EGU2020-4599

EGU2020: Sharing Geoscience Online

Session: TS7.5 | D1287 | EGU2020-4599

Central Asian Tectonics –Pamir, Tian Shan and Tibet from Paleozoic to Present

07 May, 2020

Bundesministerium für Bildung und Forschung

CATENA

Seismic Behavior Along a Fault Segment in an Active Continental Collision Zone: New Paleoseismic and Structural Data of the Pamir Frontal Thrust in the Alai Valley, Kyrgyzstan, Central Asia.

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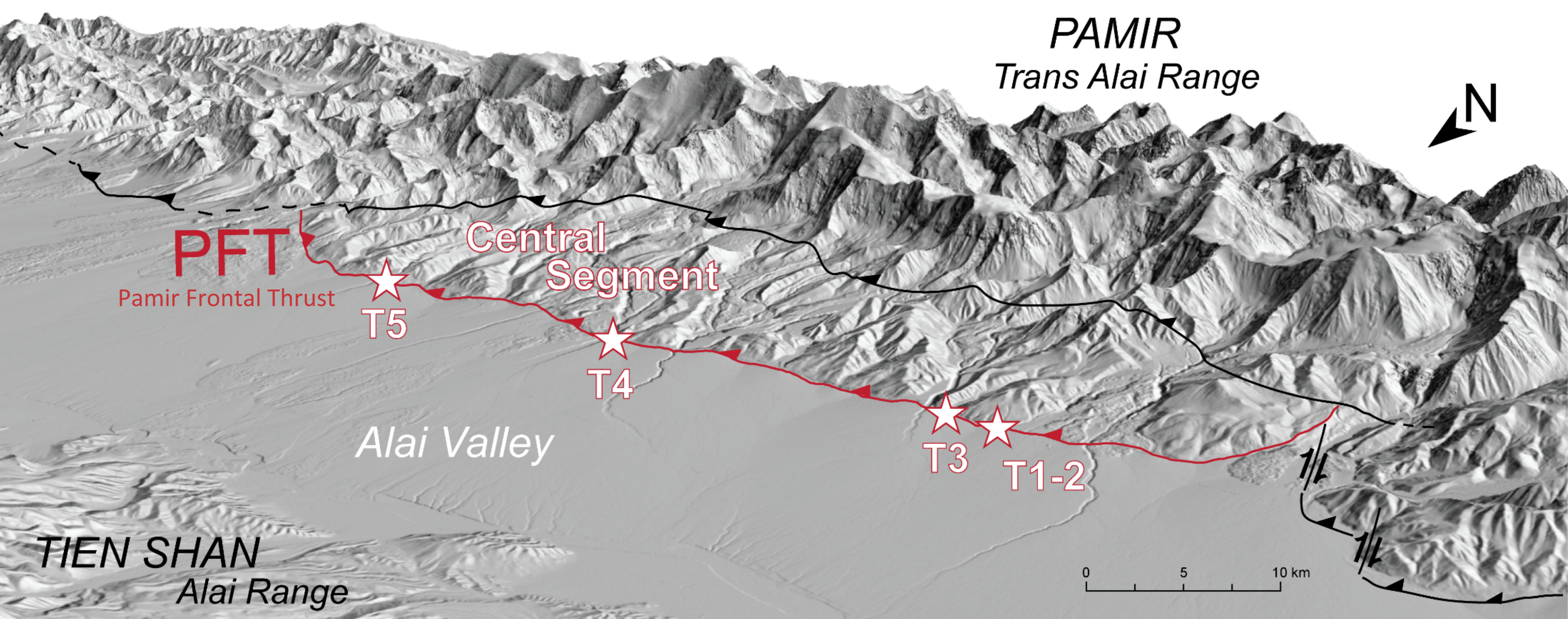

THE NORTHERN PAMIR AND THE ALAI VALLEY

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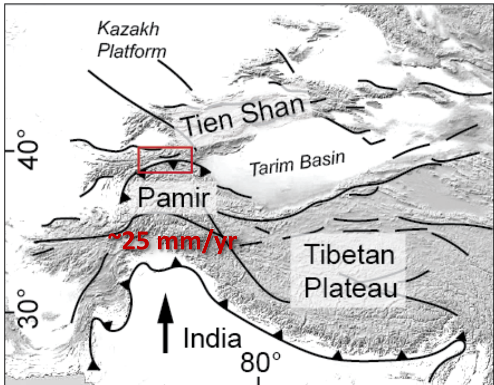
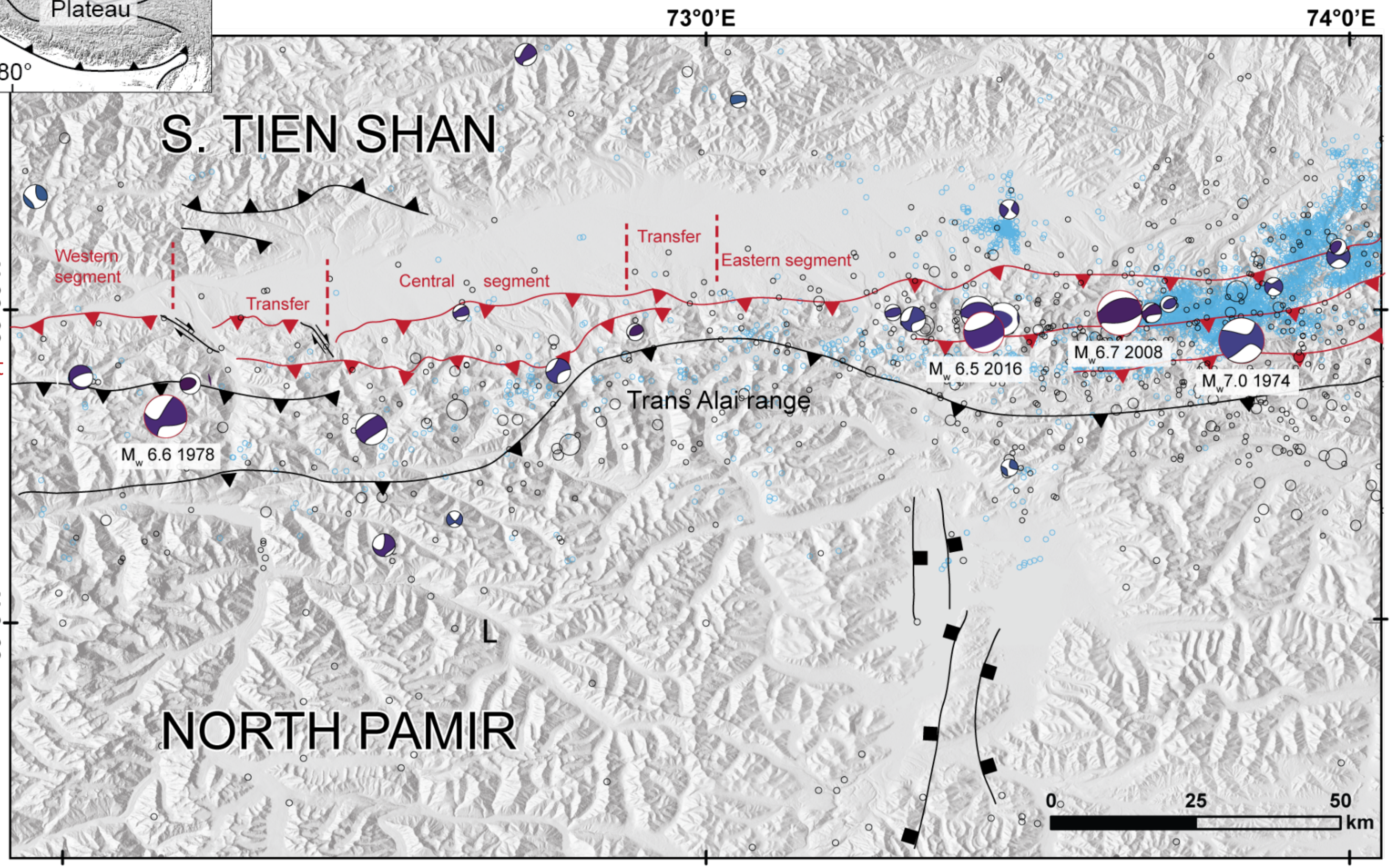


PAMIR - accommodates ½ of 50 mm/yr
of total N-S shortening
between India and Eurasia

PFT
Pamir Frontal Thrust

MPT
Main Pamir Thrust



THE NORTHERN PAMIR AND THE ALAI VALLEY

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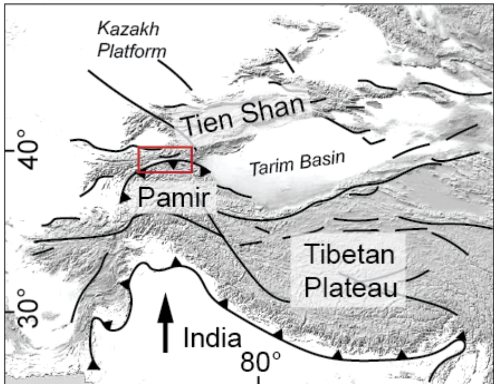
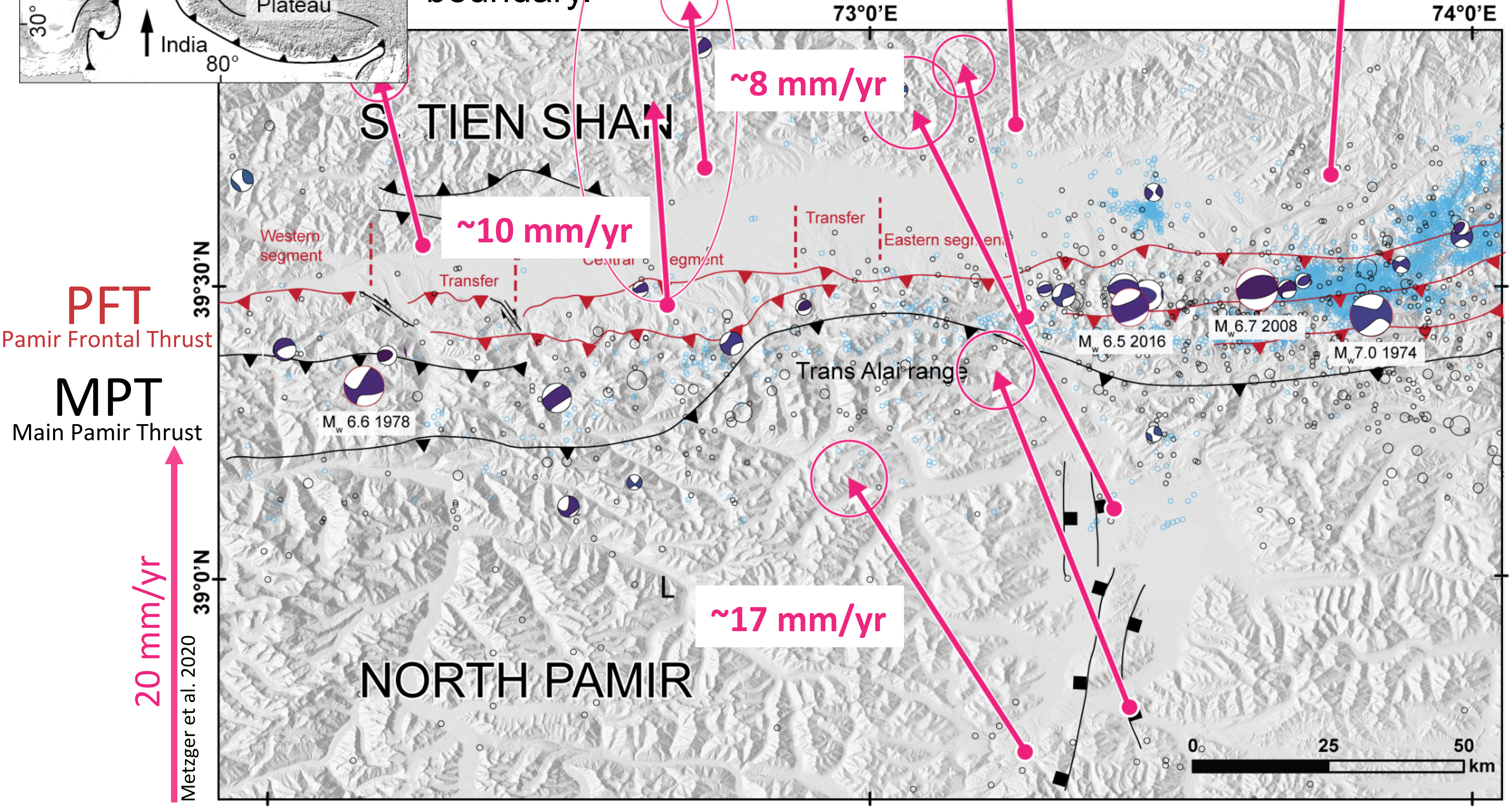
- Geodetic GPS velocity **~10-15 mm/yr** of ~25 mm/yr of convergence between the central Pamir and Eurasia.

