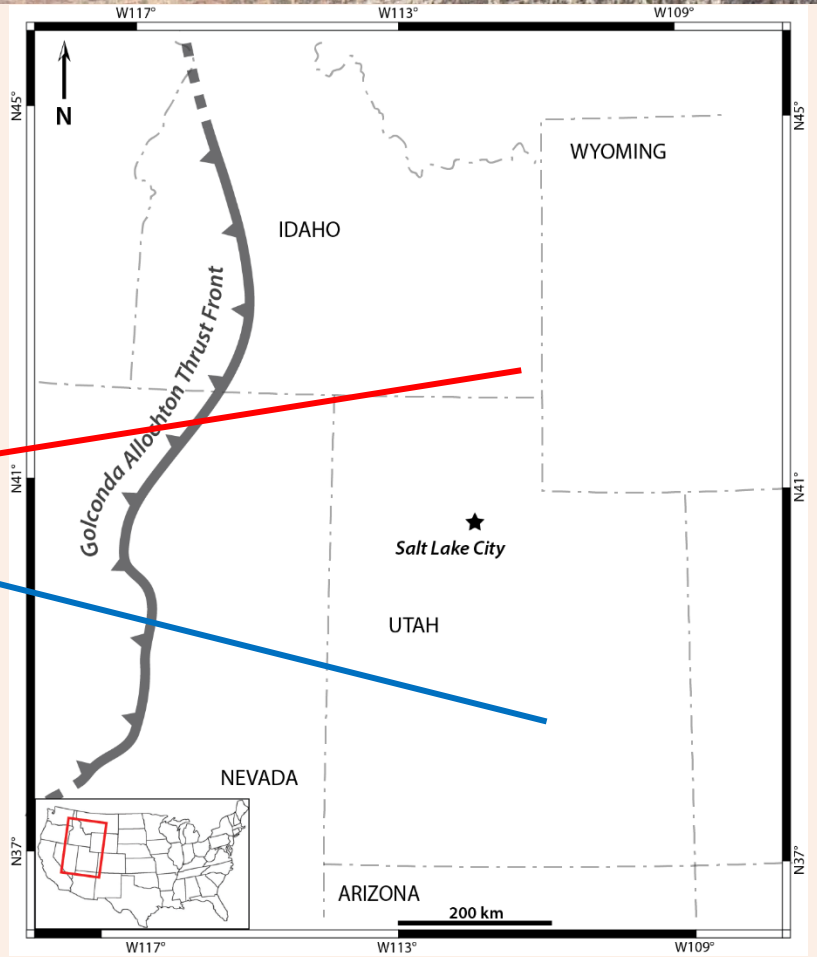
P/T Boundary-Smithian interval (~1,5 ma) in the Sonoma Foreland Basin (western US)

⇒ Basin formed due to Golconda Allochton emplacement around the PTB (Sonoma Orogeny, ~252 Ma)
⇒ Excellent fossil and sedimentary record of the aftermath of the PTB-crisis
⇒ Paleogeography of the region still poorly constrained

Context of the study



Brayard et al.*, 2013*



Empiric observations => **Sedimentary record varies in the basin:**

- Transgressive trends recorded in the basin with marine incursions from the North
- **Different facies associations**: from terrigenous and dolomitic red beds, to mixed bioclastic limestones and terrigenous sediments
- **Variation in sedimentary thickness**

Aim of this work

What is the nature of the main controlling factor(s) over the sedimentation in the Sonoma Foreland Basin during the PTU-Smithian interval?

Role of the foreland nature of the basin in the aforementioned sedimentary distribution?

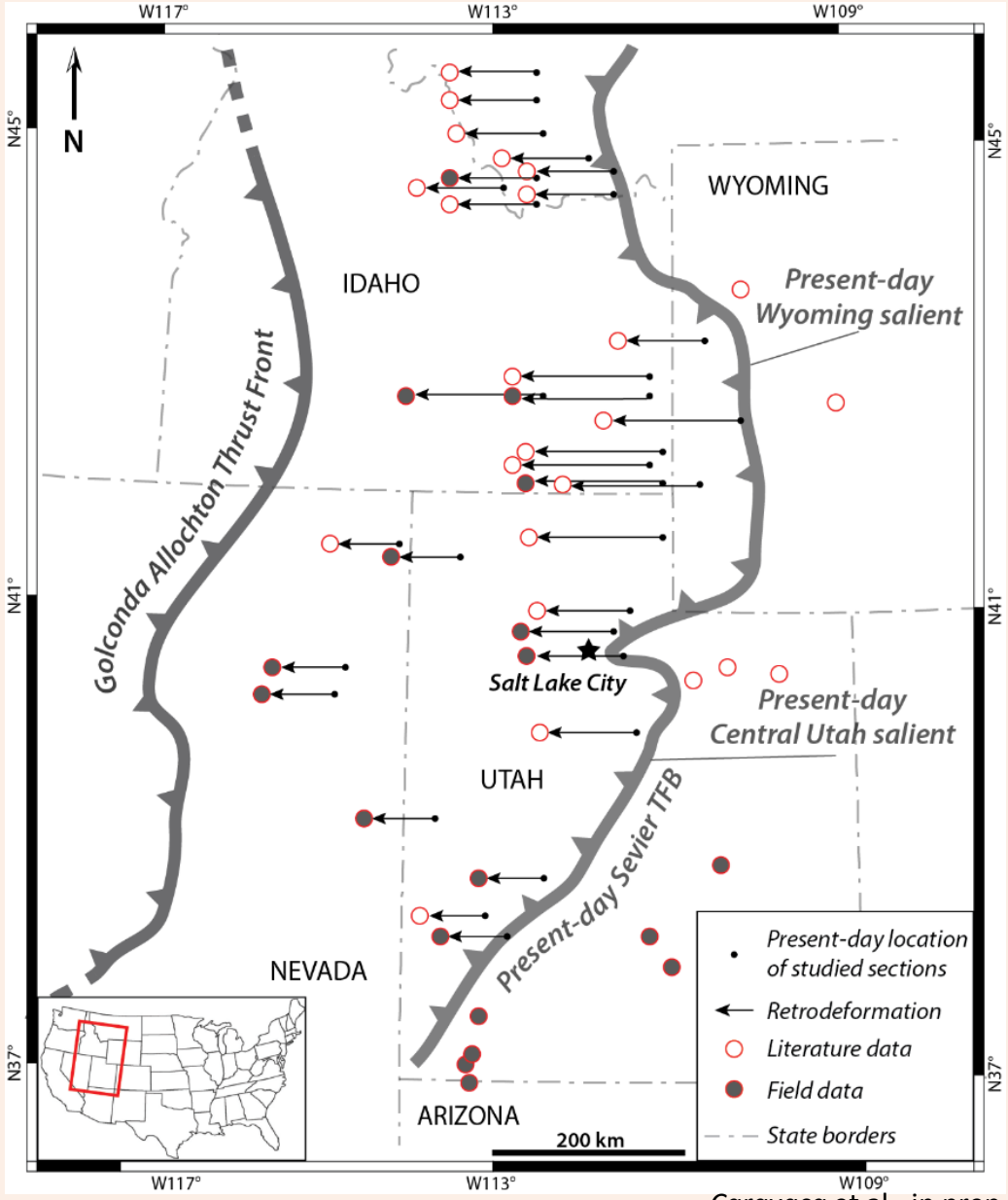
Methods

Database:

- 43 selected sections after literature and field work
- Study of the PTU-Smithian interval
- Biostratigraphic framework (after Brayard *et al.*, 2013)

Palinspastic reconstructions:

- Necessary to obtain an unbiased view of the basin
- Original location of the sections



Caravaca et al., in prep.

