EP014-09 - Asynchronous strath terrace formation in a collisional mountain belt

Link to a video of the oral presentation → here

PhD work about to be submitted

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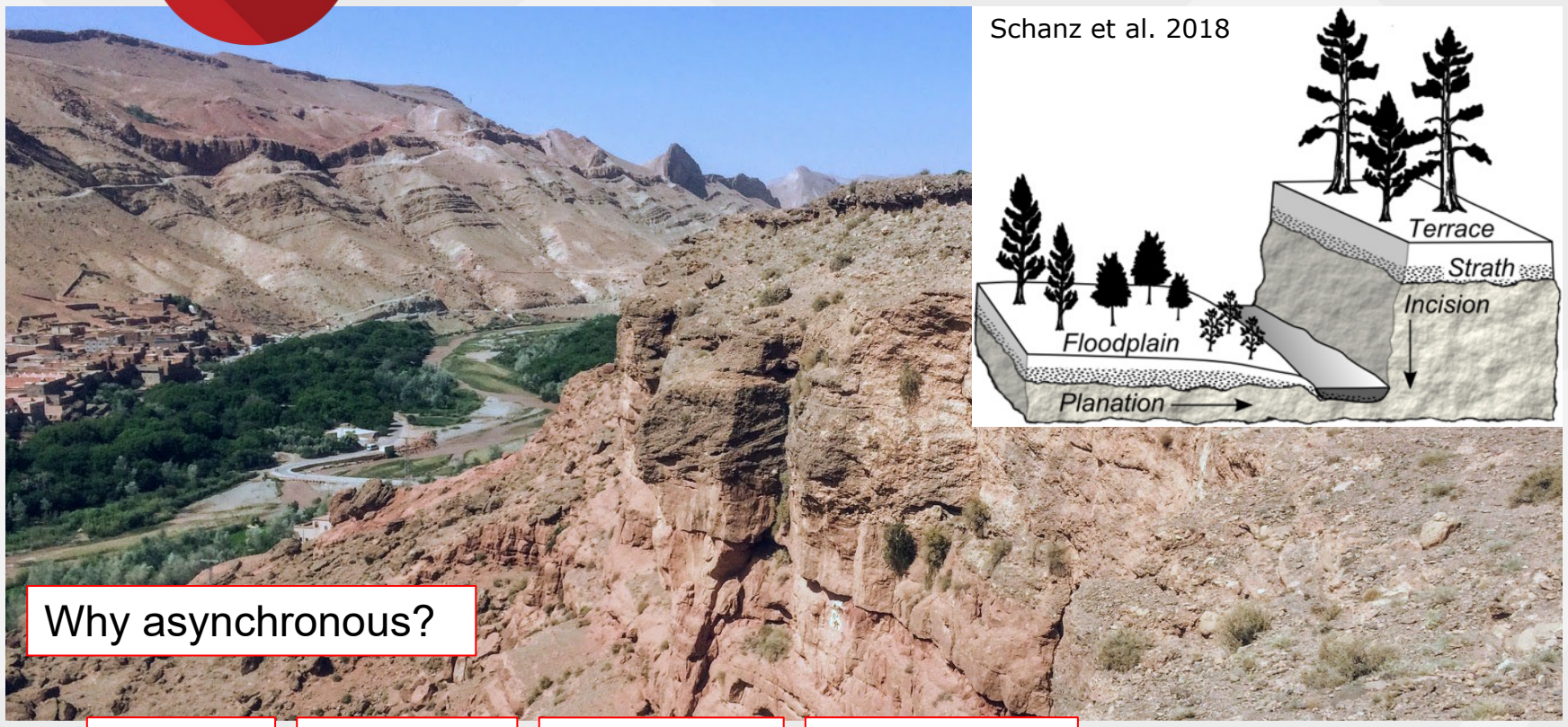

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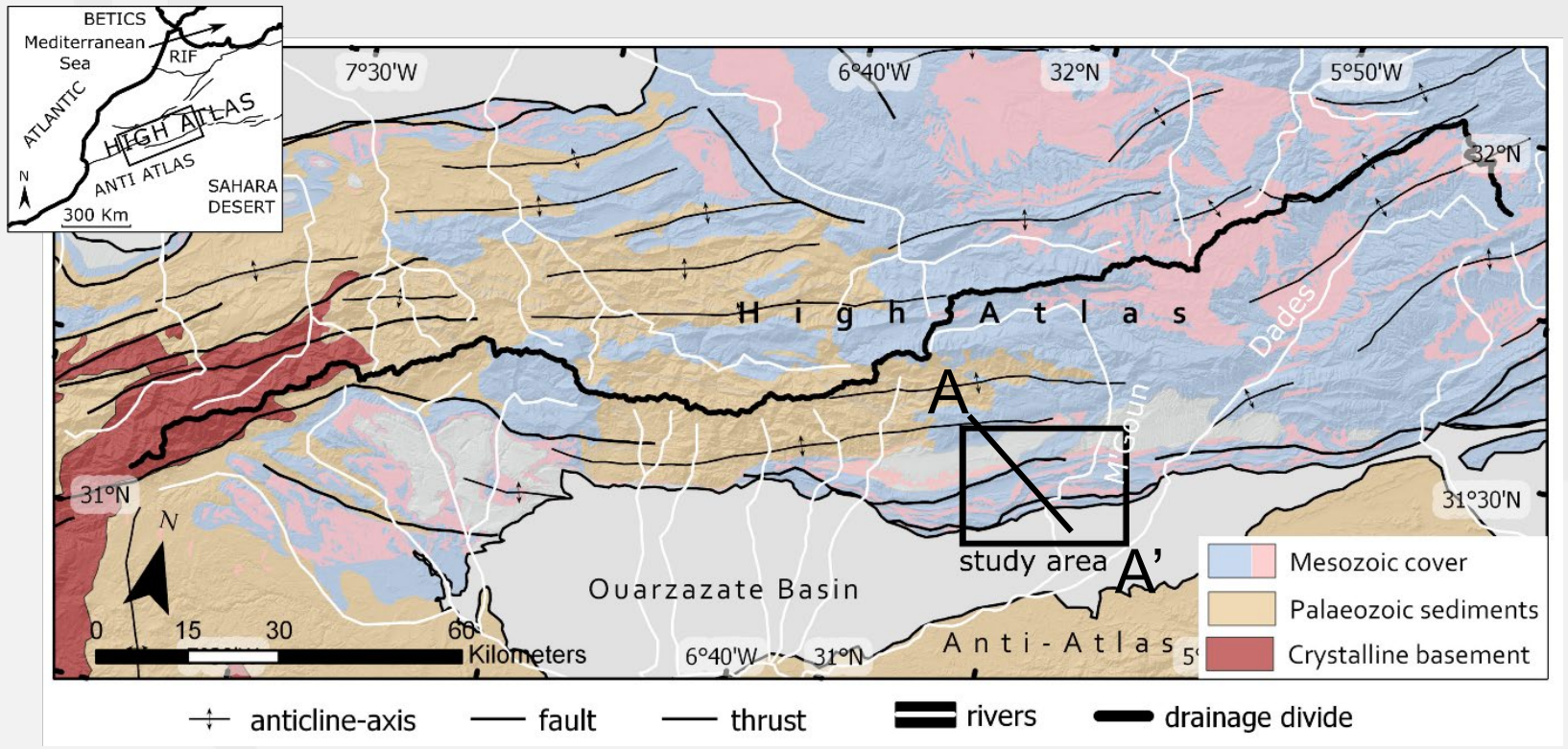
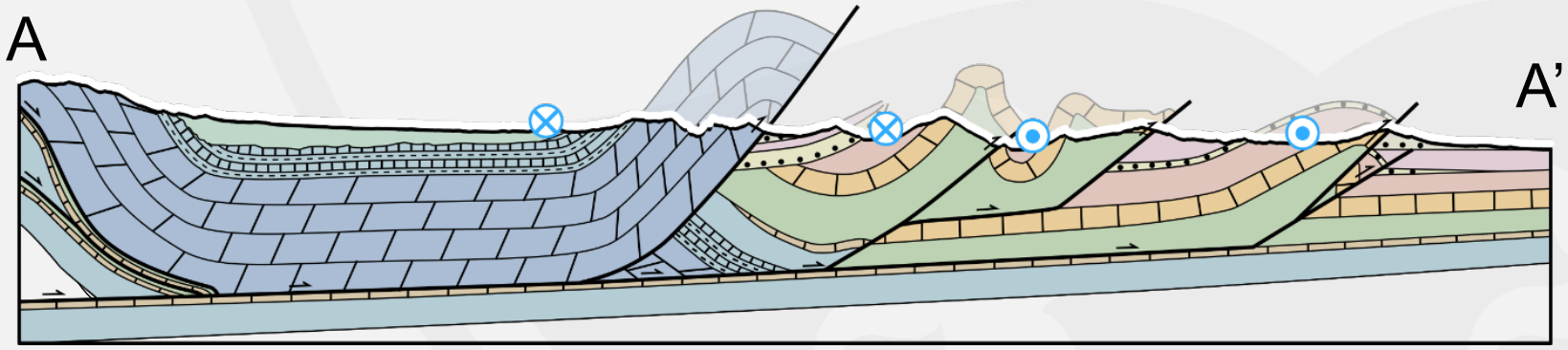


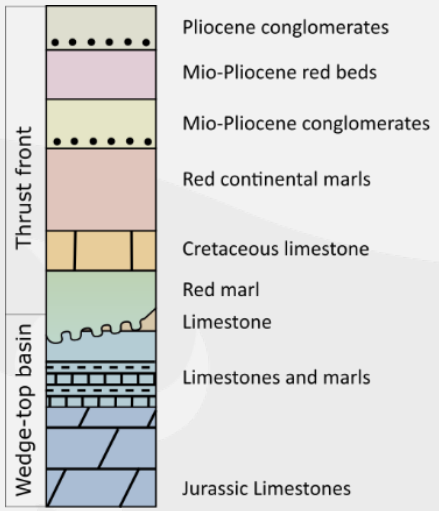
Modified from Zondervan et al. 2020 (EPSL)

Lithology: order of magnitude difference in rock strength and erodibility
(Zondervan et al. 2020)

Passive tectonic structure: thrust stacks determine valley width



Zondervan et al. (in prep)



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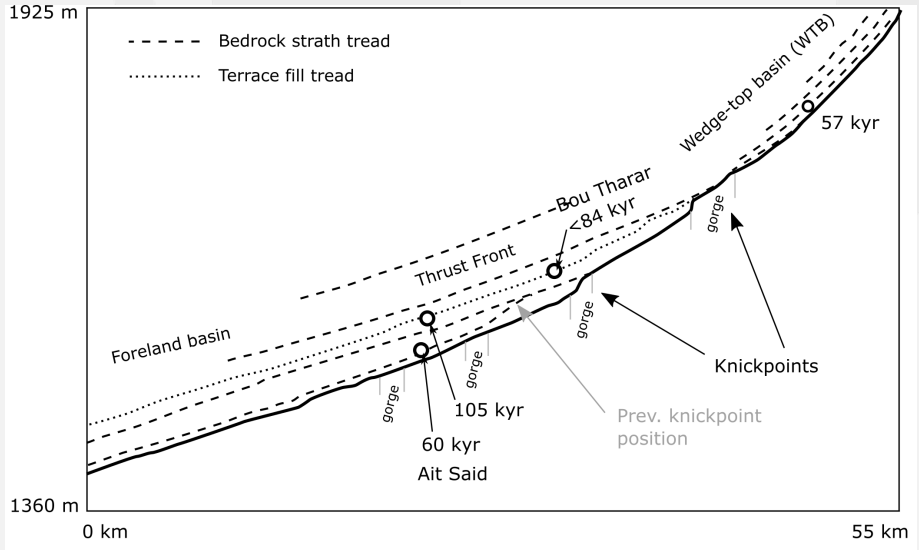
Approach

1. Quantitative geomorphology



Zondervan et al. (in prep)

2. Quantitative sedimentology

3. Innovative geochronology

Stacy Phillips, 2020

Erosion | Transport | Deposition | Morphology

At which spatial and temporal scales does lithology affect landscape evolution?