- Rapid decrease over short distance along northern Pamir boundary.





How is the regional tectonic character reflected by the geomorphology and earthquake geology in the Alai Valley?

- How much of the Pamir Frontal thrust (PFT) is activated during an earthquake rupture?

- Are paleoseismic slip history and geodetically-derived shortening rates compatible?

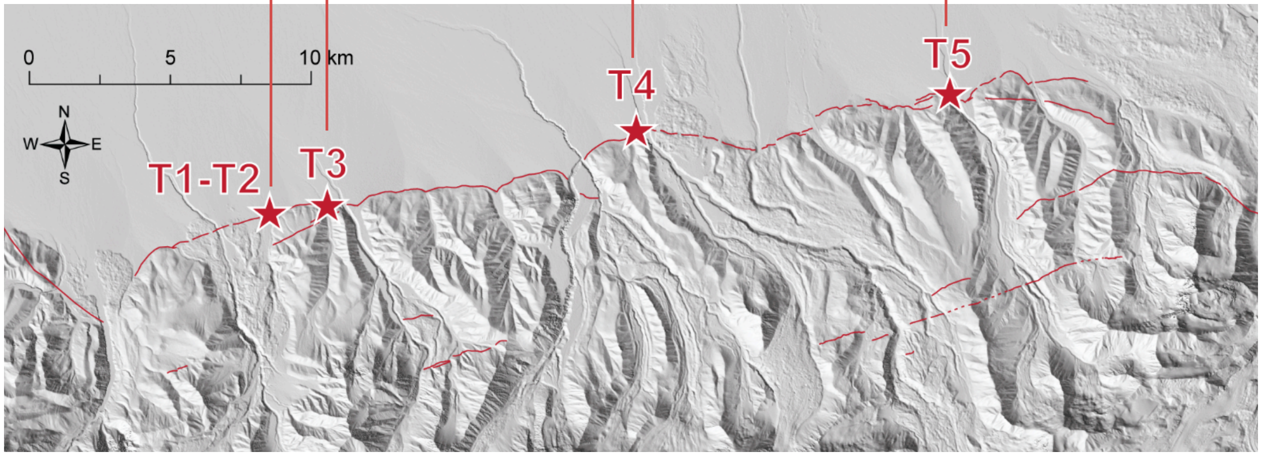
The presented data is based on five paleoseismological trenches across the Central Segment of the PFT (Pamir Frontal Thrust)

2017: Achyk-Suu

2018: Ylaisu

1999: Komansu

2018: Tashkungey



Central Segment of the PFT

WORKFLOW EXAMPLE: Tashkungey

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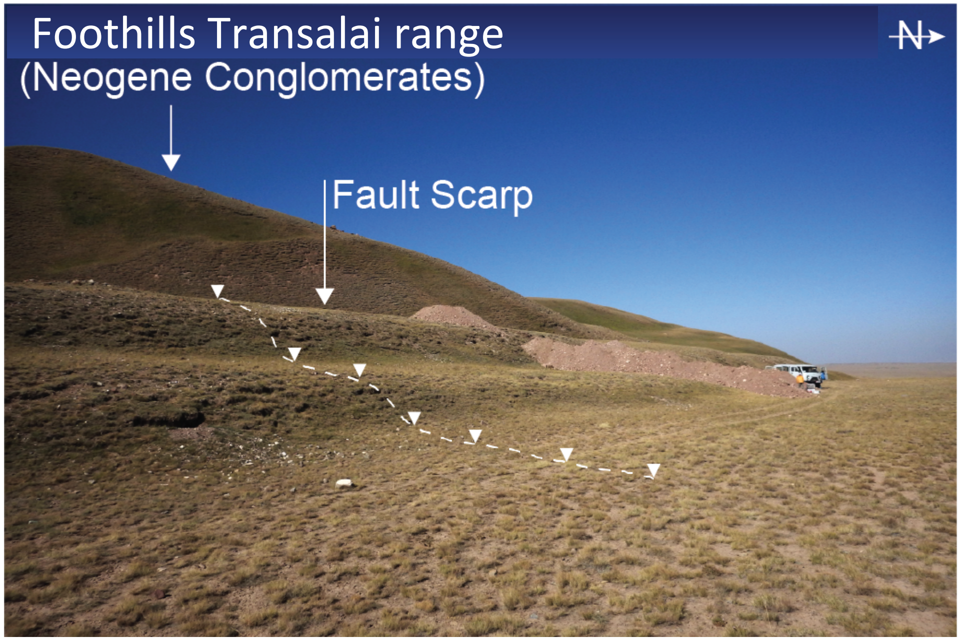
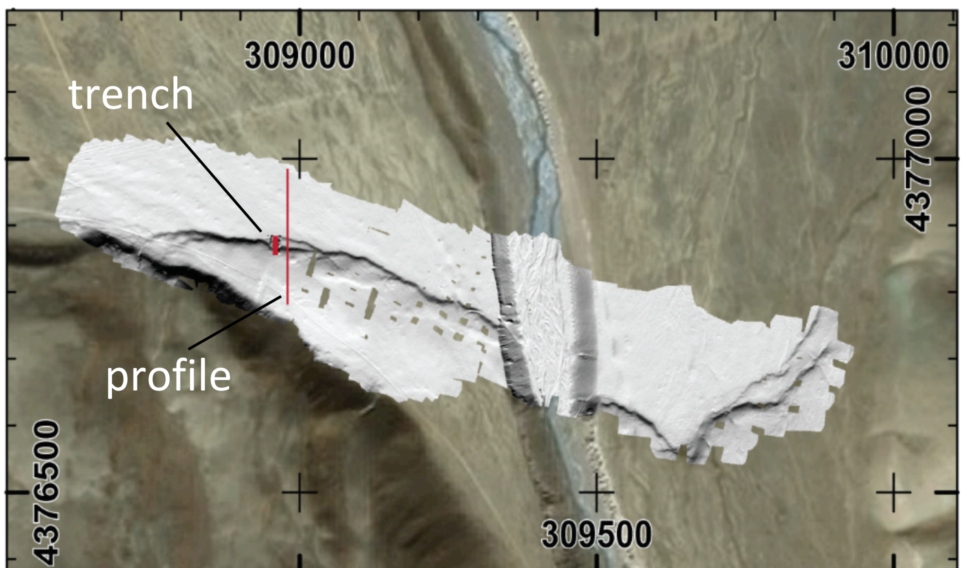
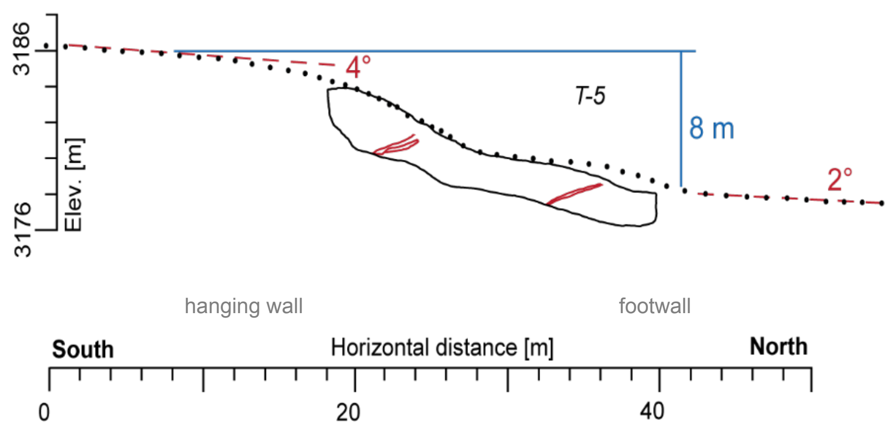