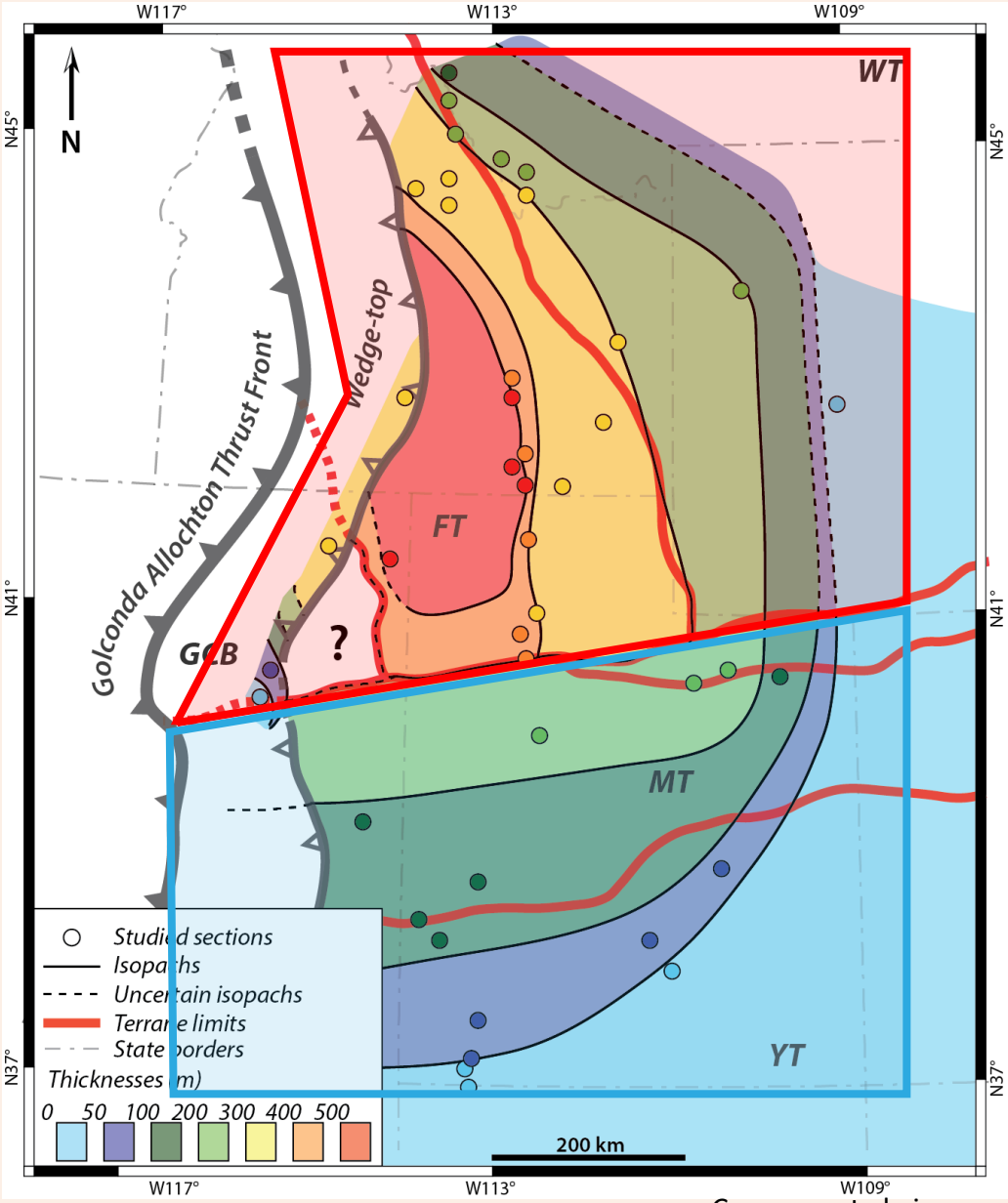
Results: thickness variations in the basin

Isopach map of the PTU-Smithian interval
⇒ **Spatial distribution of sedimentary thickness**

2 different parts in the basin:

- **Northern high thicknesses** zone (>300 up to ~550m thick)

- **Southern low thicknesses** zone (~10 up to 250m thick)

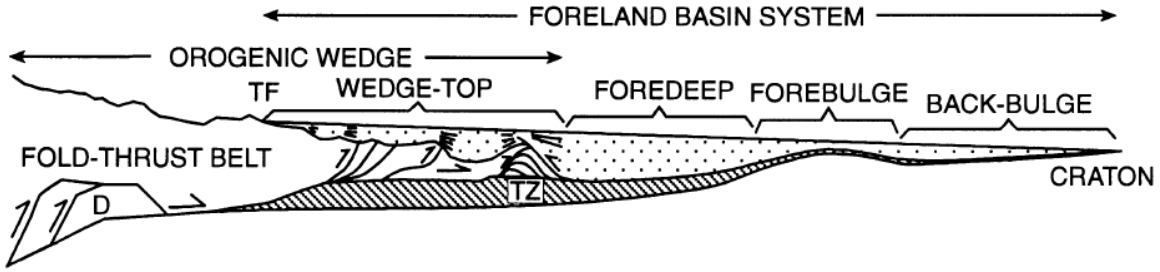


Caravaca et al., in prep.