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Results

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Erosion | Transport | Deposition | Morphology

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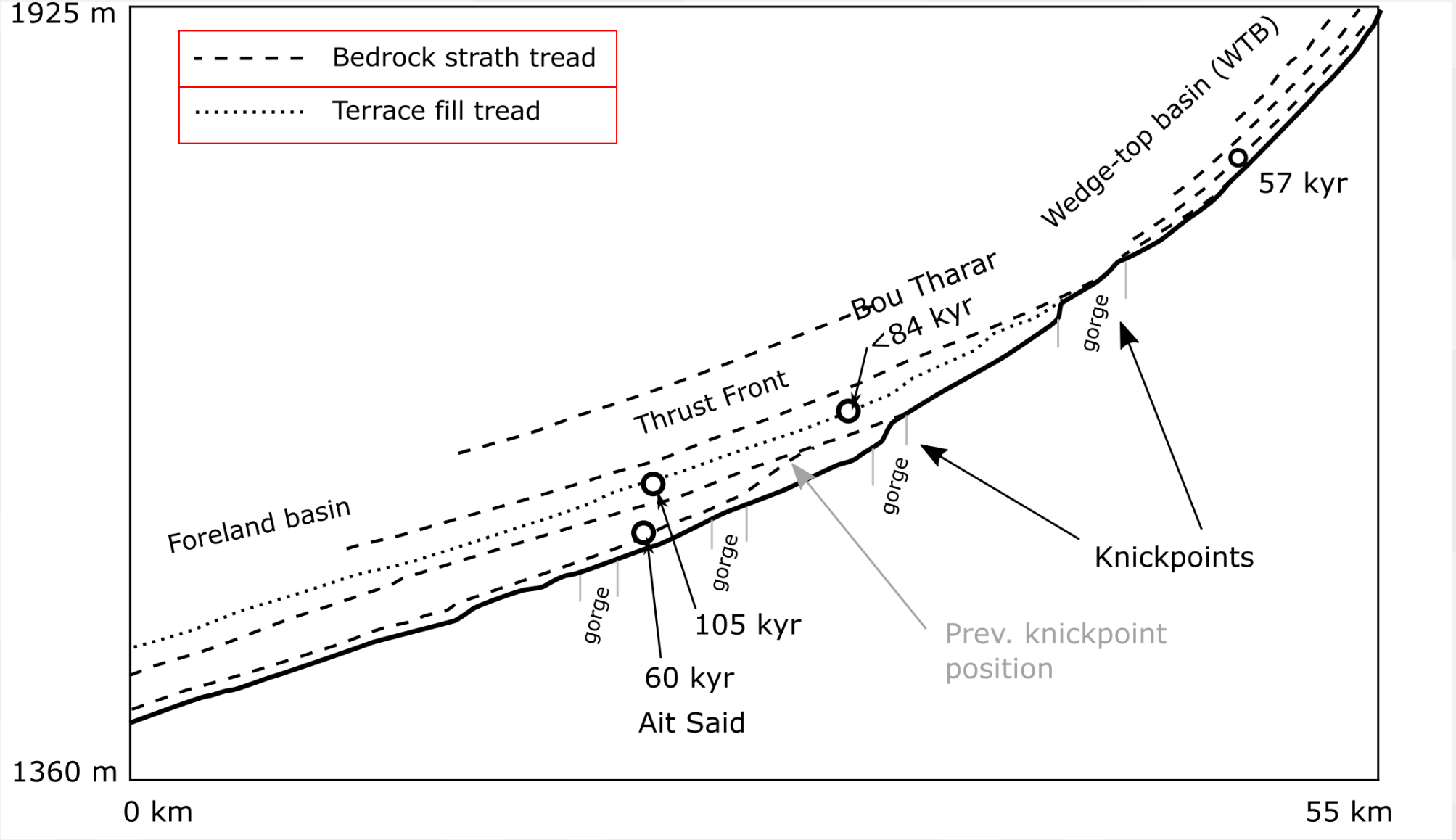

Zondervan et al. (in prep)

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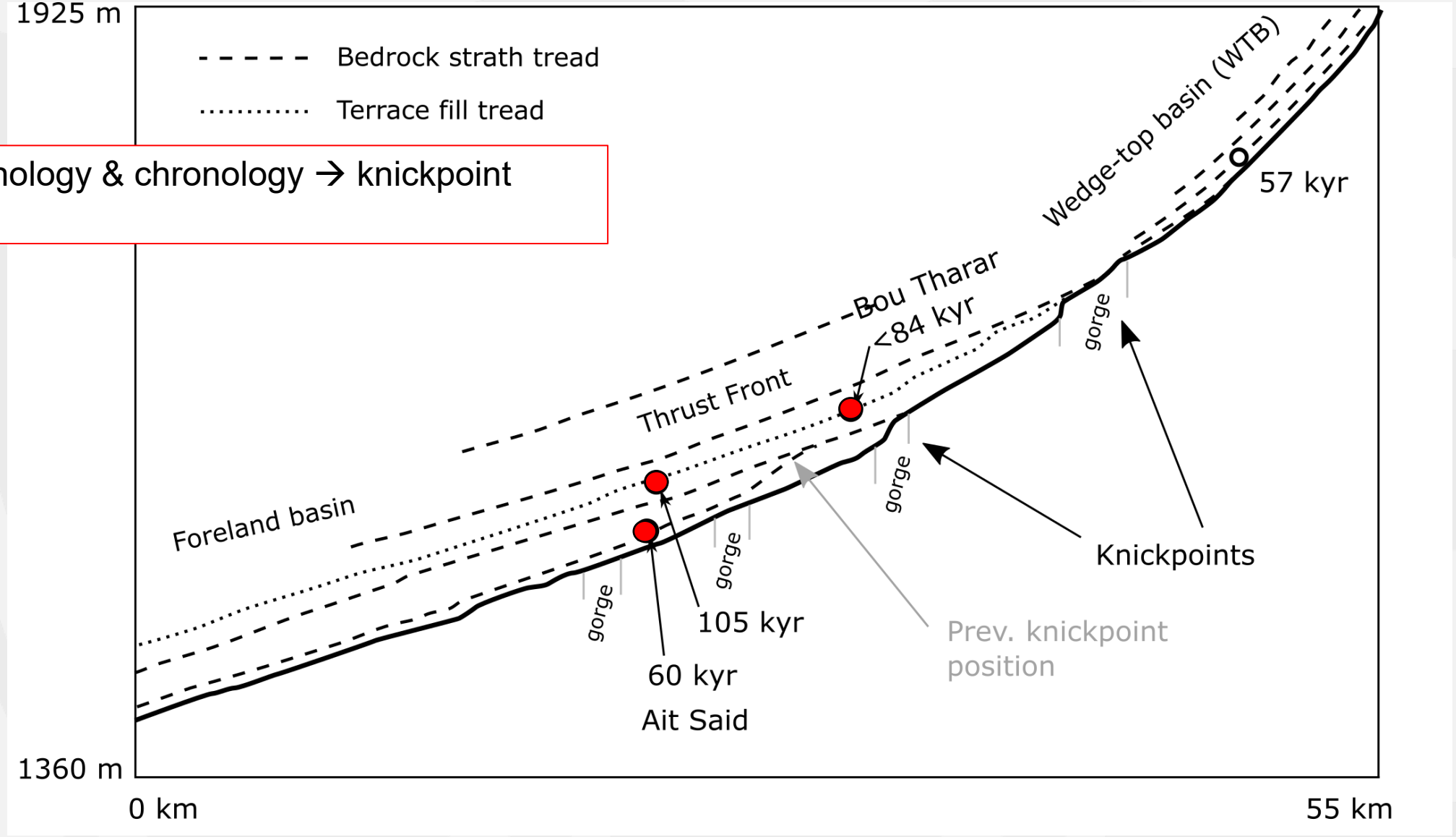
Erosion | Transport | Deposition | Morphology

Geomorphology & chronology → knickpoint migration



Zondervan et al. (in prep)

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Erosion | Transport | Deposition | Morphology