High-resolution DEM from drone survey

dGPS topographic profiles



WORKFLOW EXAMPLE: Tashkungey

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South

Tashkungey

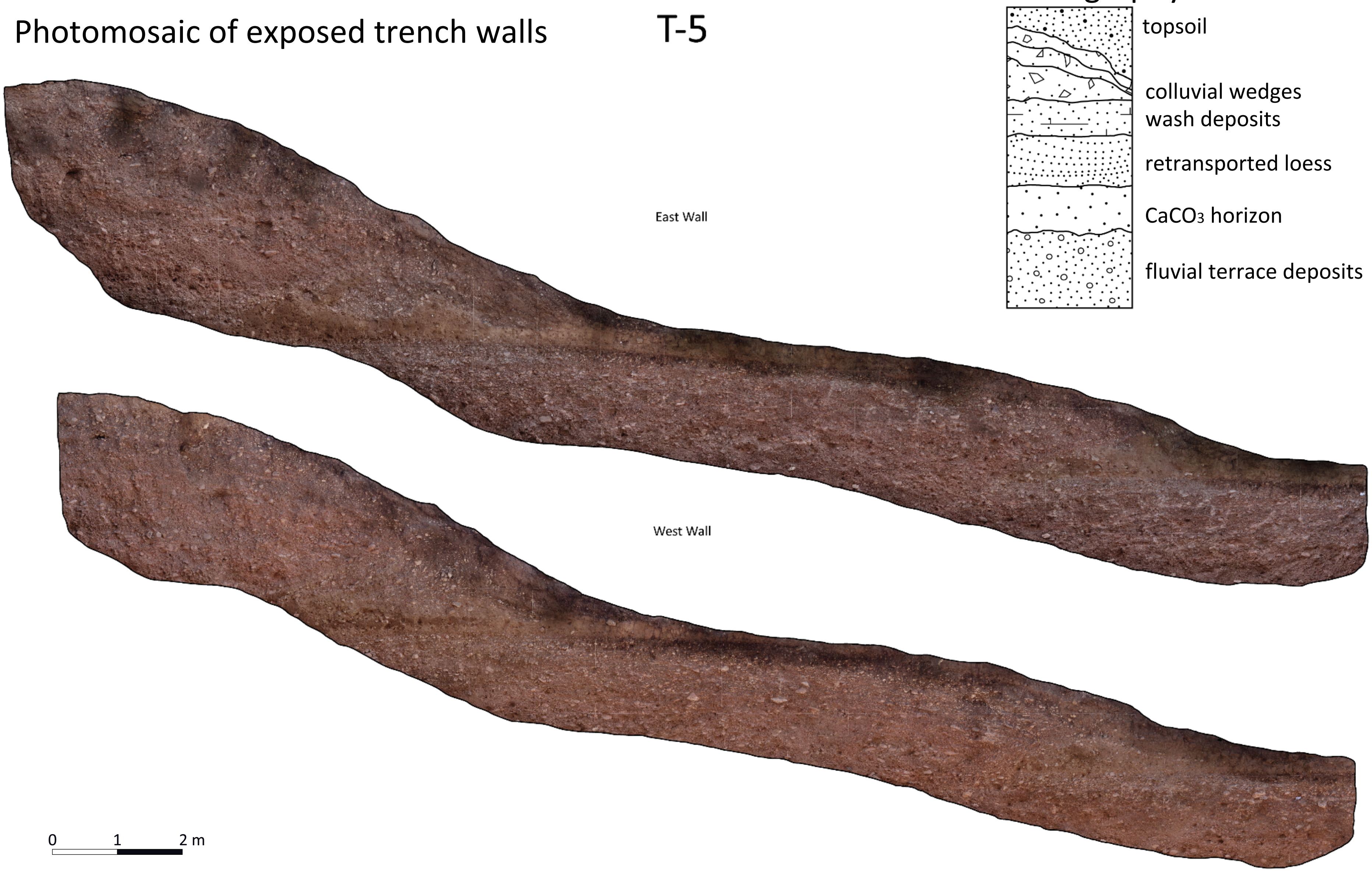
39.520219°N 72.777639°E

T-5

North

Photomosaic of exposed trench walls

Stratigraphy



0 1 2 m

WORKFLOW EXAMPLE: Tashkungey

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South

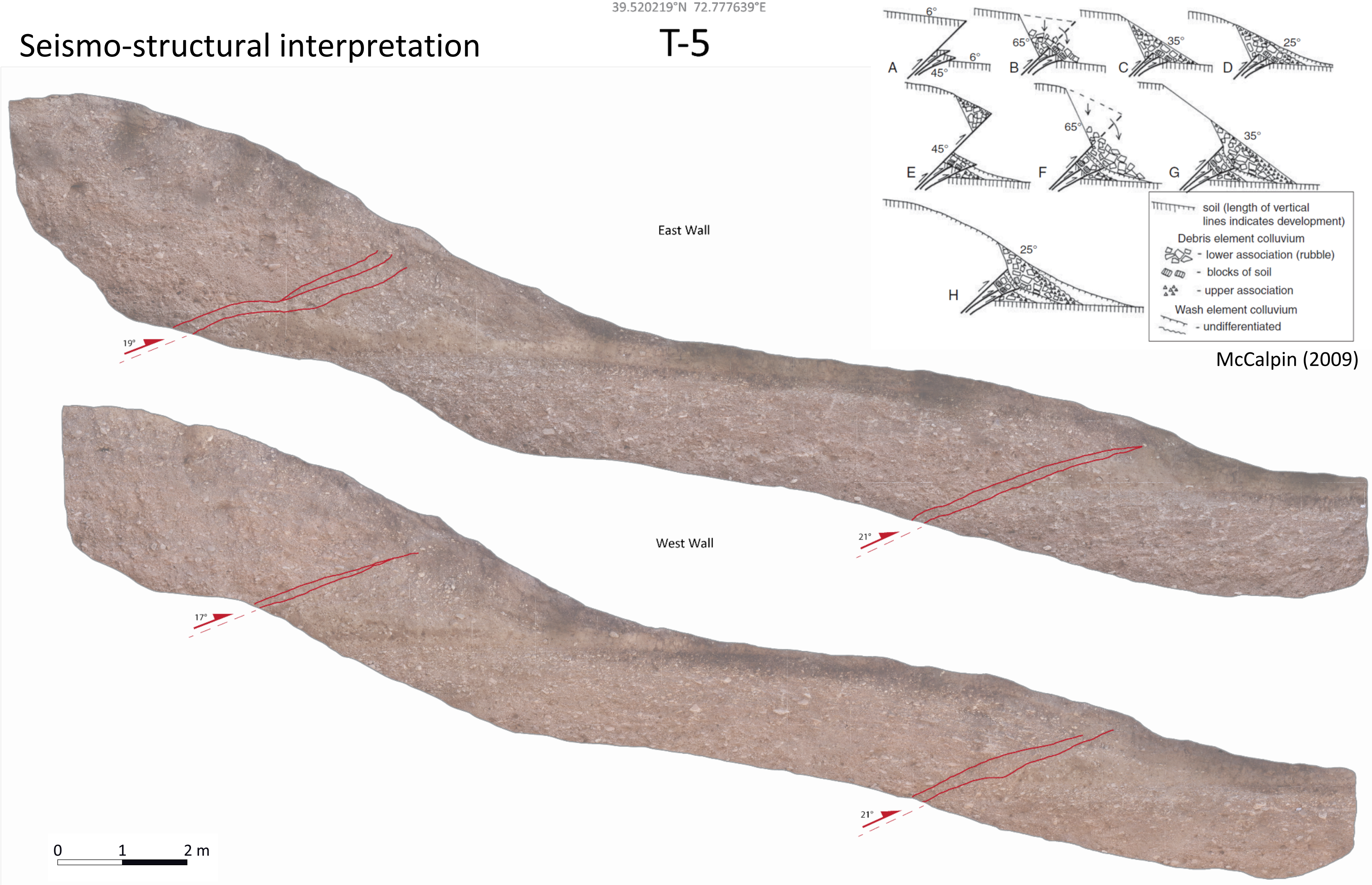
North

Tashkungey

39.520219°N 72.777639°E

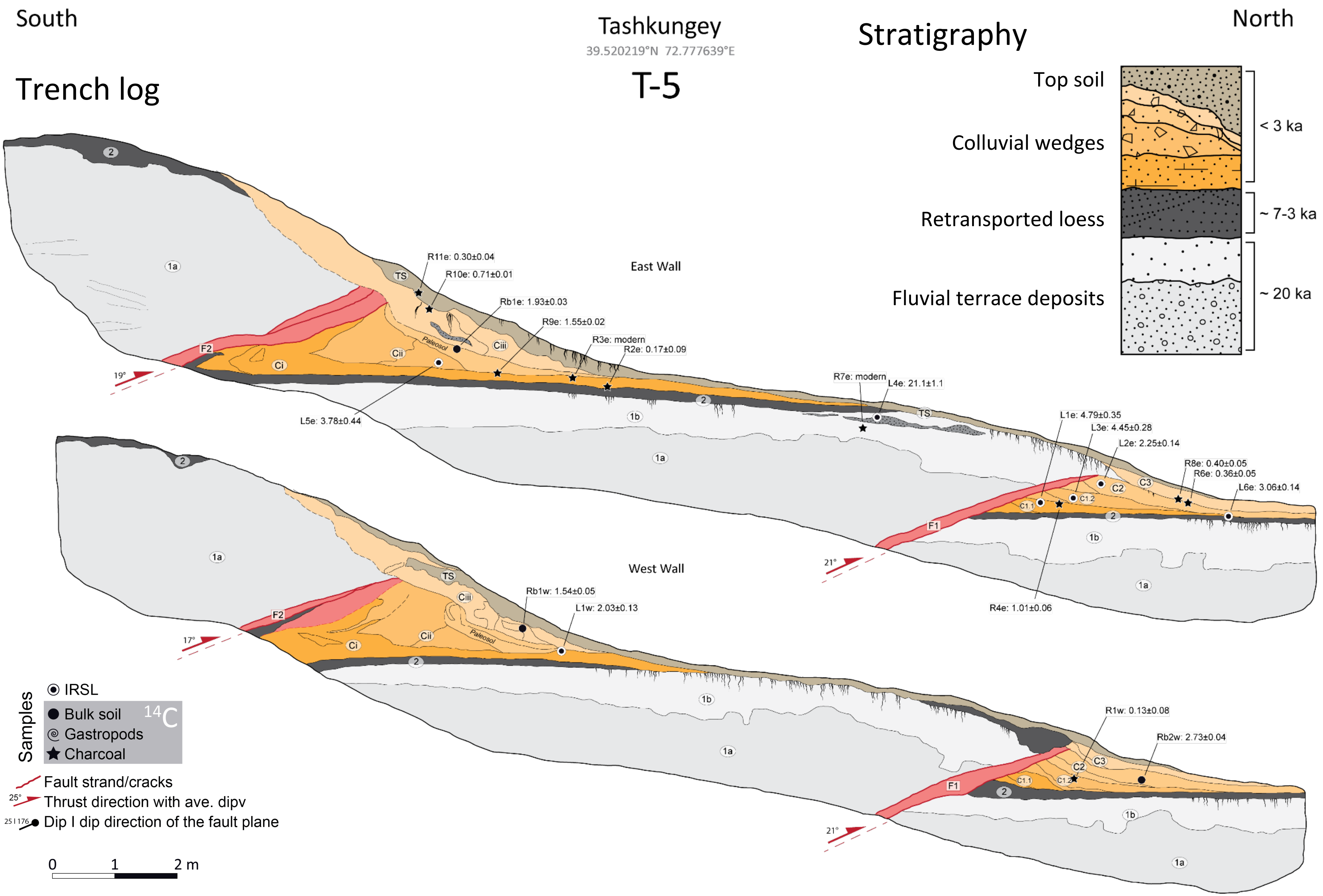
Seismo-structural interpretation