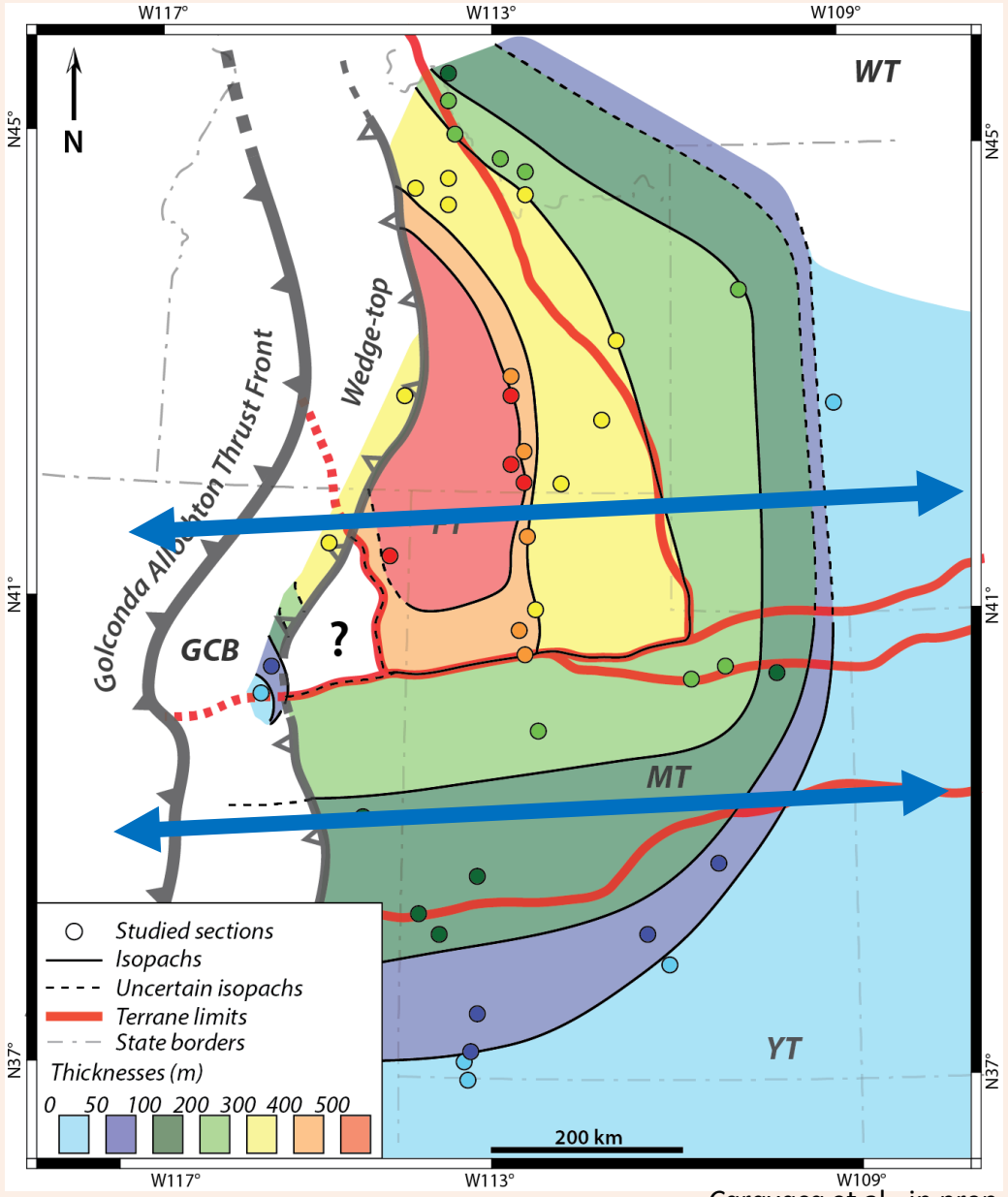
Results: thickness variations in the basin

East-West pattern:
- Thickening trend towards West
- Lower thicknesses in westernmost parts

⇒ **Coherent with Foreland Basin System**
(*sensu* DeCelles & Giles, 1996)



DeCelles & Giles, 1996



Caravaca et al., in prep.

Results: thickness variations in the basin

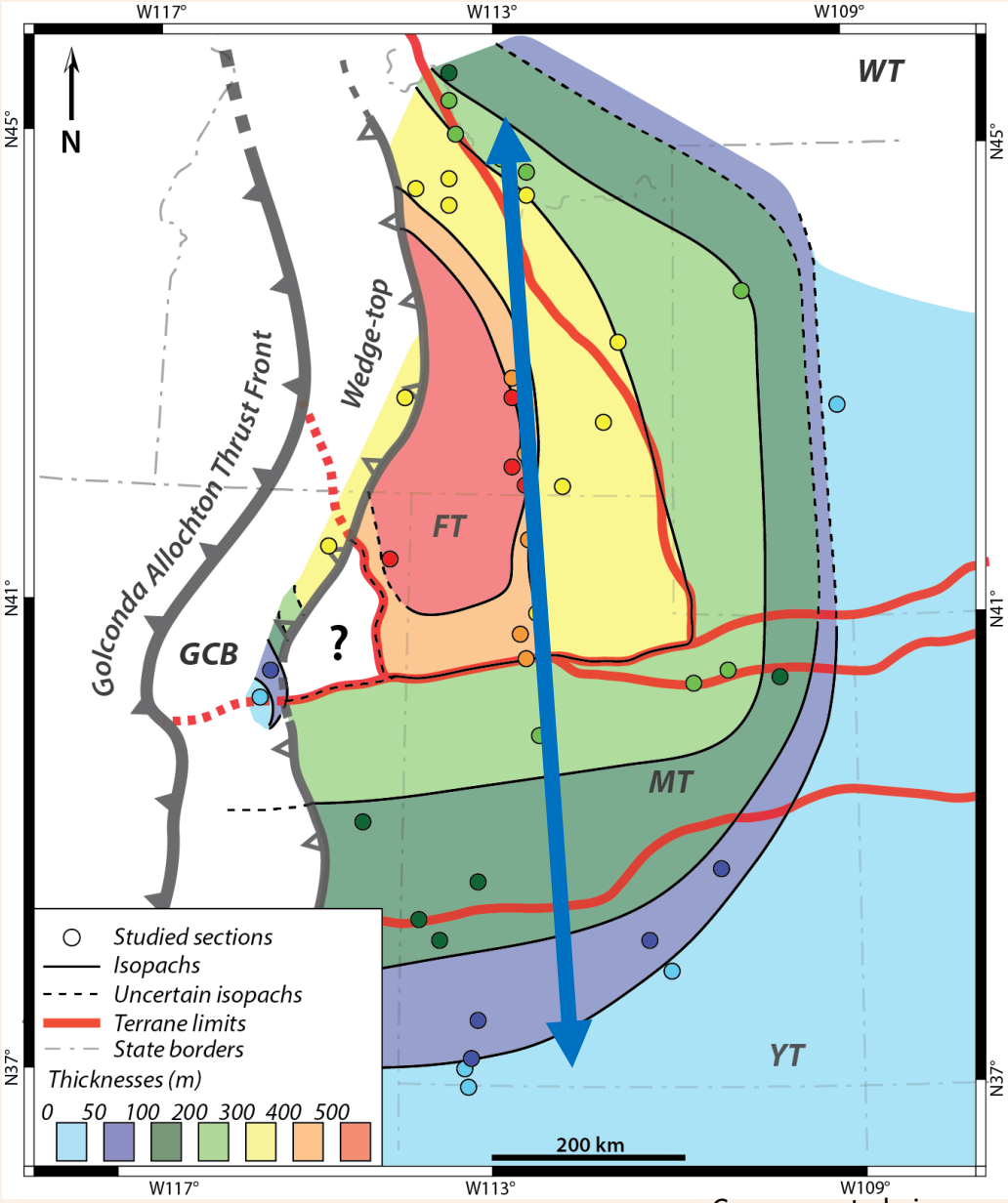
Sedimentary accumulation caused by **foreland flexuration**

2 different parts in the basin(N-S pattern):

- Northern high thicknesses zone (>300 up to ~550m thick)

- Southern low thicknesses zone (~10 up to 250m thick)

⇒ ***Why 2 different zones in this single basin as the result of Golconda Allochton emplacement?***



Caravaca et al., in prep.