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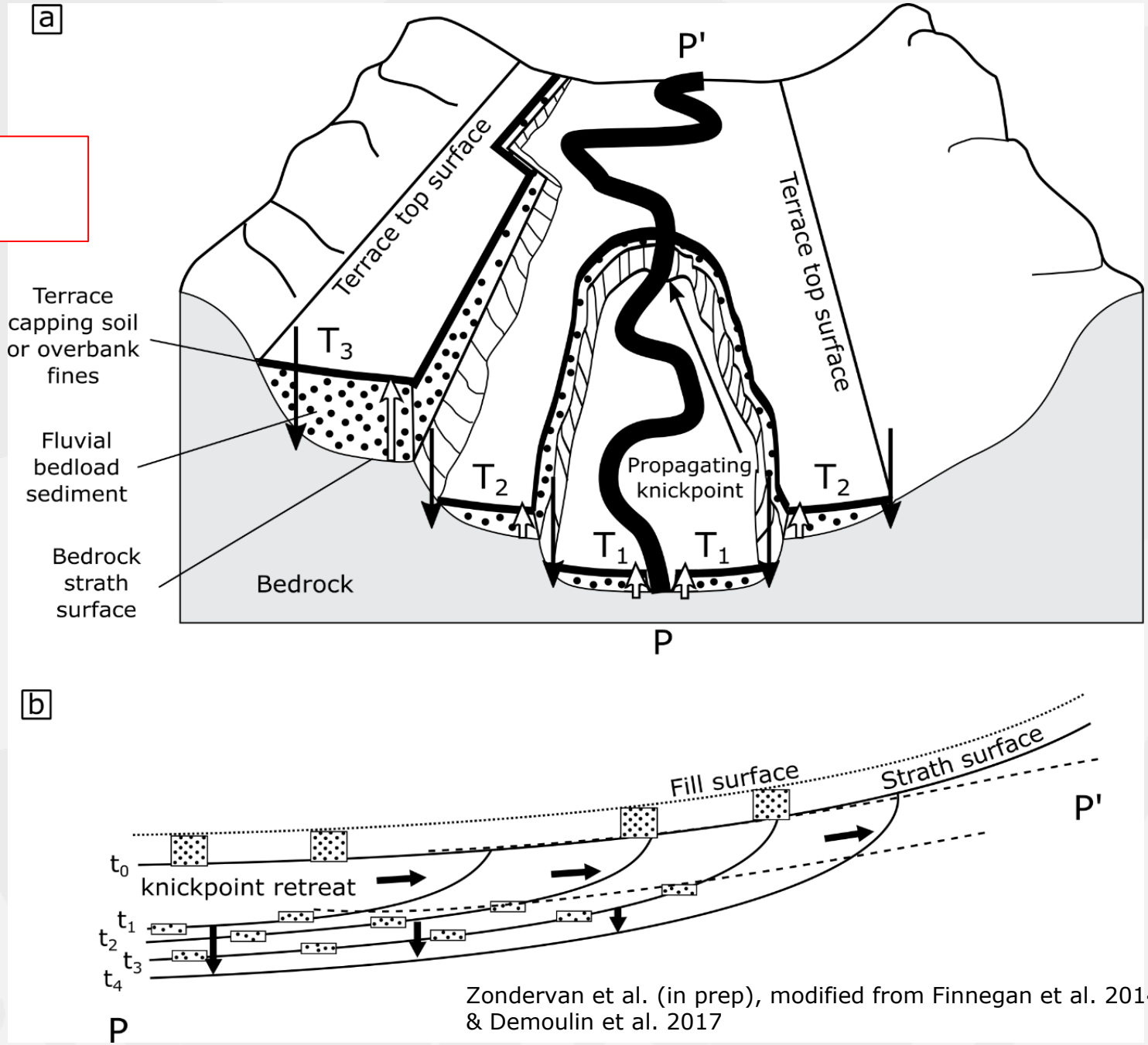

Zondervan et al. (in prep), modified from Finnegan et al. 2014 & Demoulin et al. 2017

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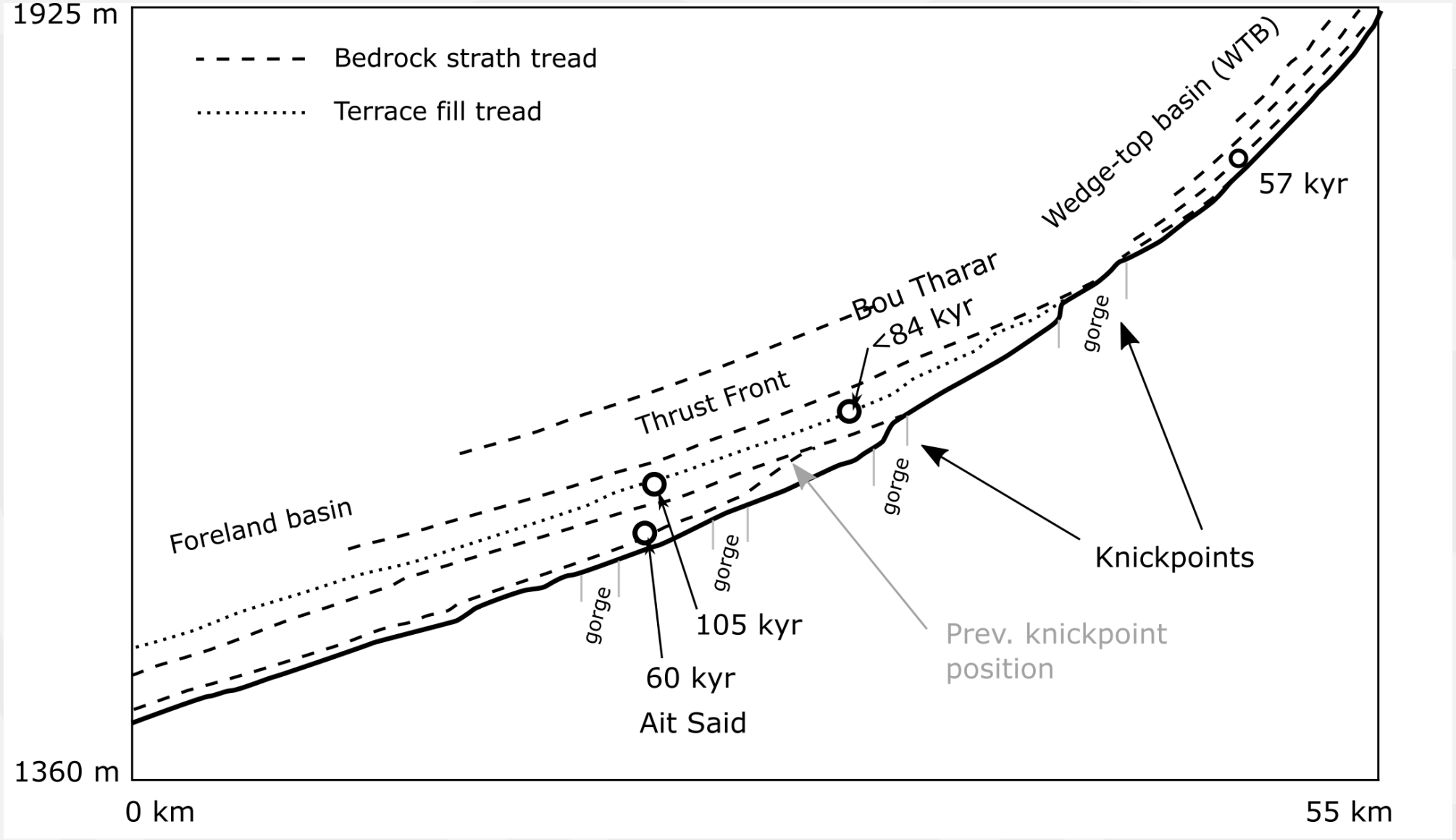

Zondervan et al. (in prep)

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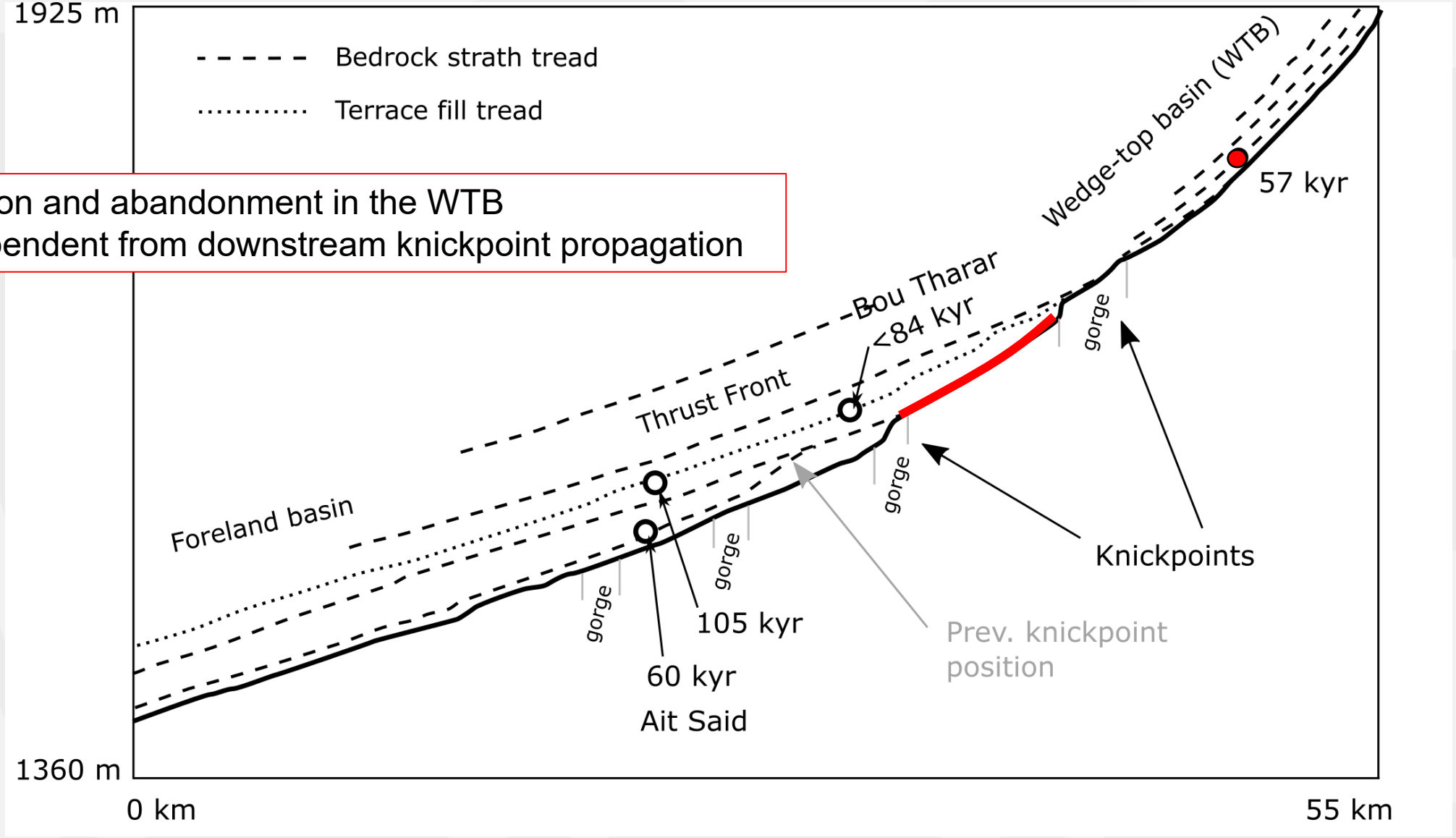
Erosion | Transport | Deposition | Morphology