T-5

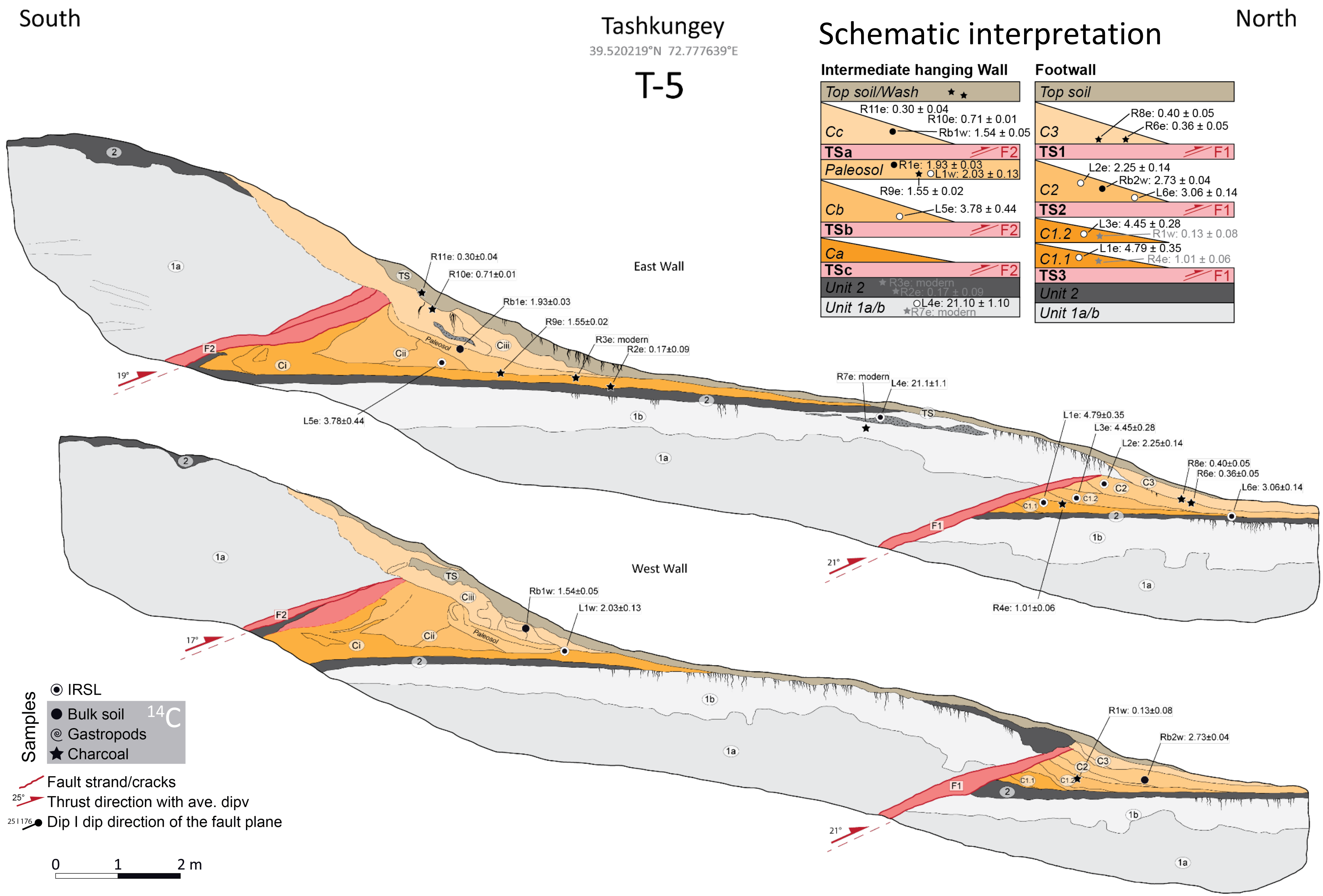


McCalpin (2009)

WORKFLOW EXAMPLE: Tashkungey



WORKFLOW EXAMPLE: Tashkungey



WORKFLOW EXAMPLE: Tashkungey

South

Tashkungey

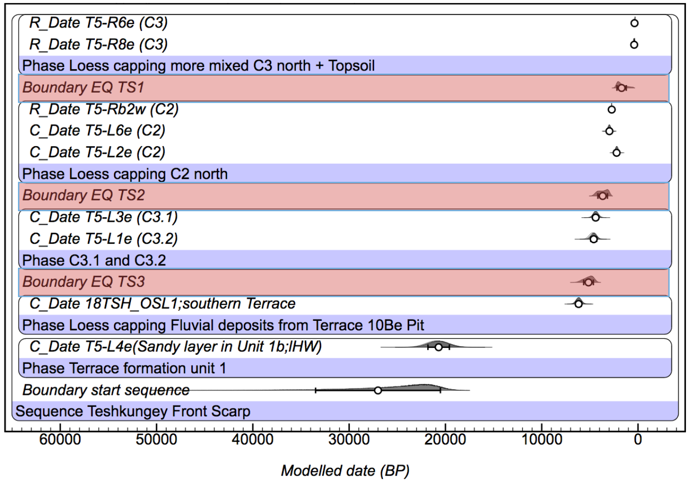
39.520219°N 72.777639°E

T-5

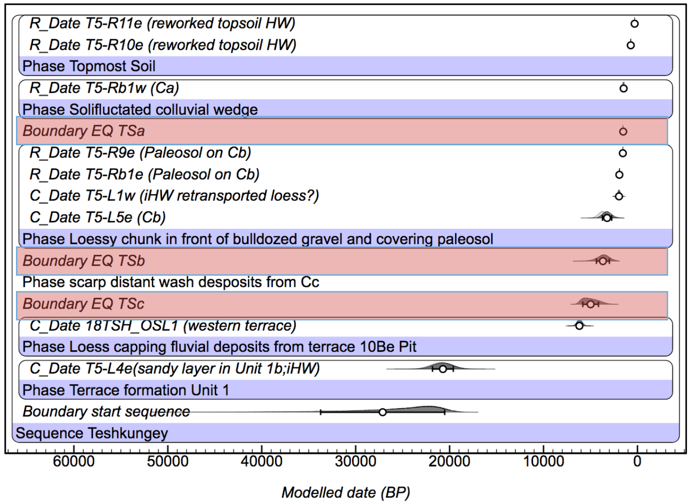
North

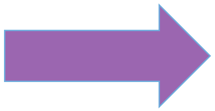
Calibration and probabilistic modeling:

Fault zone F1

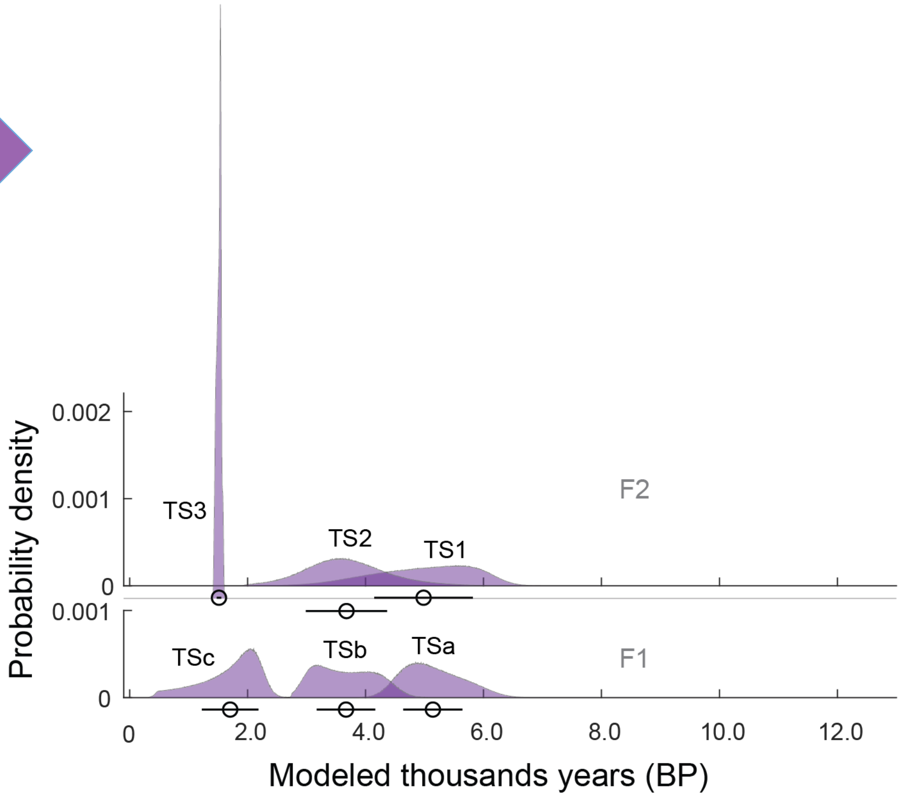


Fault zone F2





Earthquake timing



OxCal v4.3.2 Bronk Ramsey (2017); IntCal13 atmospheric curve (Reimer et al 2013)