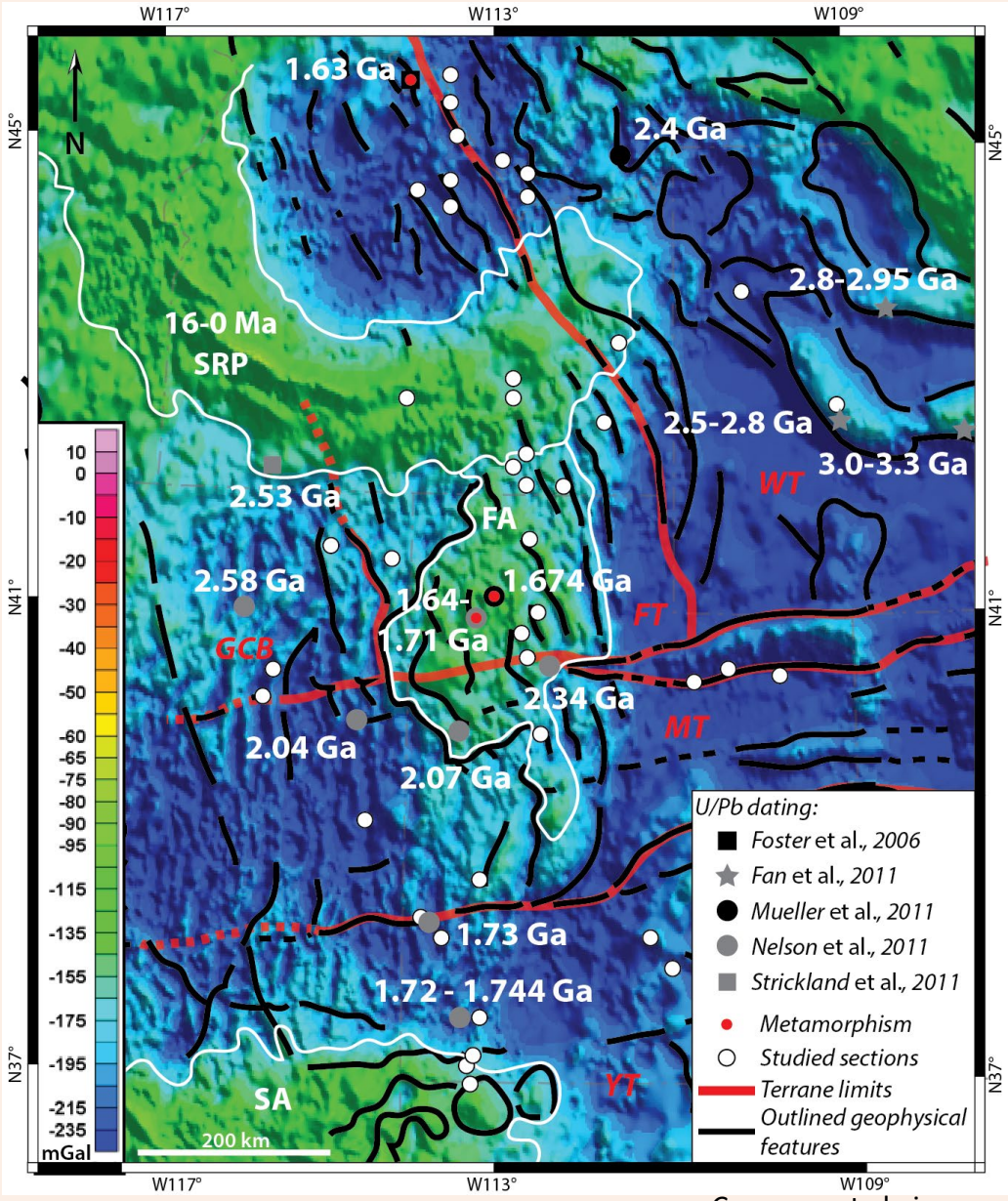
Results: terranes map of the basin

Composition of **the basement of the basin**?

⇒ Construction of a new **terrane map** from:
- U/Pb dating (literature data)
- Bouguer gravity anomaly map (Kucks, 1999)

Five terranes identified, with different ages:

- Archean Wyoming Terrane
- Archean Grouse Creek Block
- Paleoproterozoic Mojave Terrane
- Mesoproterozoic Yavapai Terrane
- Mesoproterozoic Farmington Terrane



Caravaca et al., in prep.

Results: terranes map of the basin

⇒ **Lithospheric nature is key control to rheological behavior**

Oldest lithospheres are **colder, more rigid, and show weaker density**

⇒ **Strong lithospheres**

- Wyoming Terrane (Archean)
- Grouse Creek Block (Archean)
- Mojave Terrane (Paleoproterozoic)