Zondervan et al. (in prep)

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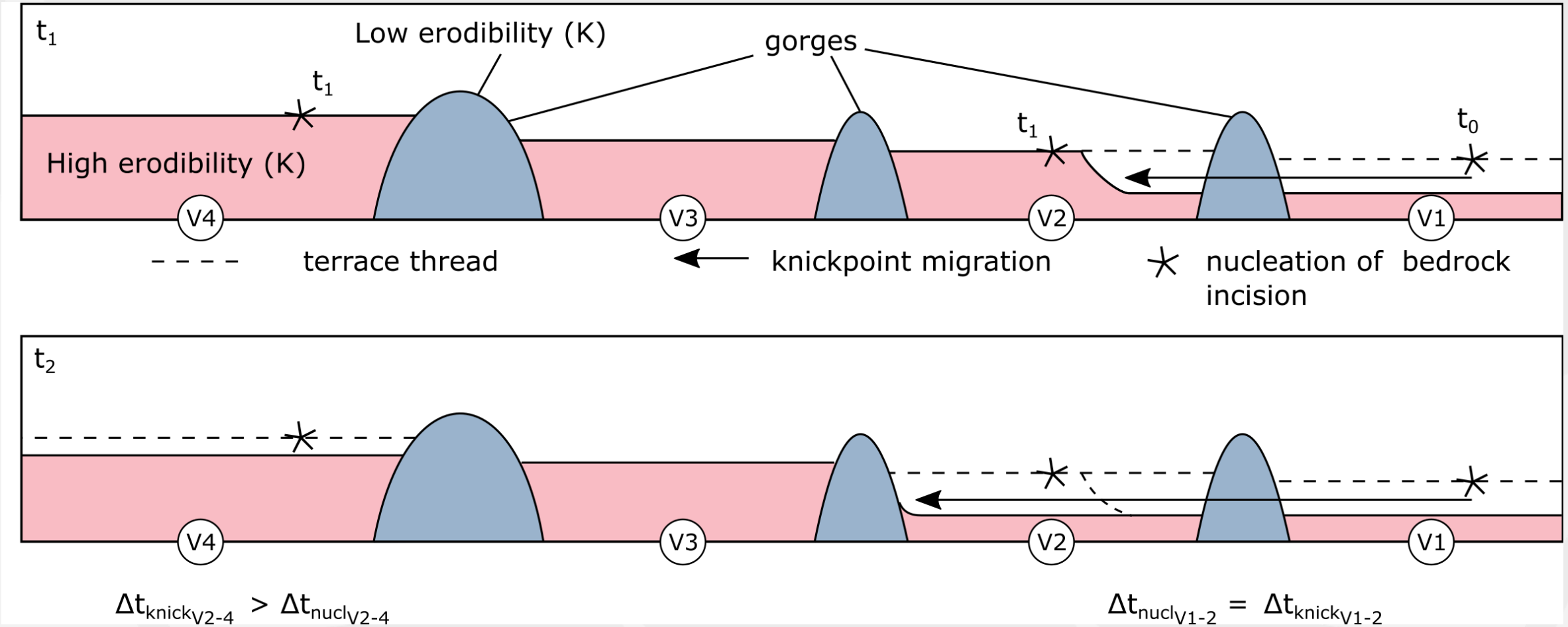
Erosion | Transport | Deposition | Morphology

Lithology controls timescale of erosional connectivity



Zondervan et al. (in prep)

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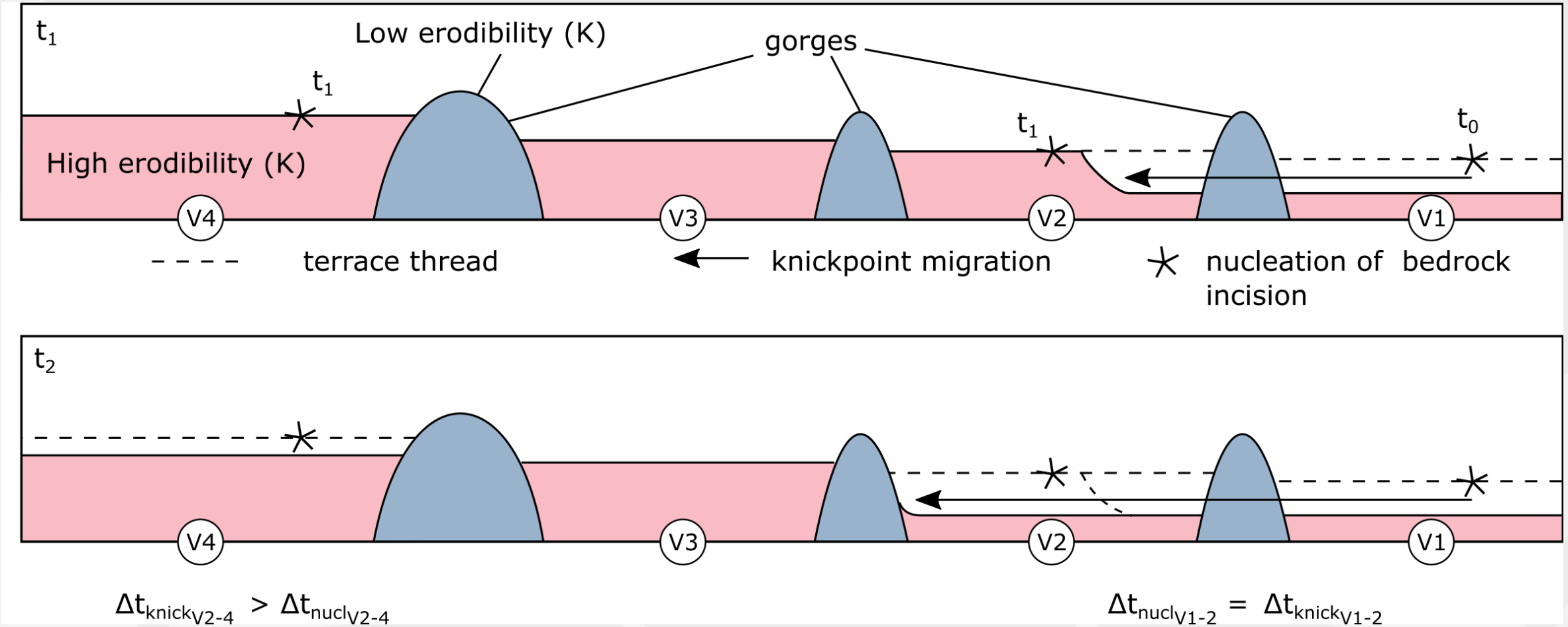
Erosion | Transport | Deposition | Morphology

Lithology controls timescale of erosional connectivity

Knickpoint migration: diachronous on 10^5 yr timescale



Zondervan et al. (in prep)

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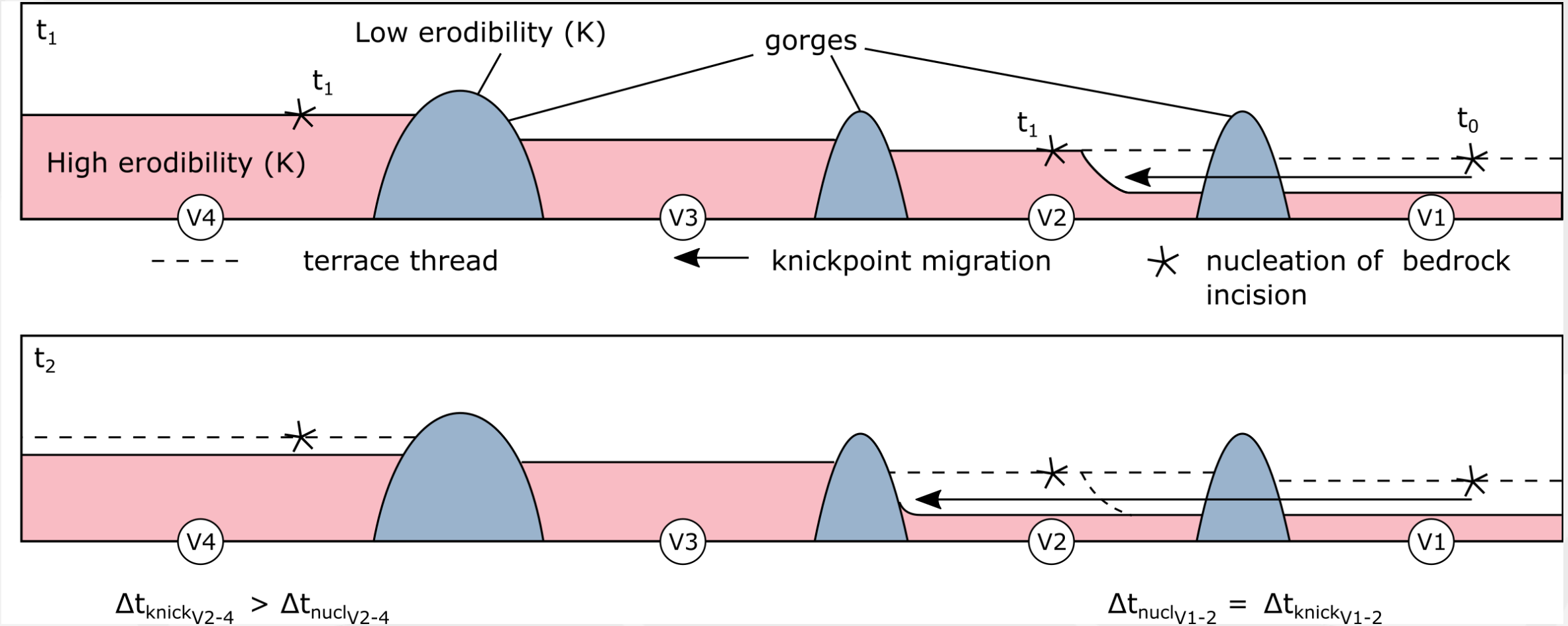
Erosion | Transport | Deposition | Morphology

Lithology controls timescale of erosional connectivity

Knickpoint migration: diachronous on 10^5 yr timescale

Terrace abandonment: asynchronous on 10^4 yr timescale



Zondervan et al. (in prep)

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Erosion | Transport | Deposition | Morphology