WORKFLOW EXAMPLE: Tashkungey

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South

Tashkungey

39.520219°N 72.777639°E

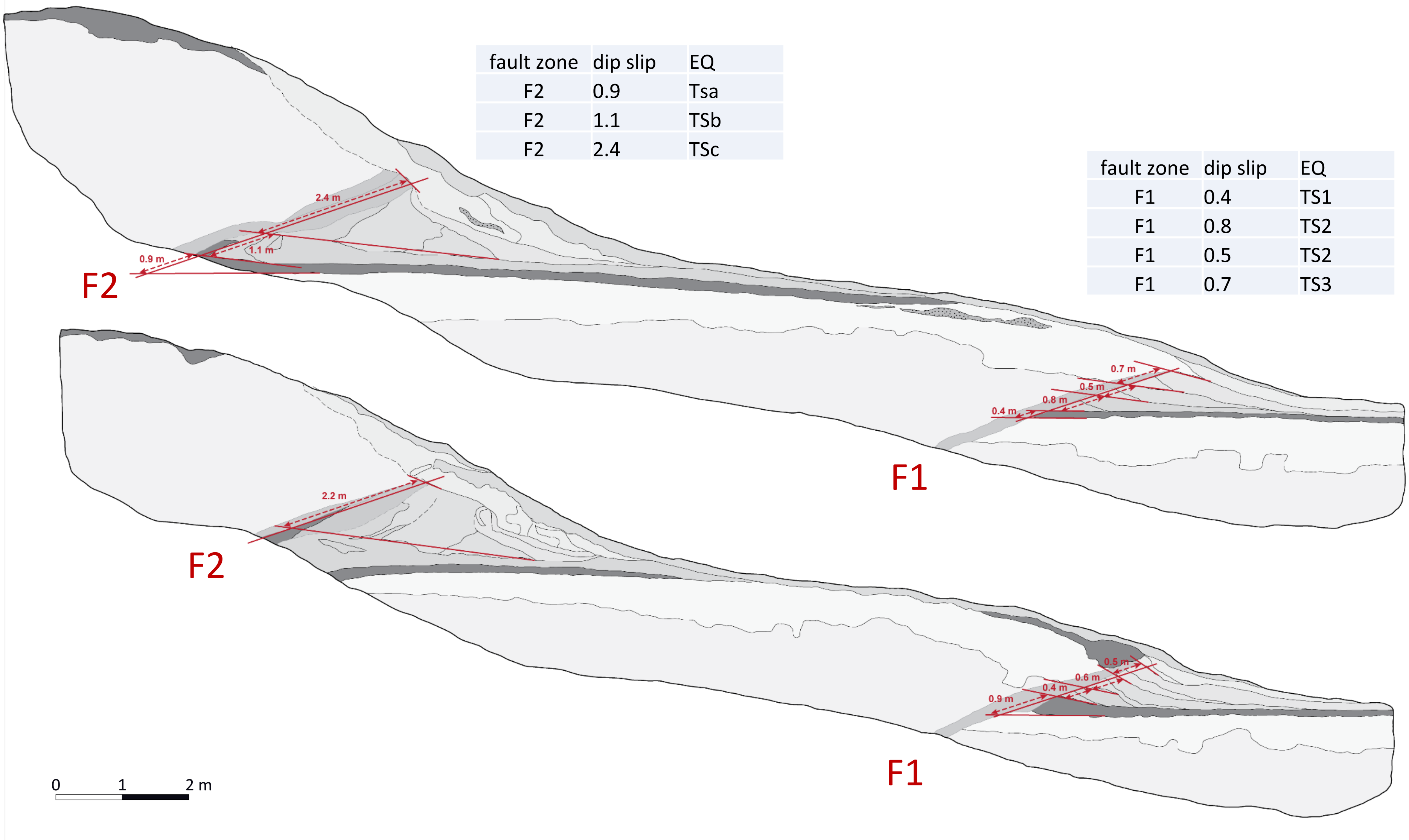
T-5

North

Dip-slip per event

fault zone	dip slip	EQ
F2	0.9	Tsa
F2	1.1	TSb
F2	2.4	TSc

fault zone	dip slip	EQ
F1	0.4	TS1
F1	0.8	TS2
F1	0.5	TS2
F1	0.7	TS3



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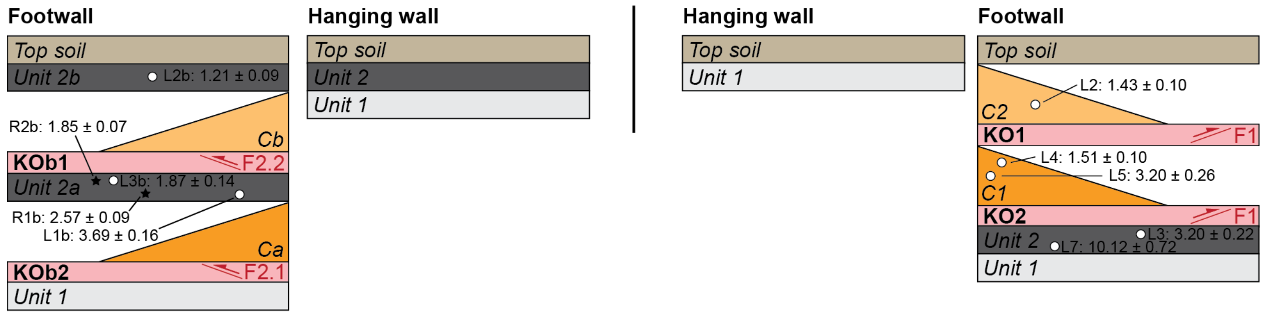
South

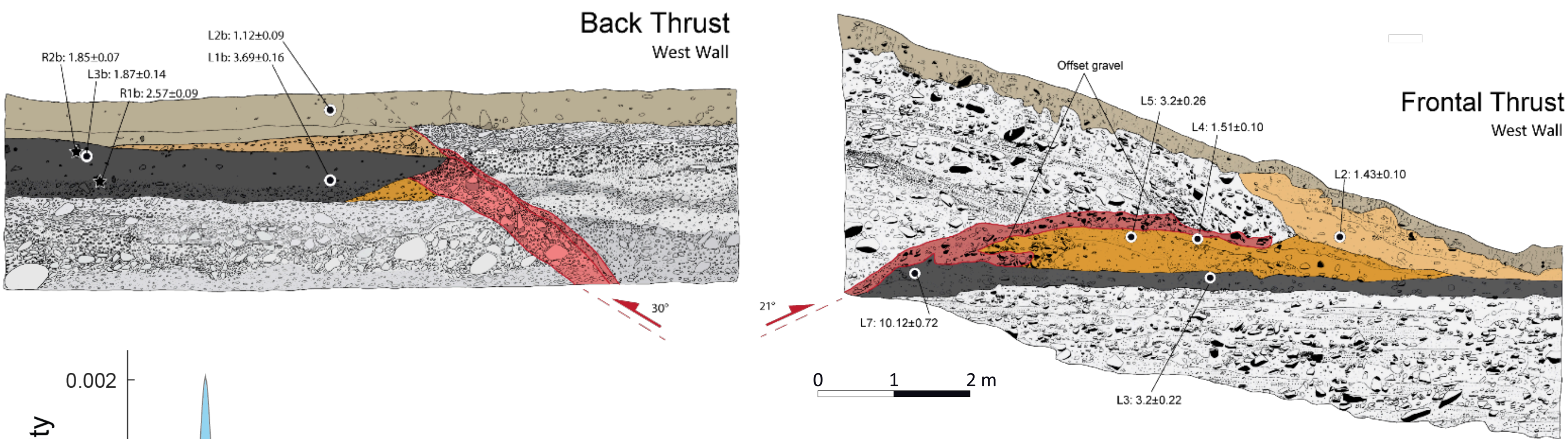
Komansu

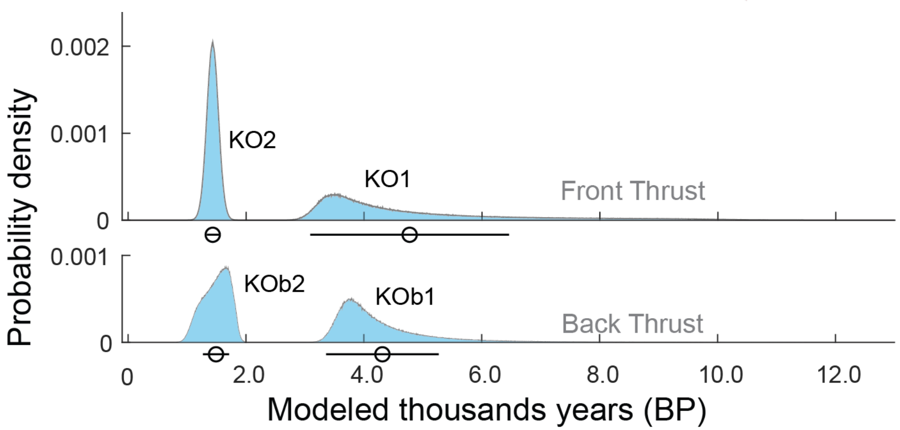
39.505461°N 72.652224°

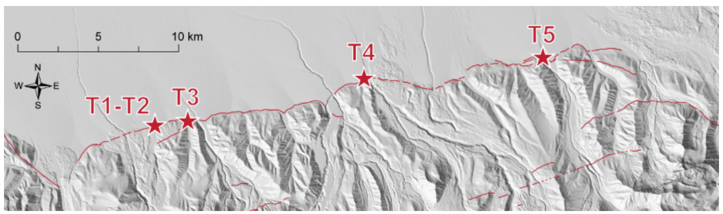
North

T-4









PALEOSEISMOLOGY ALONG THE PFT

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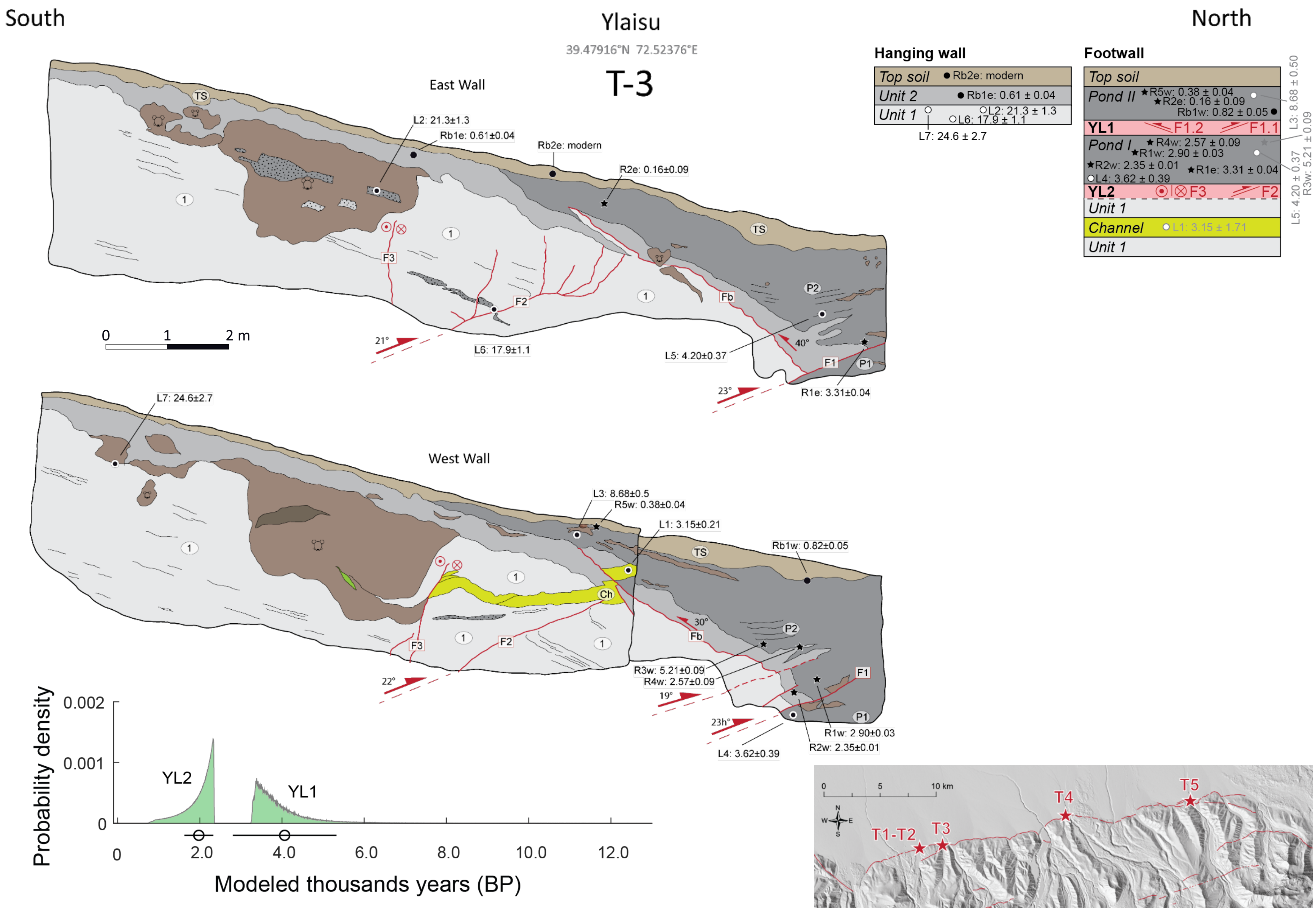