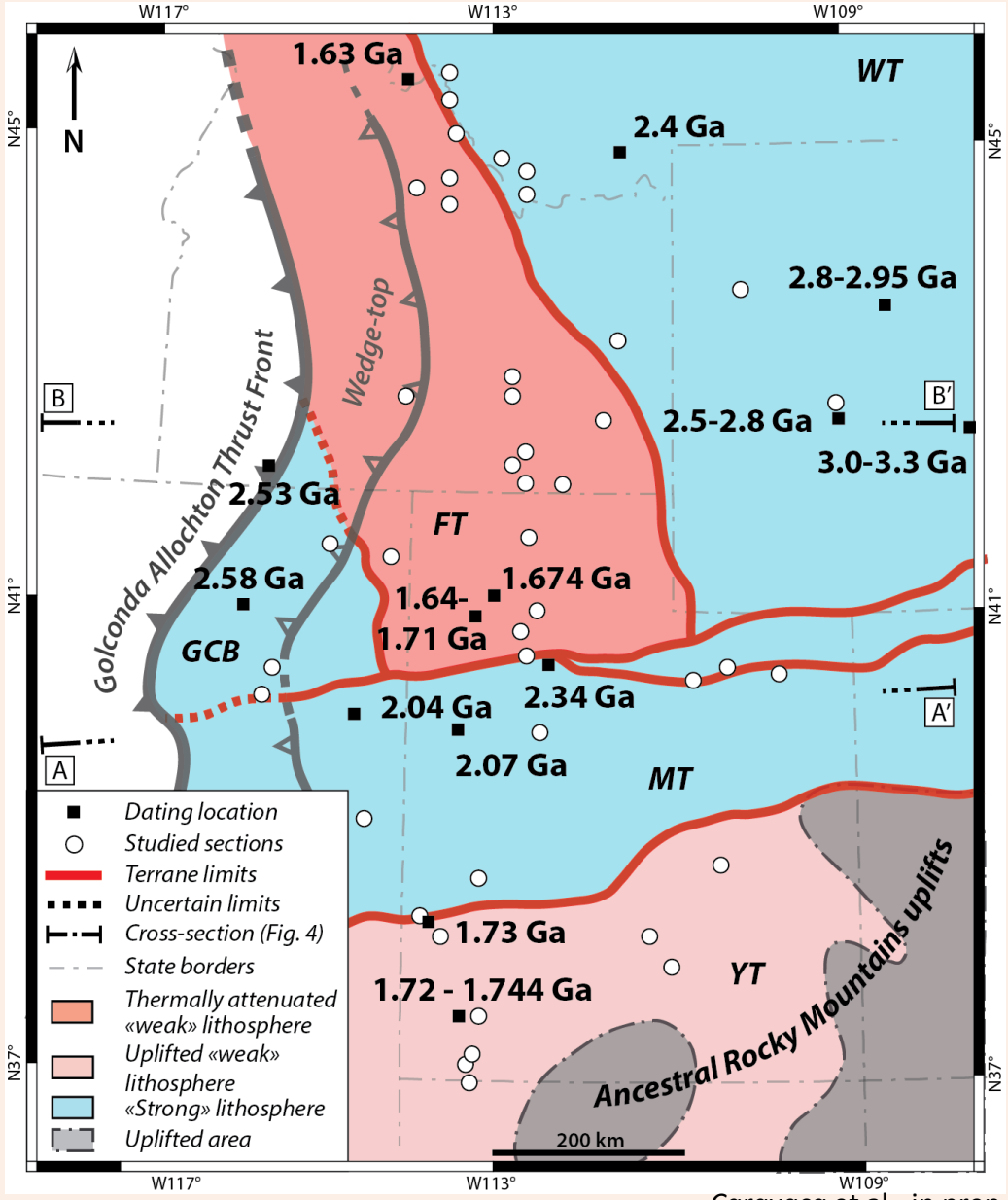
Conversely, juvenile lithospheres show **lesser rigidity**

⇒ **Weak uplifted lithosphere**

- Yavapai Terrane (Mesoproterozoic) with positive relief due to ARM orogeny

⇒ **Weak attenuated lithosphere**

- Farmington Terrane (Mesoproterozoic Mobile Belt)



Caravaca et al., in prep.

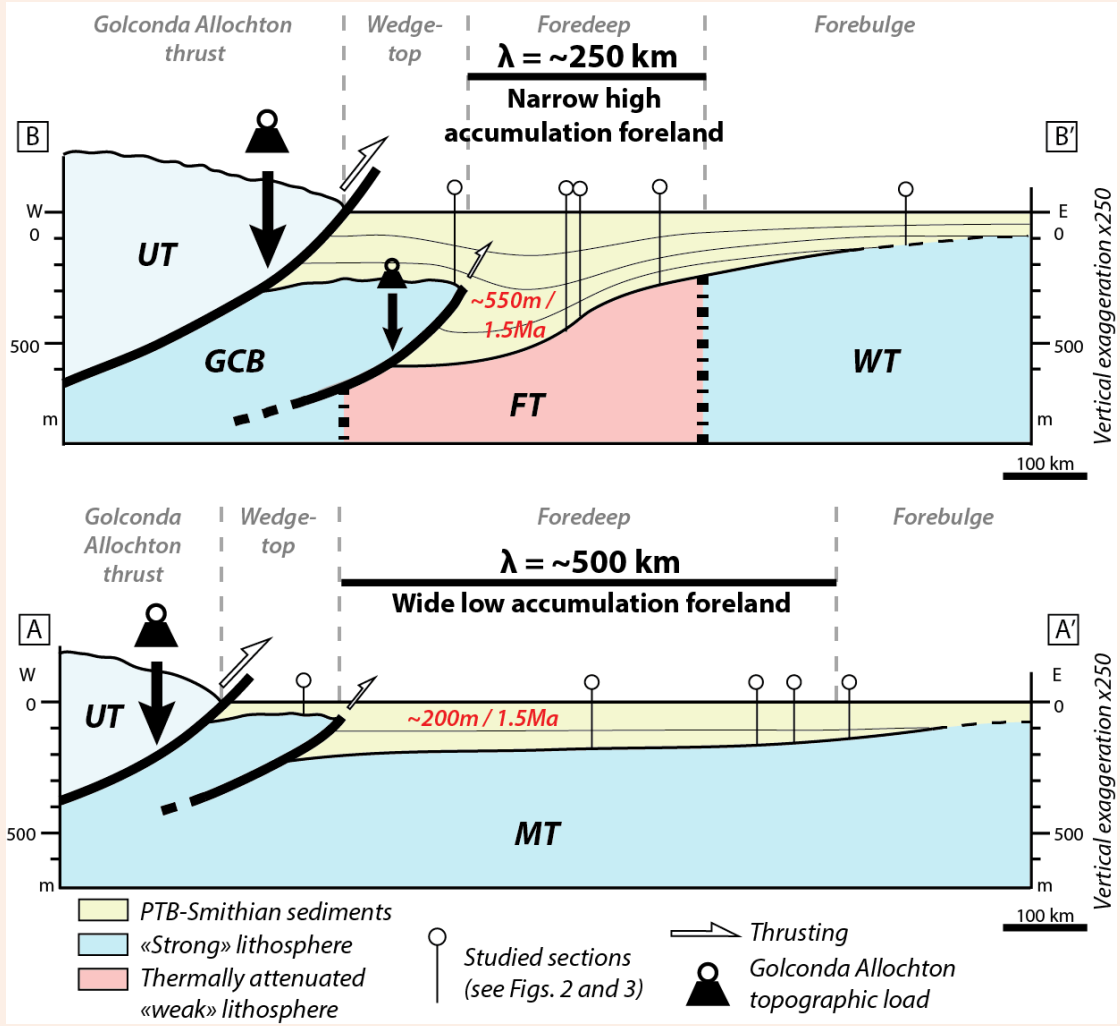
Discussion

Northern part of the basin:

- **Weak lithosphere** (Farmington Terrane)
- **High sedimentary thicknesses**
- Lower thicknesses on strong lithospheres (Wyoming Terrane and Grouse Creek Block)

Southern part of the basin:

- **Strong lithosphere** (Mojave Terrane)
- **Low sedimentary thicknesses**



Caravaca et al., in prep.