Lithology controls timescale of erosional connectivity

Knickpoint migration: diachronous on 10^5 yr timescale

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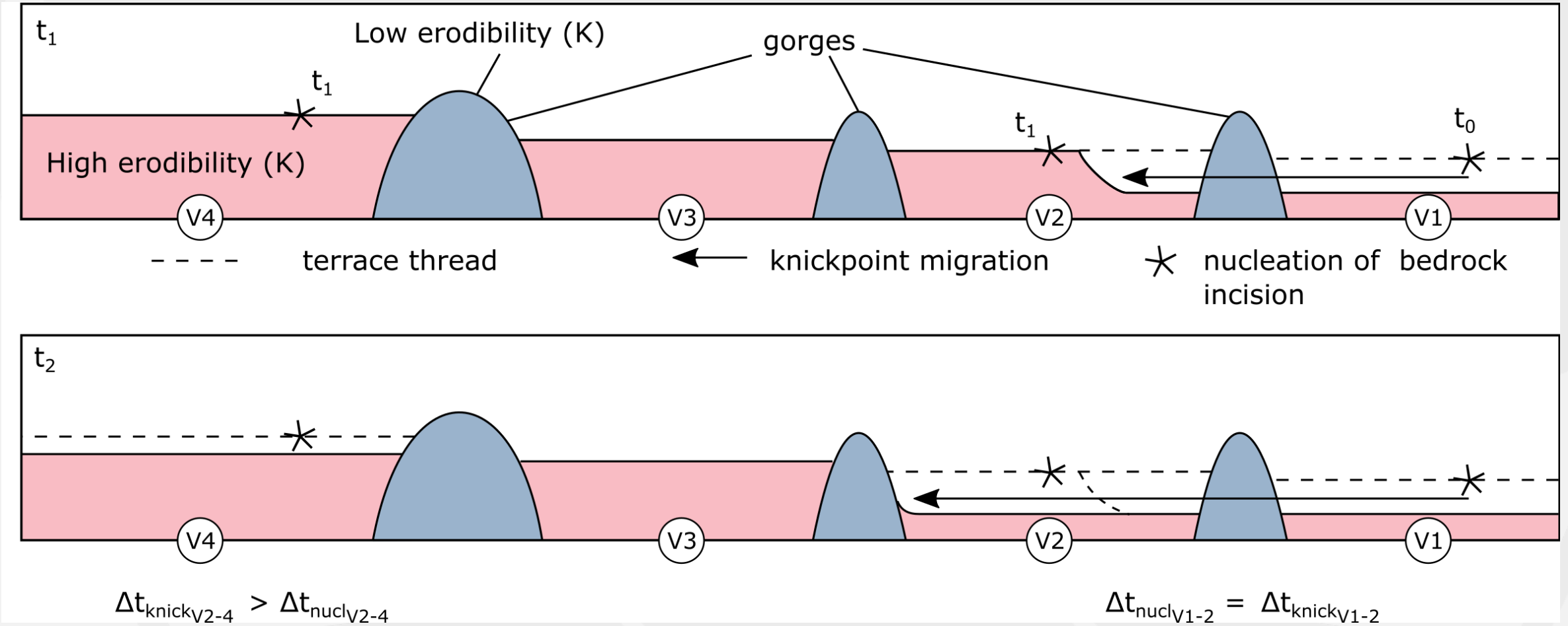

Zondervan et al. (in prep)

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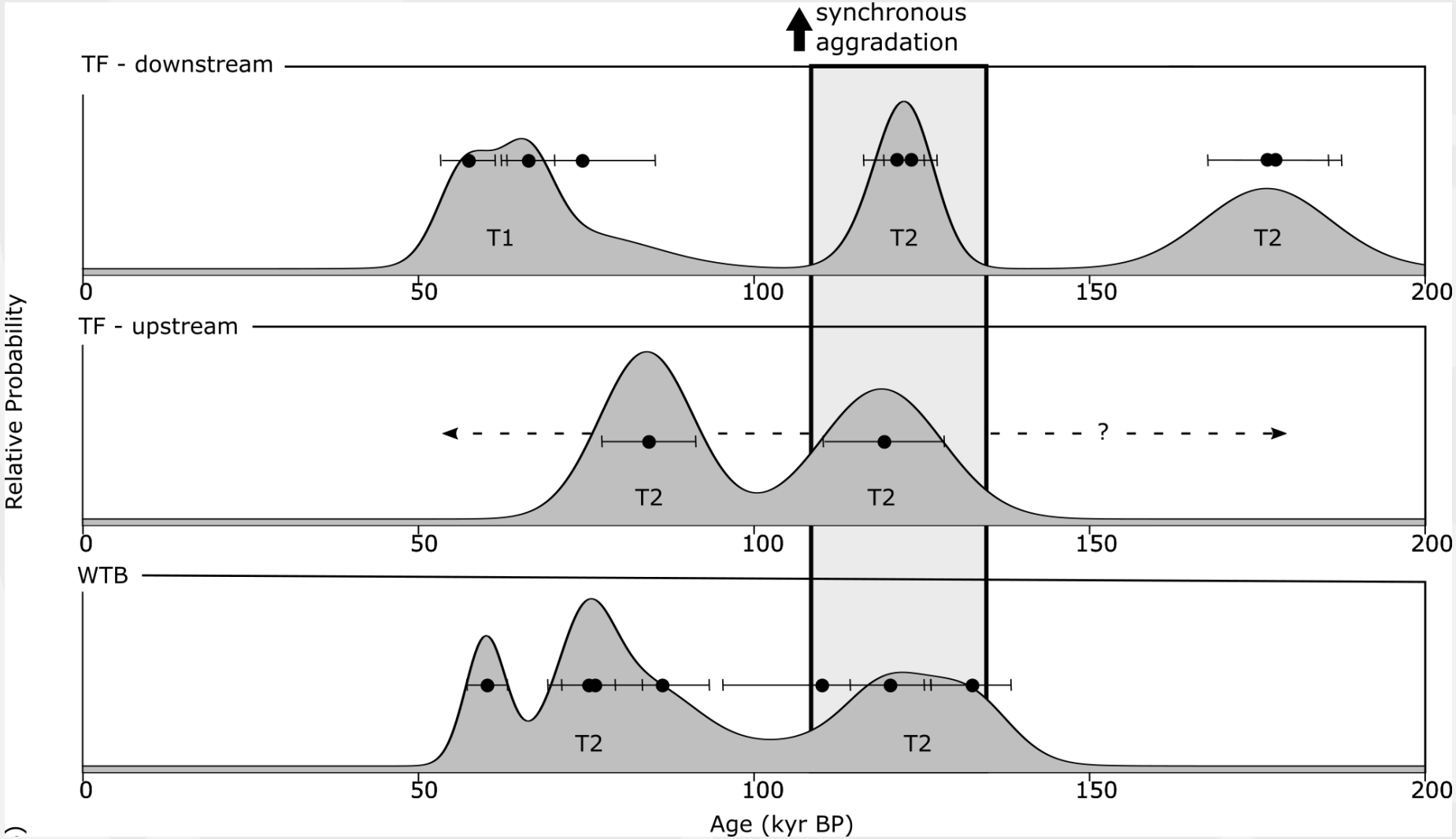
Erosion | Transport | Deposition | Morphology

One identified synchronous aggradation event 110-130 ka, incision and planation asynchronous



Zondervan et al. (in prep)

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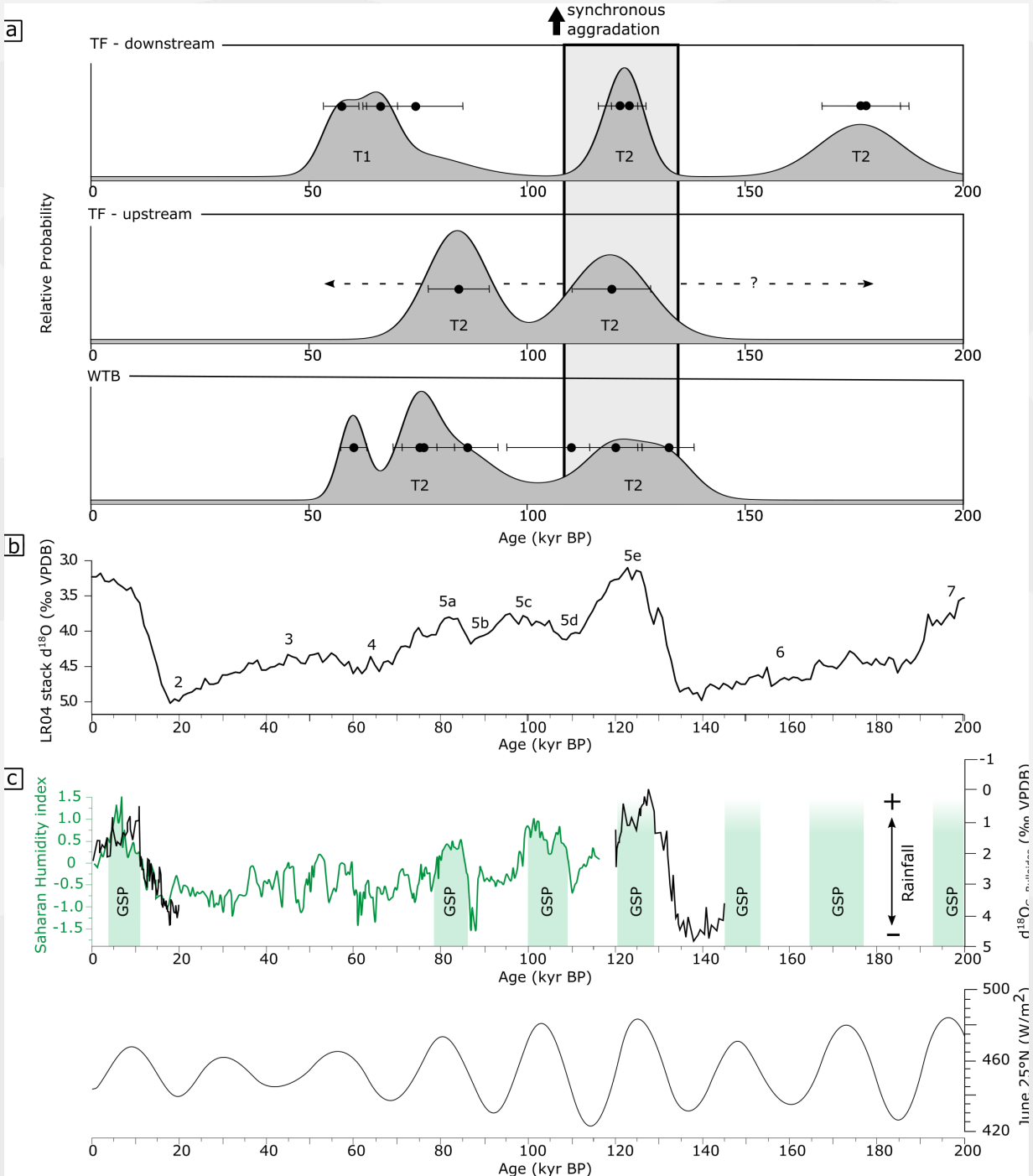
Erosion | Transport | Deposition | Morphology