PALEOSEISMOLOGY ALONG THE PFT

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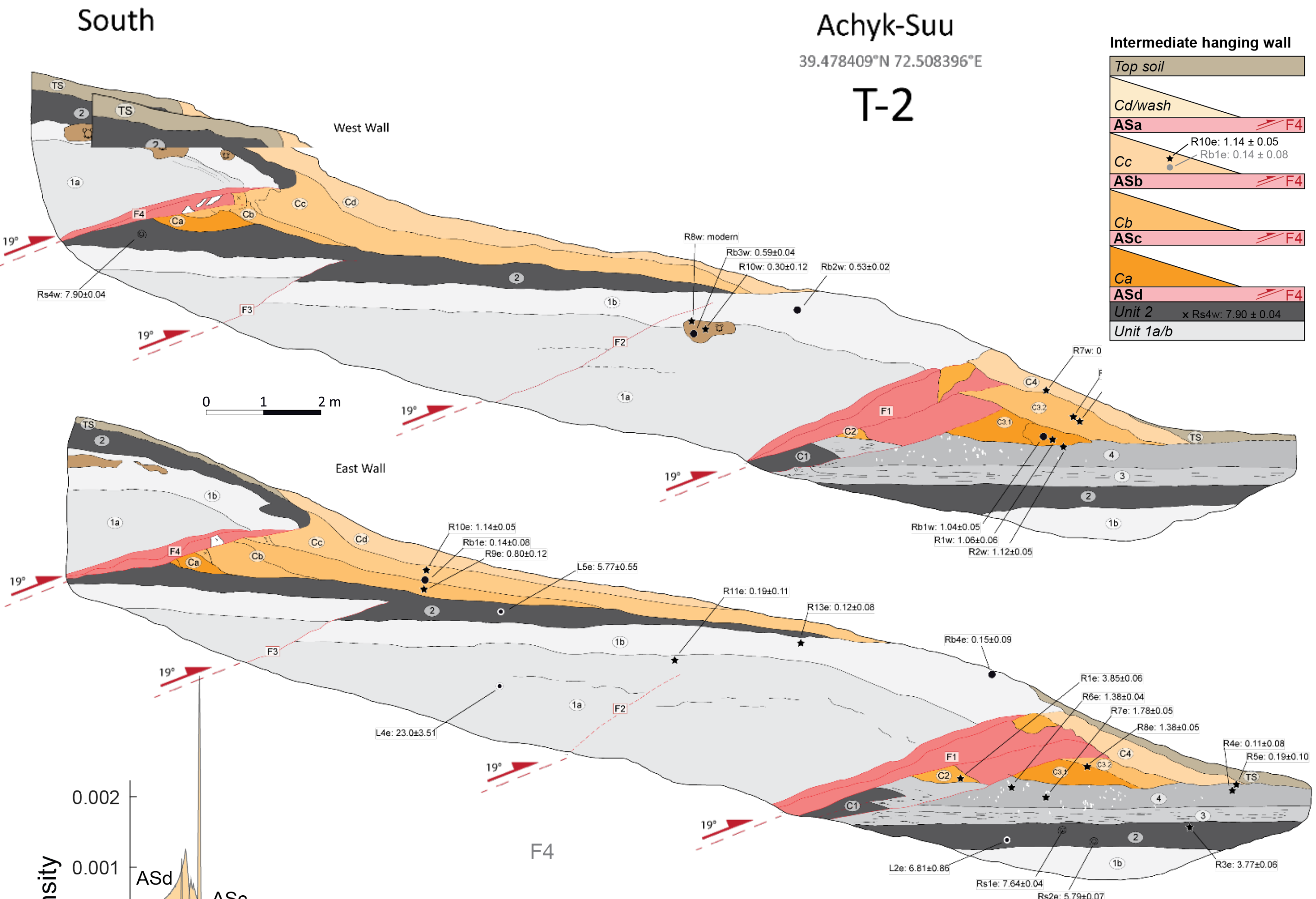

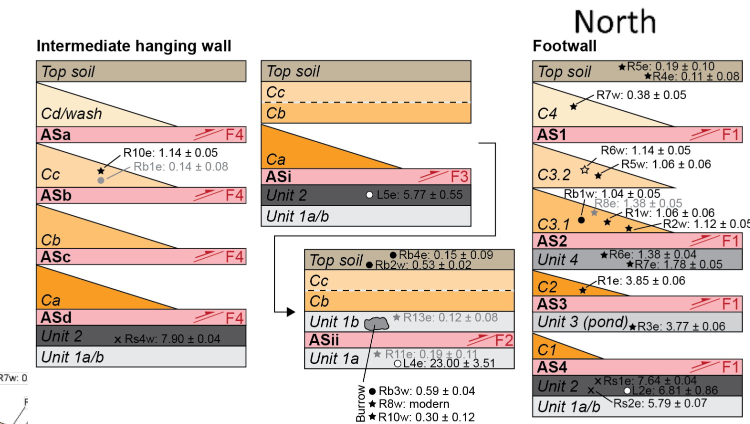

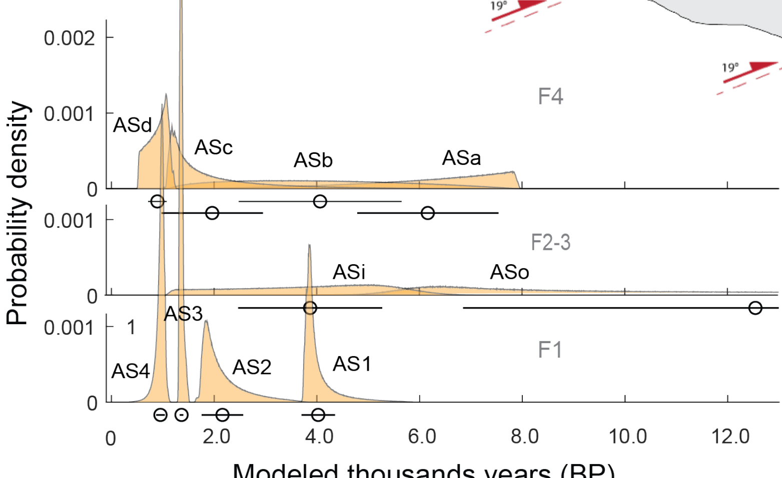

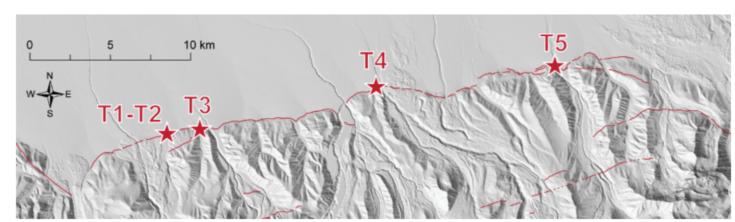

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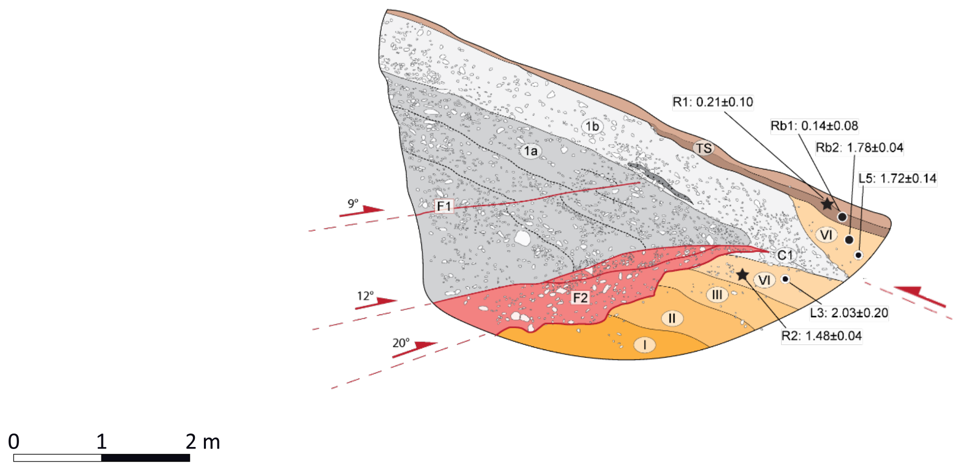
South