Perspectives: depositional settings

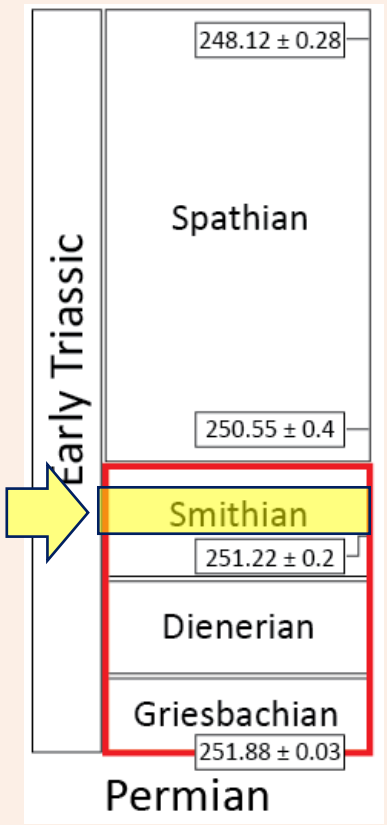
Depositional settings distributions between the *Owenites* and *Anasibirites* ammonoids biozones (middle Smithian)

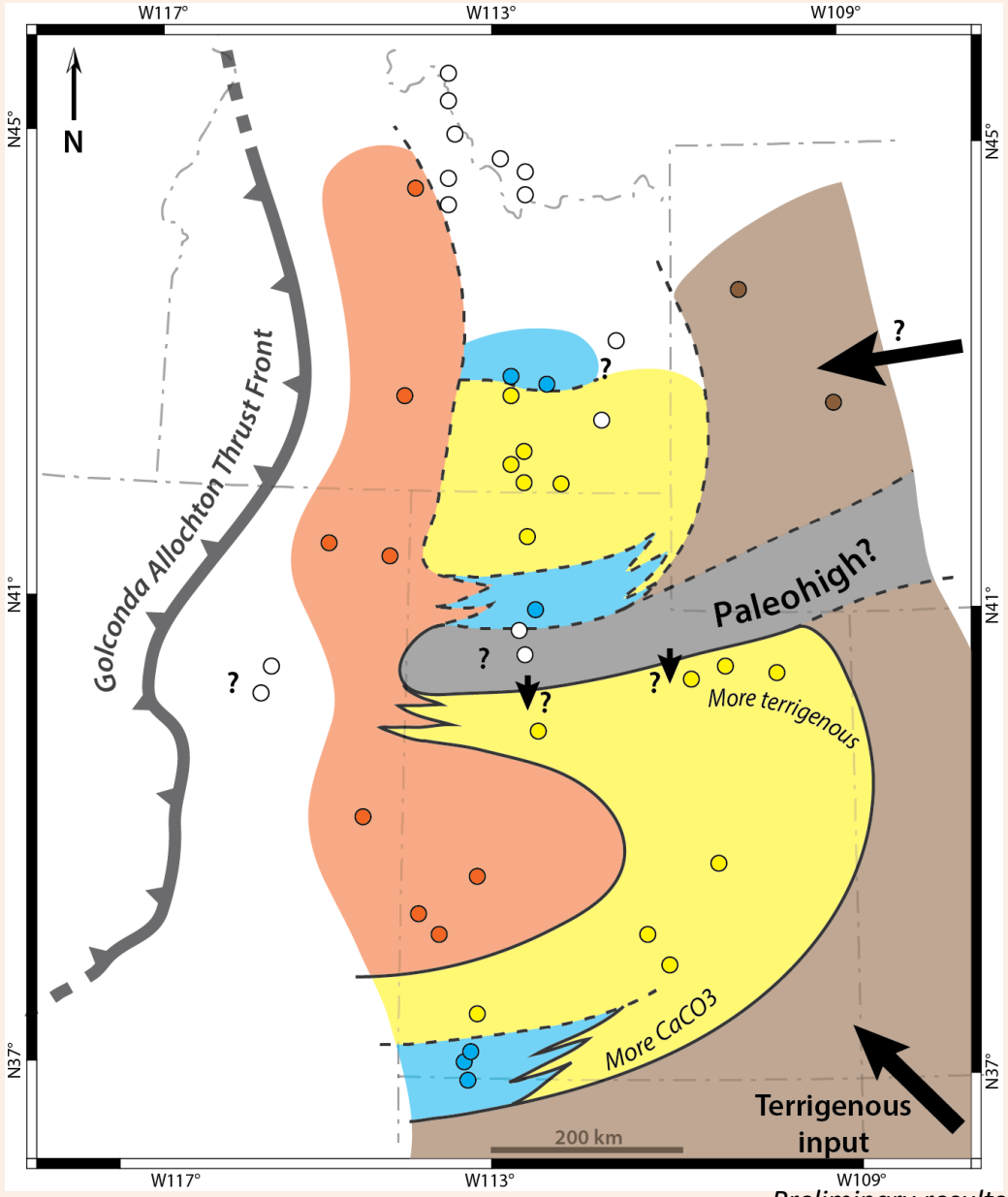
Striking **differences between southern and northern parts** of the basin:

⇒ **Differences between paleontological and sedimentological record**

⇒ **Paleogeography to be reconstructed** using this integrative set of data

⇒ **Impact of lithospheric control**





Depositional settings:
- Deep subtidal
- Shallow subtidal
- Subtidal to intertidal (microbial carb.)
- Transitional/coastal (red beds)