Climate record has a heavy precession signal



Zondervan et al. (in prep)

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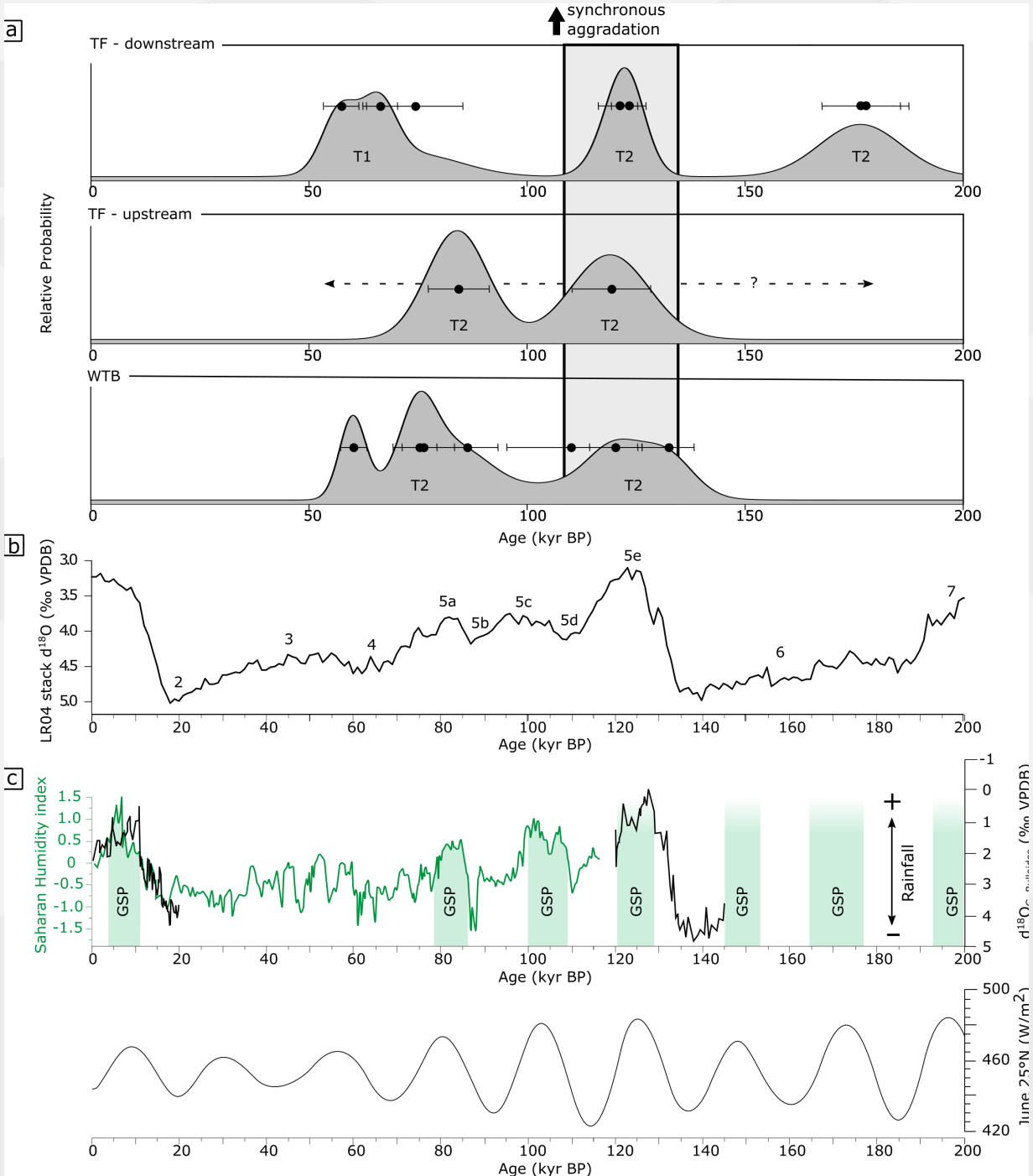
Synchronous aggradation correlates with MIS 5e interglacial maximum → maximum precipitation



Zondervan et al. (in prep)

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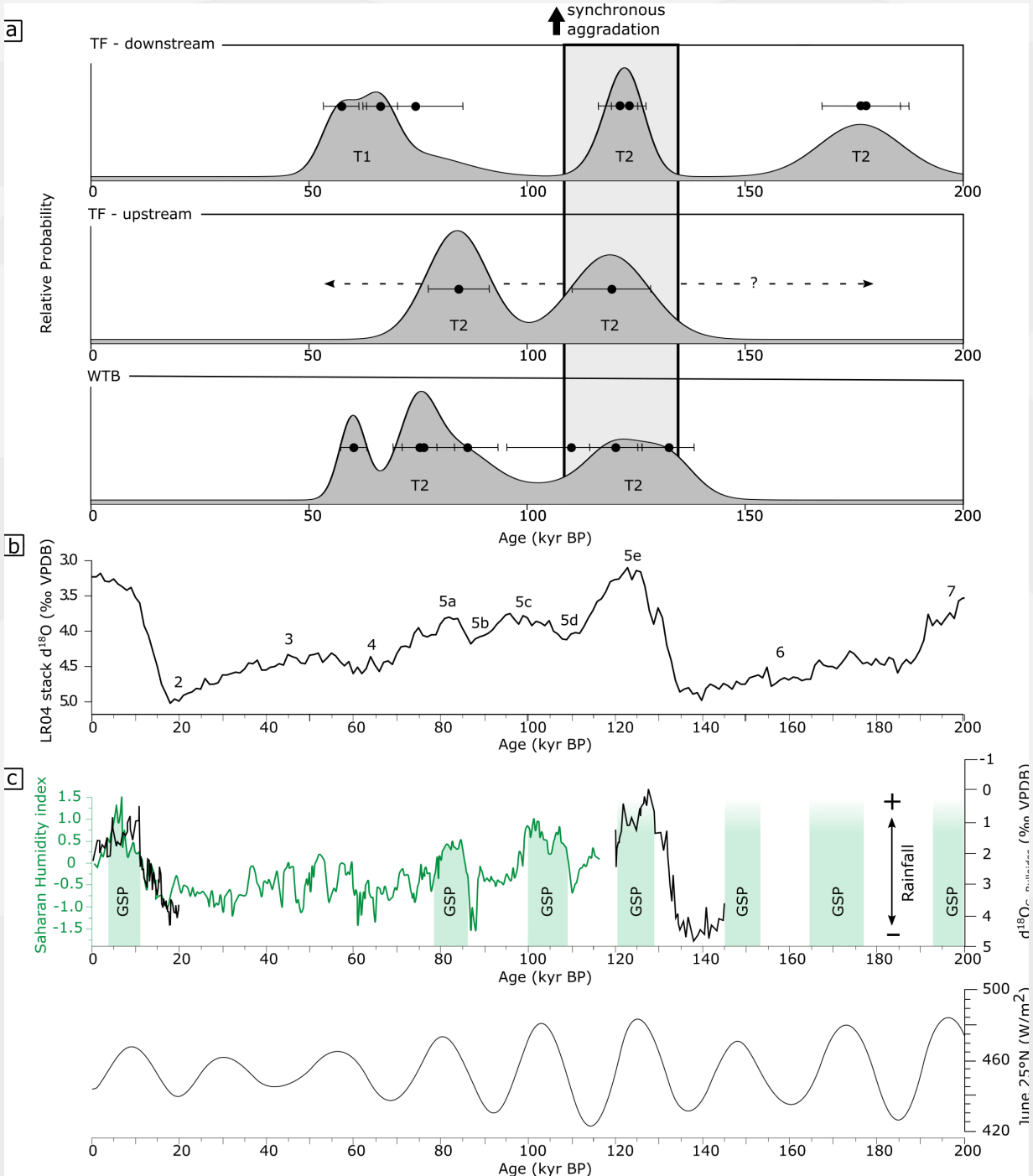
Synchronous aggradation correlates with MIS 5a interglacial maximum → maximum precipitation

Why asynchronous sediment flux on 10^4 yr timescale?



Zondervan et al. (in prep)

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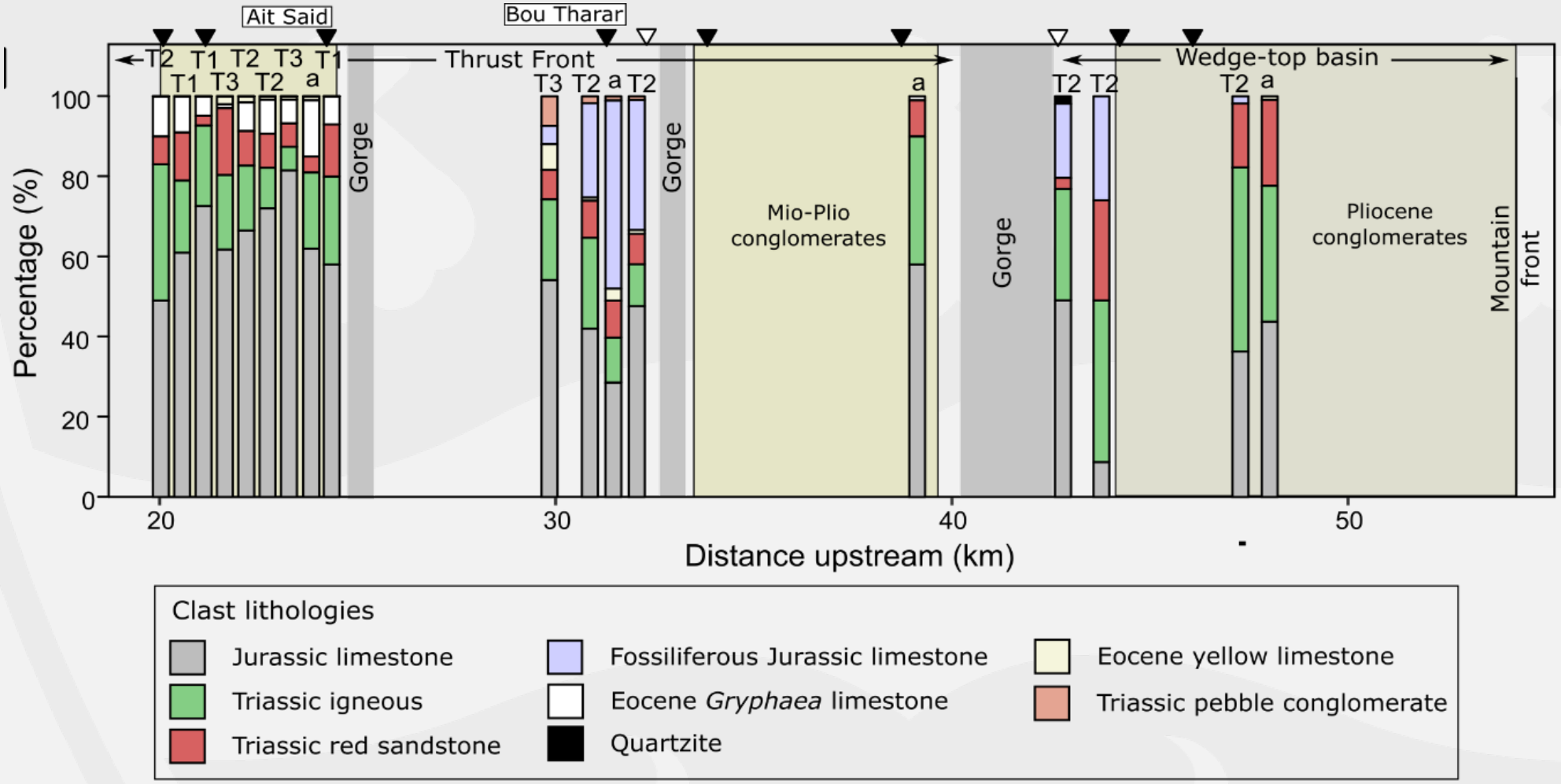
Clast lithological distribution → low longitudinal connectivity, dominant lateral sediment flux