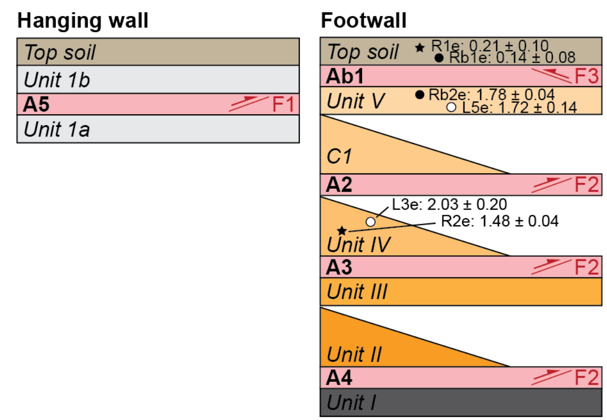
North

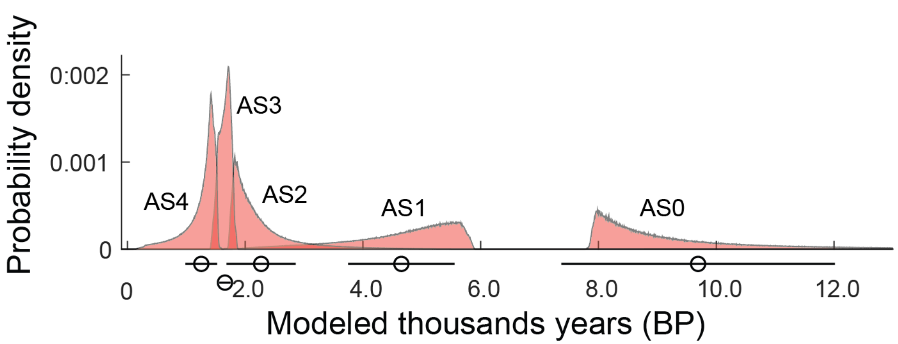
Achyk-Suu

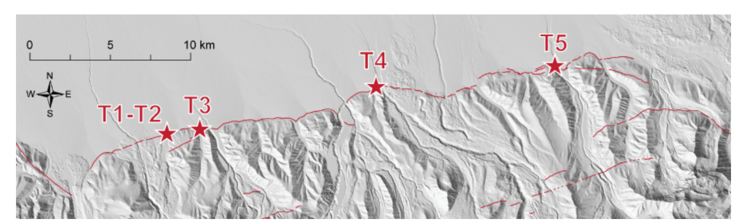
39.475939°N 72.498243°E

T-1



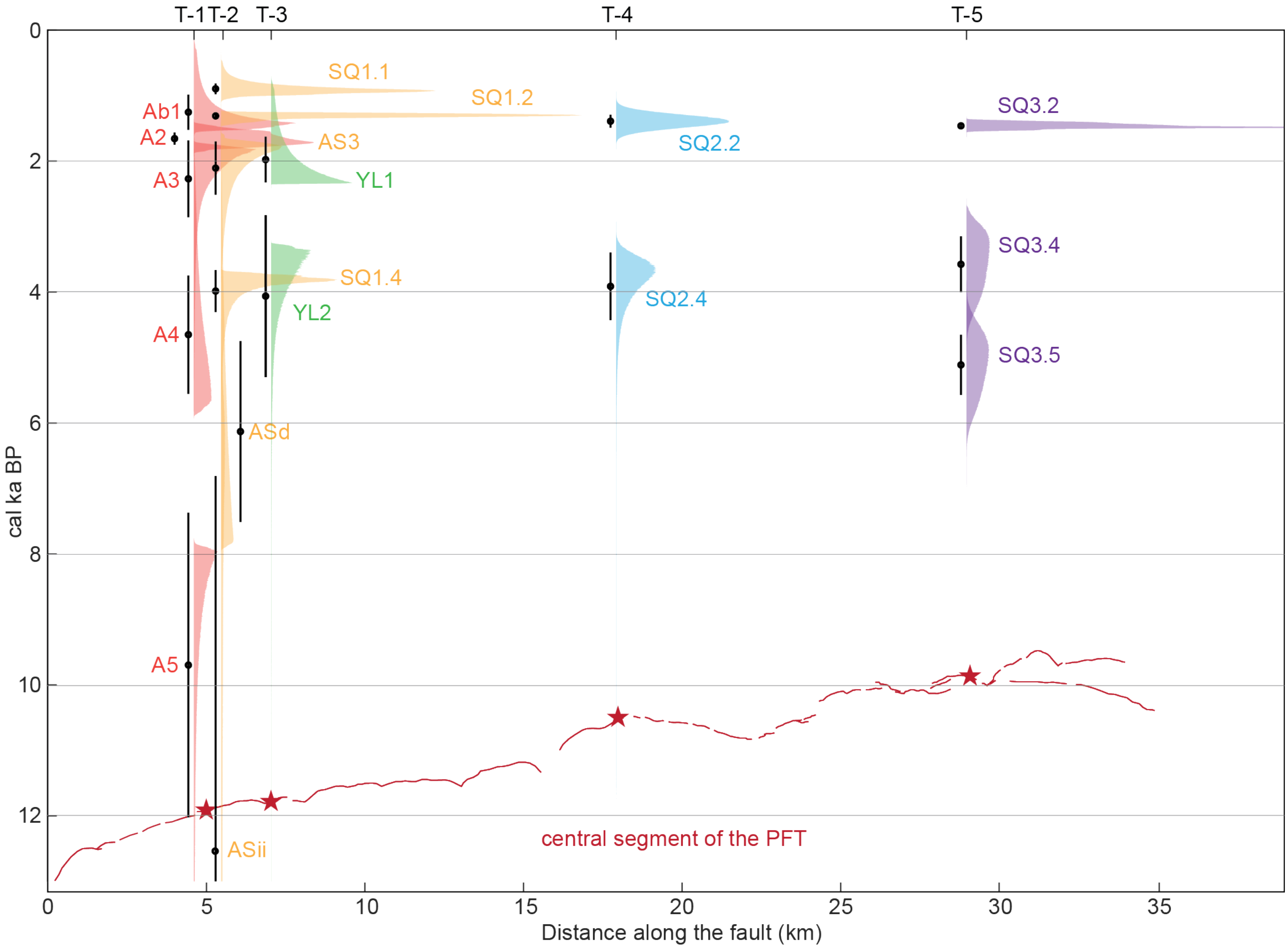






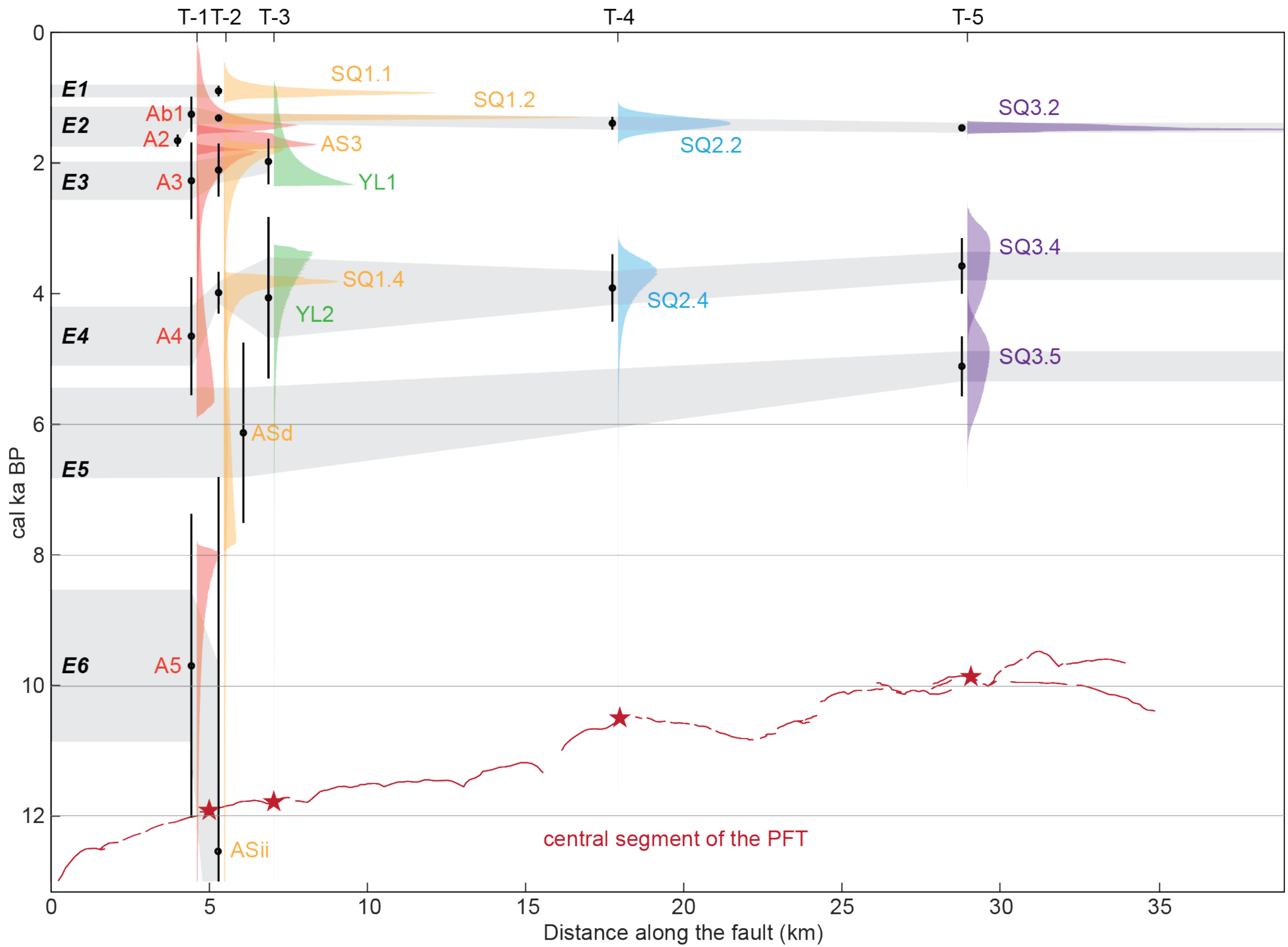
PALEOEARTHQUAKE TIMING: Central Segment

Intergration of paleoseismic data from each trench



PALEOEARTHQUAKE TIMING: Central Segment

Optical correlation of earthquake chronologies between all sites



PALEOEARTHQUAKE TIMING

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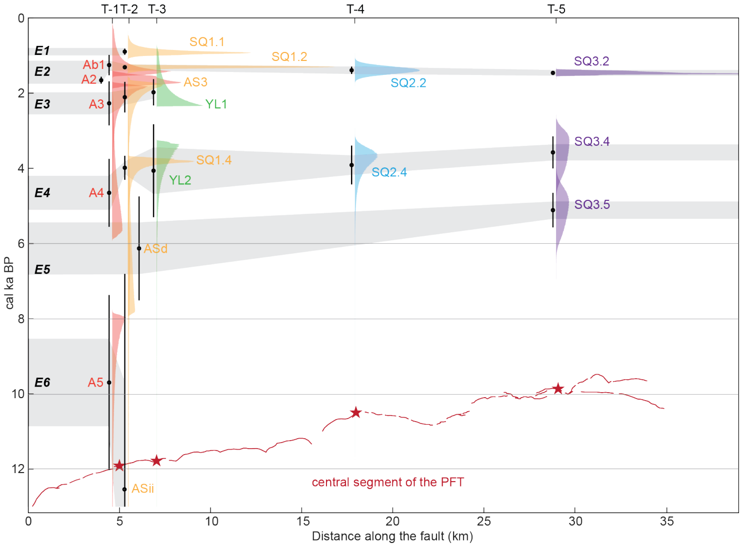
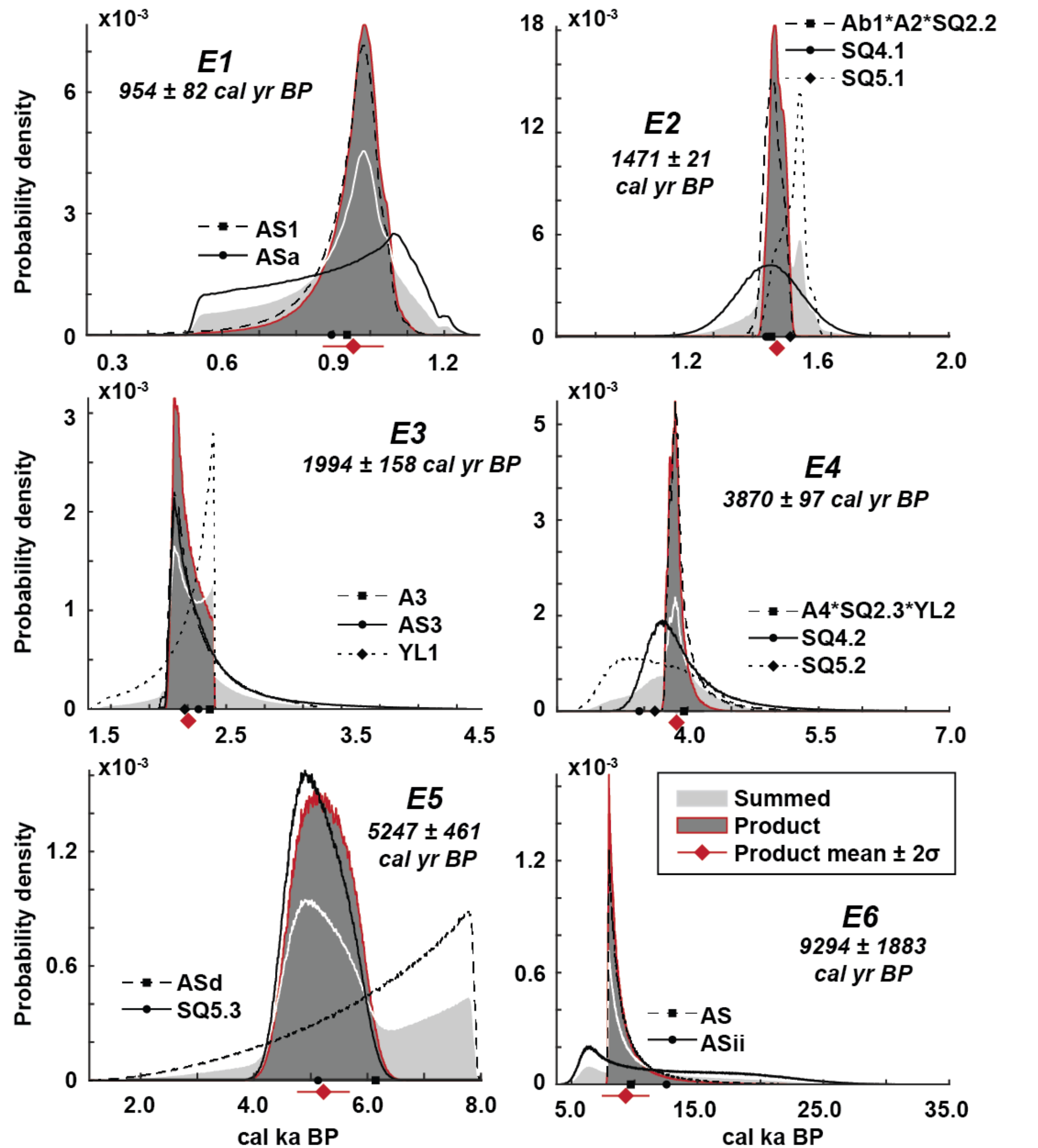
Optical correlation