Preliminary results

Conclusion

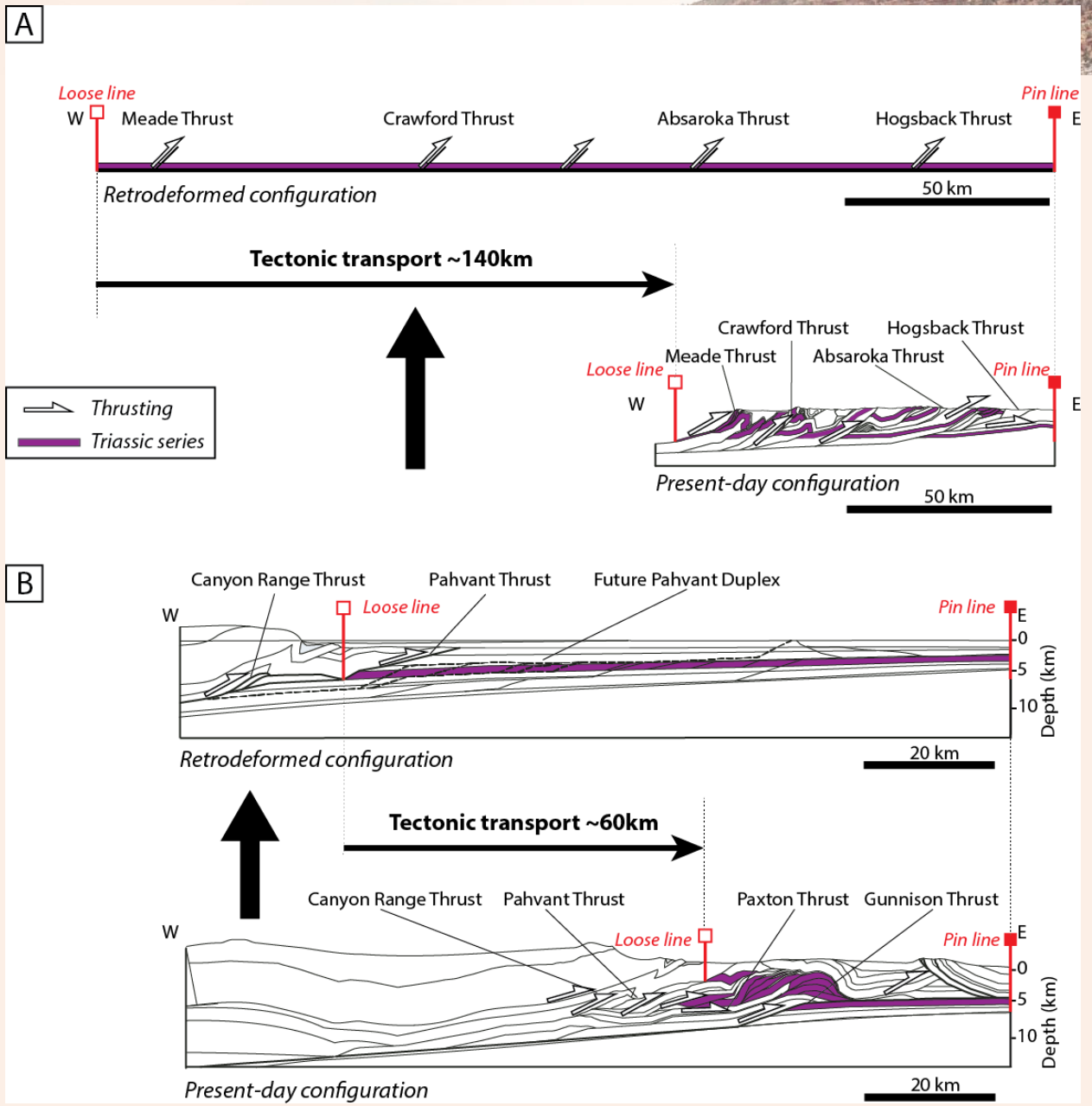
- Sonoma Basin acts as a **foreland system** during the P/T Boundary-Smithian interval (~1,5ma)

- The **main controlling factor** over sedimentary accumulation and thus depositional settings distribution **is of lithospheric origin**

Thank you for paying attention!

Supplements

Retrodeformation method



Caravaca et al., in prep.

Oldest lithospheres are:

- Thicker and colder than juvenile counterparts (due to R* elements depletion
- More buoyant (d°<d° juvenile lithos.)

$\Rightarrow$ More rigid and resistant to flexuration

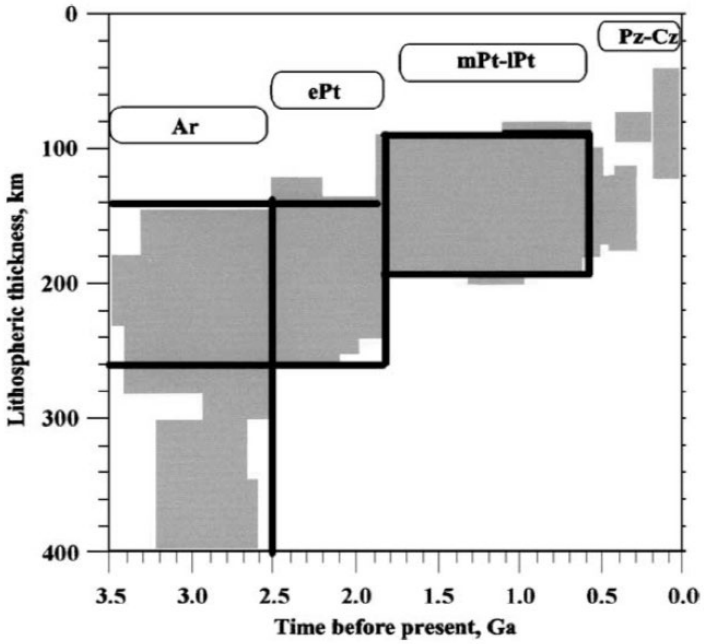


Fig. 2. Lithospheric thermal thickness versus geologic age of the continental lithosphere. The Archean lithosphere has bimodal thickness distribution centered at ~350 and ~220 km. Gray area shows the lithospheric thickness estimates derived from thermal data (Artemieva and Mooney, 2001). Key: Ar—Archean; ePt, mPt, lPt—early, middle and late Proterozoic, respectively; Pz—Paleozoic; Cz—Cenozoic.