Zondervan et al. (in prep)

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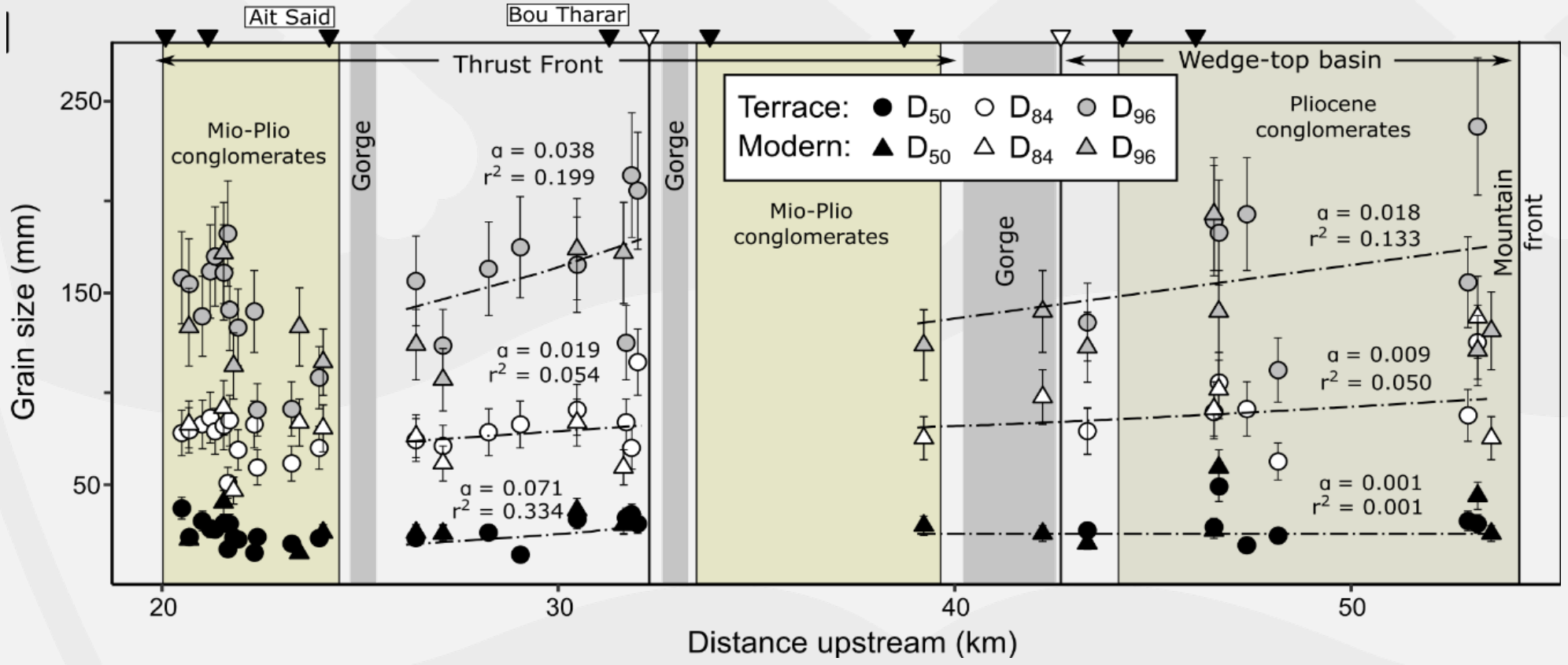
Erosion | Transport | Deposition | Morphology

Low/absent grainsize fining rate→ low longitudinal connectivity, dominant lateral sediment flux



Zondervan et al. (in prep)

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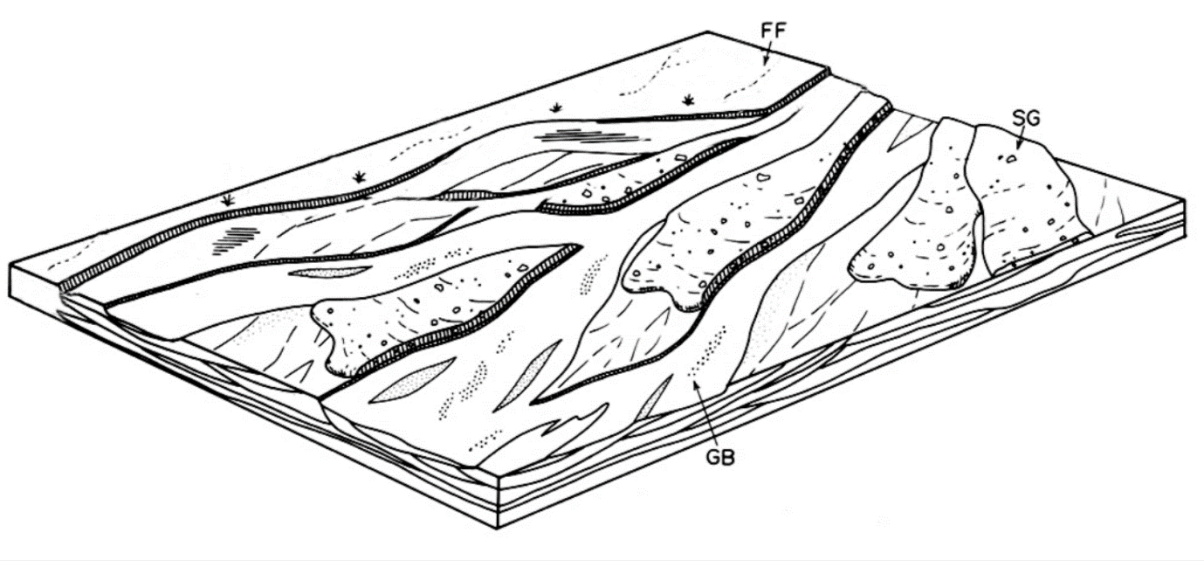
Erosion | Transport | Deposition | Morphology

Facies →
nature of sediment flux (fluvial, fans)



Zondervan et al. (in prep),
modified from Miall 1985

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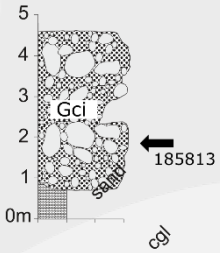
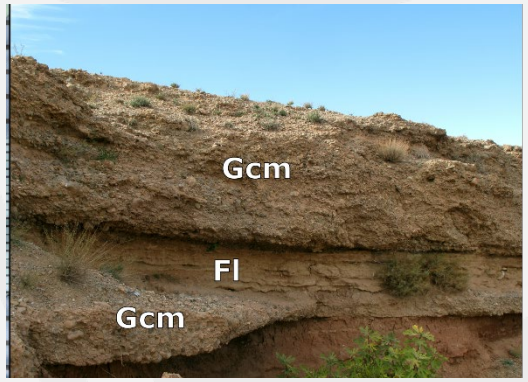
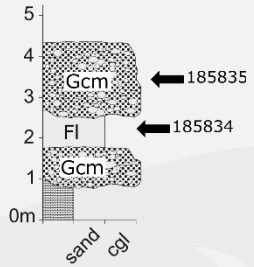
Erosion | Transport | Deposition | Morphology

Control of stochastic vs gradual process on river channel sediment flux depends on valley width

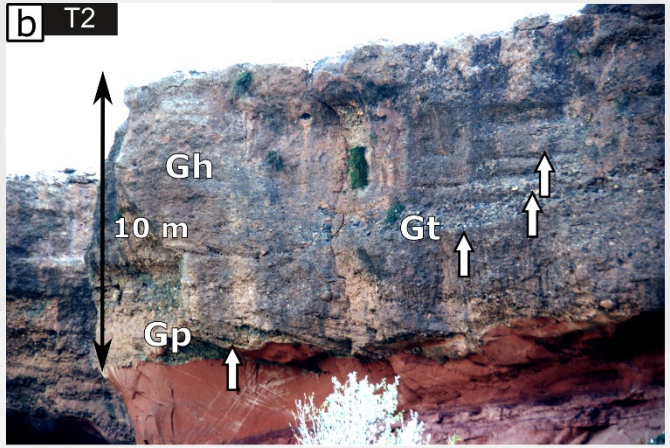
Unconfined WTB (3.5 km wide valley)

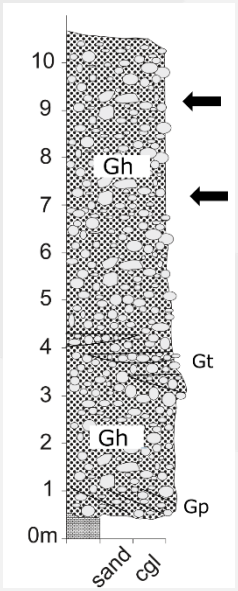






Confined Thrust Front (150 m – 650 m wide valley)





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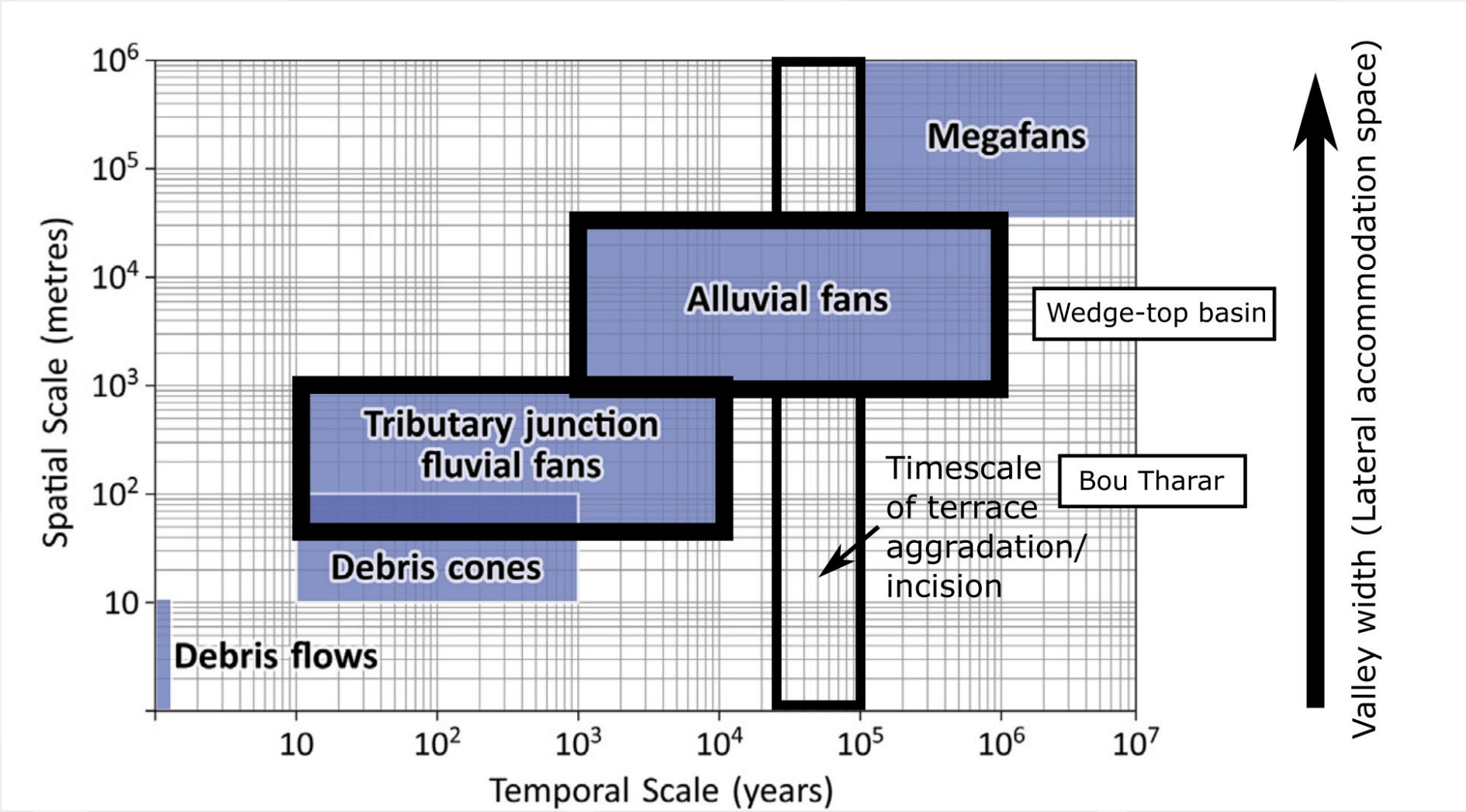
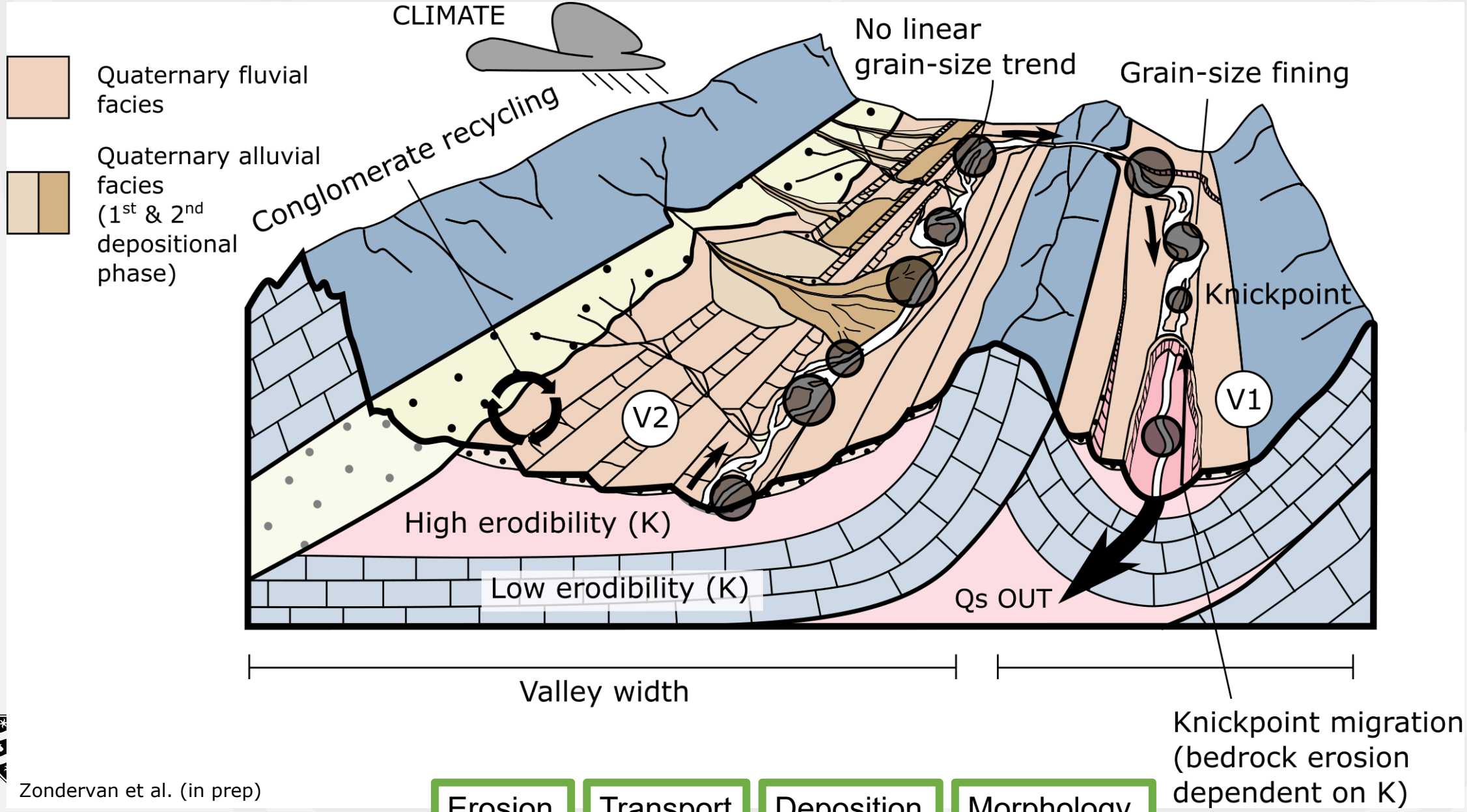
Erosion | Transport | **Deposition** | Morphology

Valley width controls the timescale of hillslope to channel buffering



Zondervan et al. (in prep)

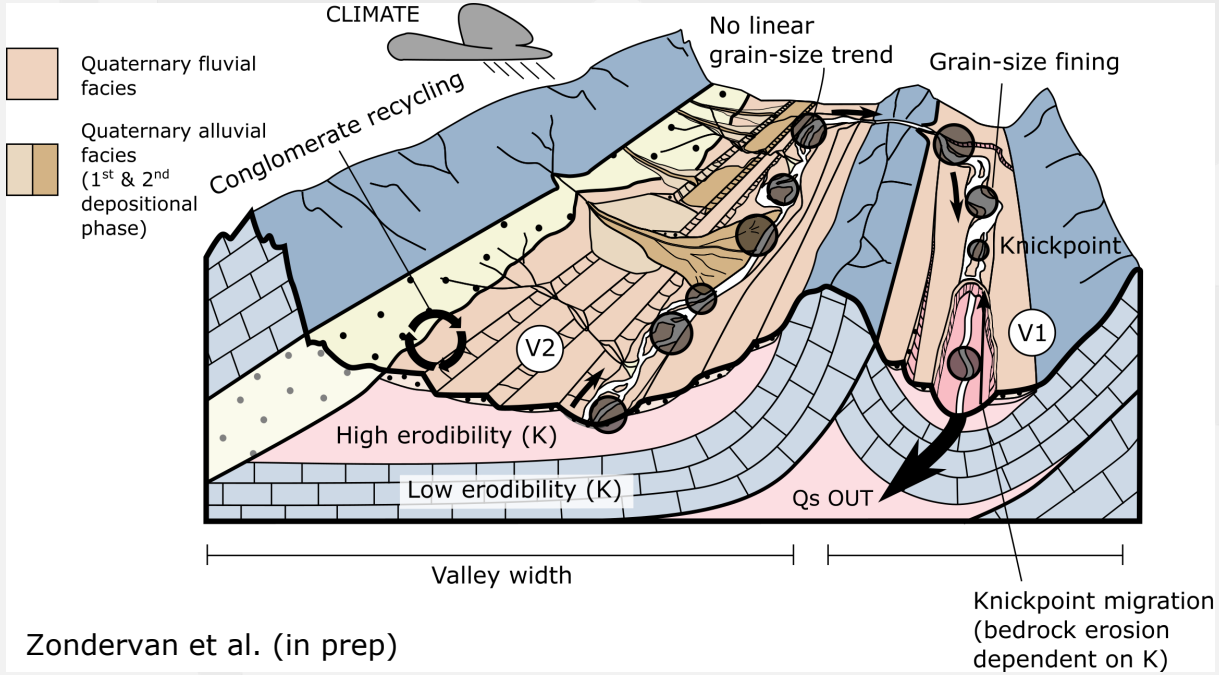
Lithological and structural controls on timescales of erosional and depositional connectivity



Zondervan et al. (in prep)

Erosion | Transport | Deposition | Morphology

Conclusions



Zondervan et al. (in prep)

Erosion

- Erosional response asynchronous on order of 10^4 – 10^5 yr

Transport

- Low longitudinal to lateral sediment flux ratio through the last ~ 200 kyr

Deposition

- Depositional response asynchronous on the order of 10^4 yr

→Asynchronous terraces

Controlled by lithological and structural control on morphology and process

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