Artemieva & Mooney, 2001

Carpathians

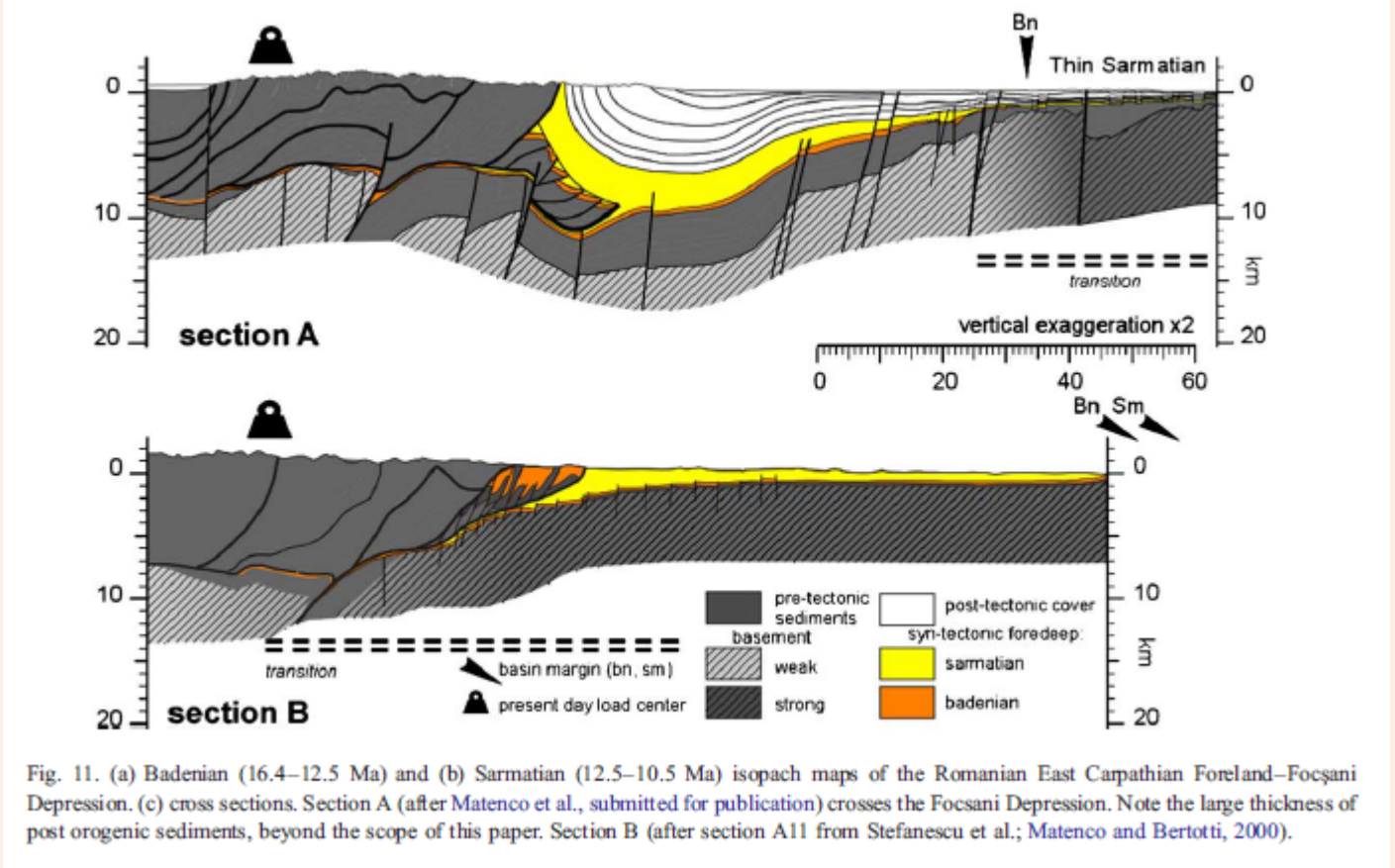


Fig. 11. (a) Badenian (16.4–12.5 Ma) and (b) Sarmatian (12.5–10.5 Ma) isopach maps of the Romanian East Carpathian Foreland–Focşani Depression. (c) cross sections. Section A (after Matenco et al., submitted for publication) crosses the Focsani Depression. Note the large thickness of post orogenic sediments, beyond the scope of this paper. Section B (after section A11 from Stefanescu et al.; Matenco and Bertotti, 2000).

Leever et al.*, 2006*

Magallanes basin

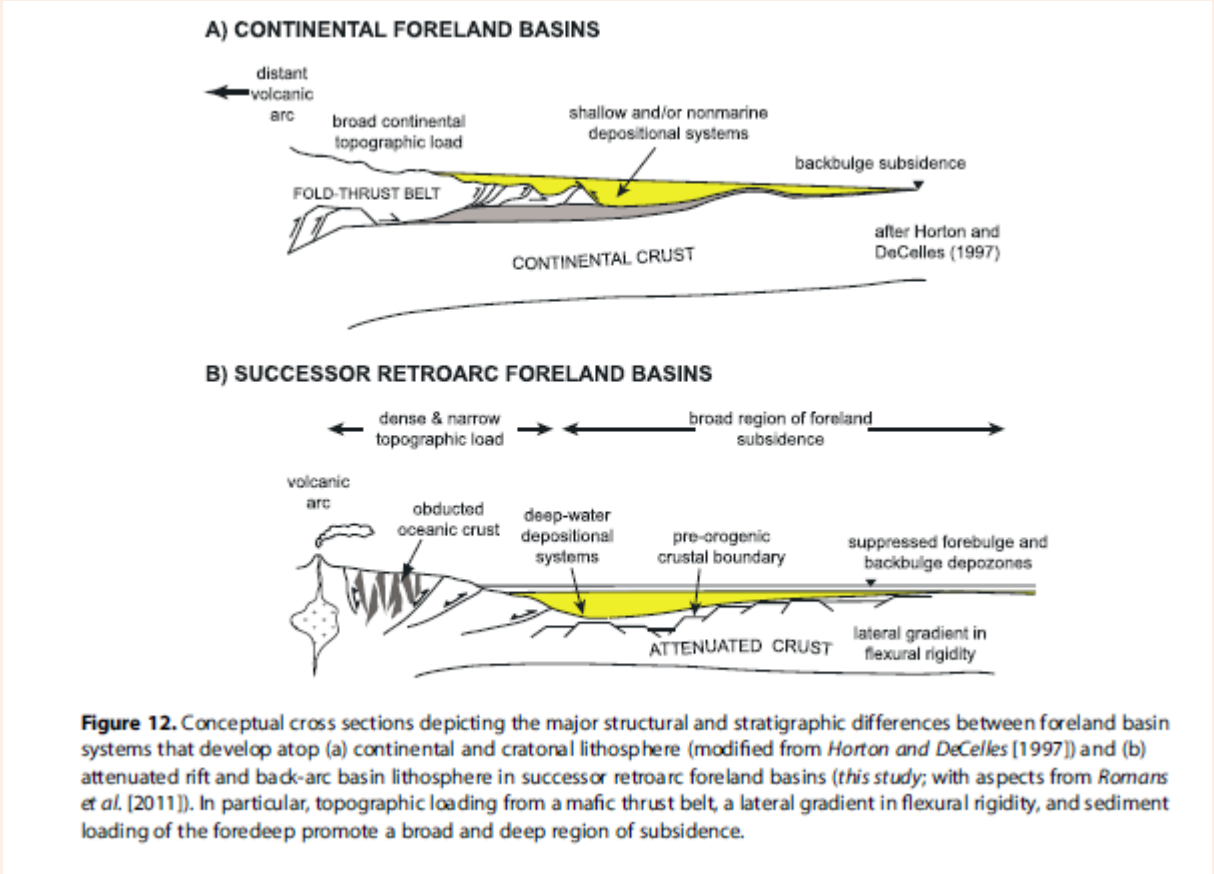


Figure 12. Conceptual cross sections depicting the major structural and stratigraphic differences between foreland basin systems that develop atop (a) continental and cratonal lithosphere (modified from *Horton and DeCelles* [1997]) and (b) attenuated rift and back-arc basin lithosphere in successor retroarc foreland basins (*this study*; with aspects from *Romans et al.* [2011]). In particular, topographic loading from a mafic thrust belt, a lateral gradient in flexural rigidity, and sediment loading of the foredeep promote a broad and deep region of subsidence.

Fosdick et al.*, 2014*