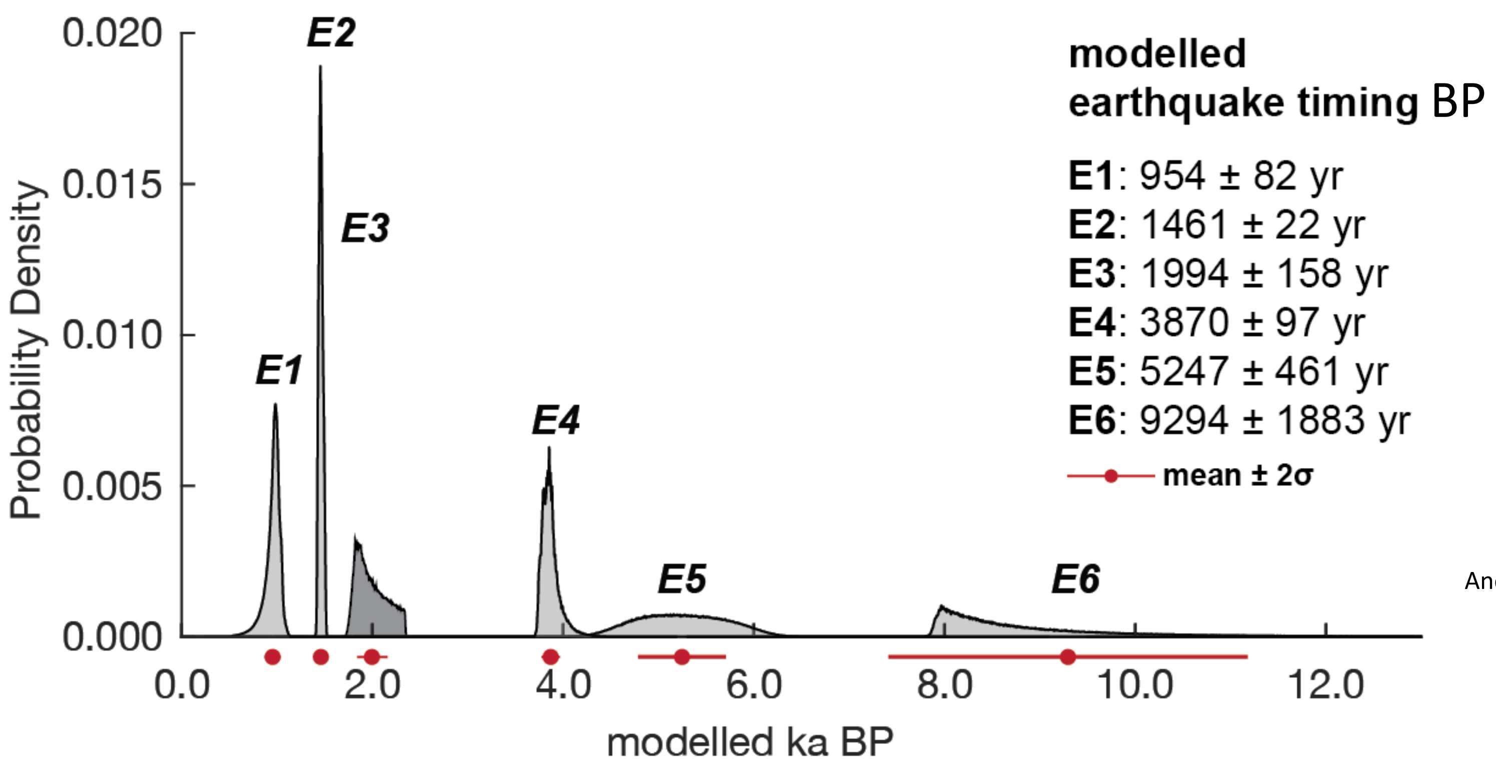


Multi-event PDF intergration

after Biasi & Weldon (2009) and DuRoss et al. (2012)

PALEOEARTHQUAKE TIMING

Revised chronology of surface-faulting during segment-wide earthquakes for the central segment of the PFT



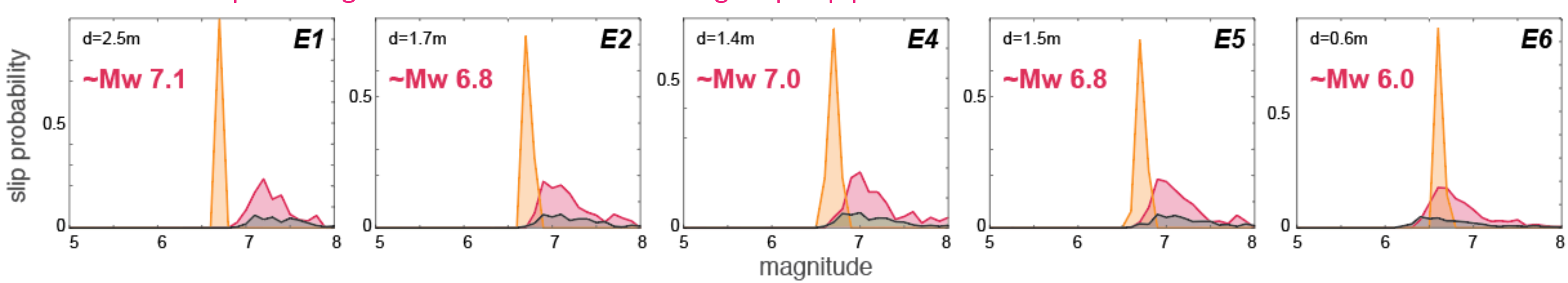
After Biasi and Weldon (2006)
And Wells and Coppersmith (1994)

all faulting
M = 6.93+0.82*log(D)

reverse faulting
M = 6.64+0.13*log(D)

all faulting updated
M = 6.94+1.14*log(D)

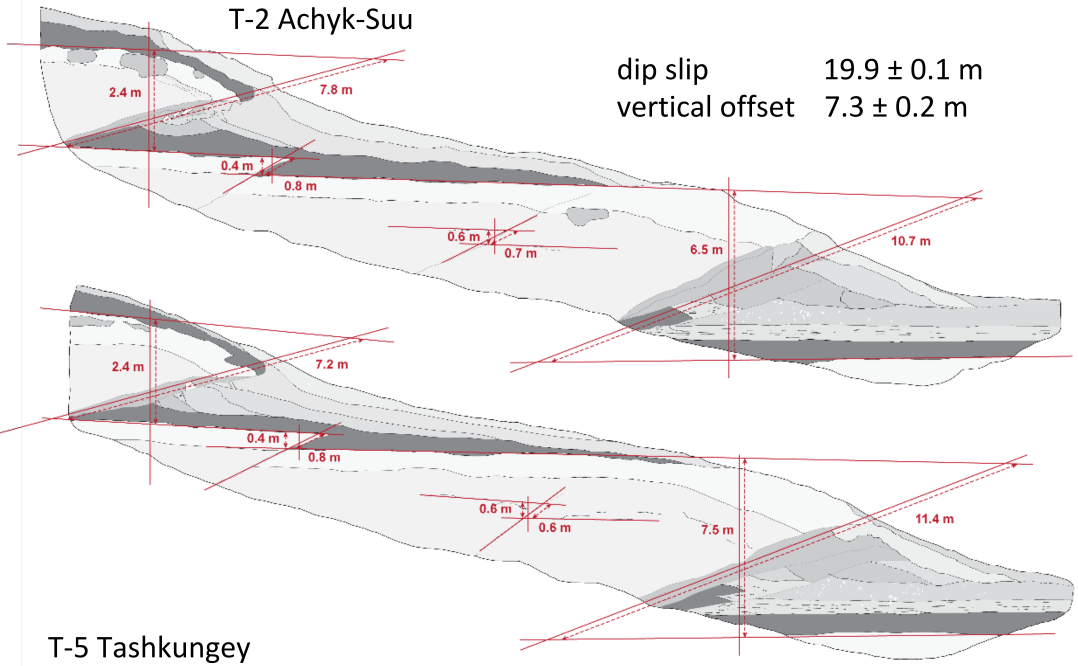
Probabilistic paleomagnitude estimates from average dip-slip per event from all trenches



CUMULATIVE DIP SLIP – SLIP RATE

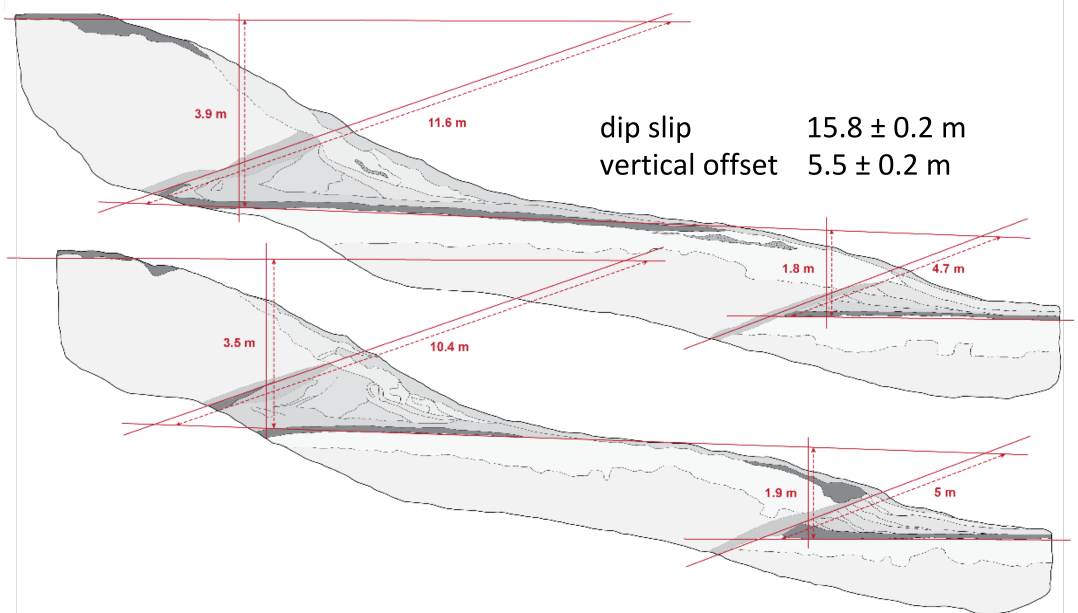
T-2 Achyk-Suu

dip slip 19.9 ± 0.1 m
vertical offset 7.3 ± 0.2 m

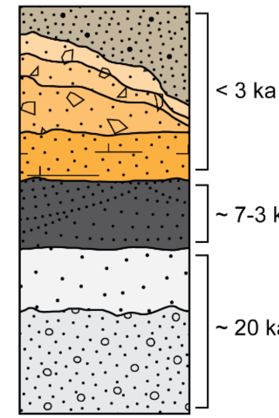


T-5 Tashkungey

dip slip 15.8 ± 0.2 m
vertical offset 5.5 ± 0.2 m



General stratigraphy along the central segment of the PFT

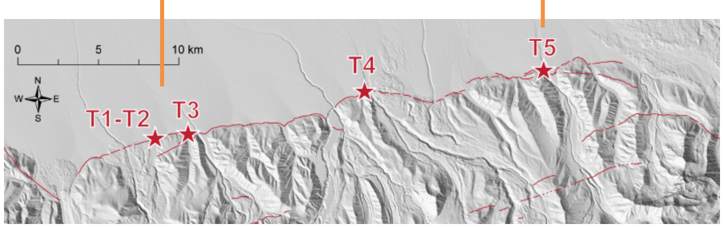


terrace formation age

~23.0 ka ~21.1 ka

retransported loess

~6.85 ka ~6.21 ka



CUMULATIVE DIP SLIP – SLIP RATE

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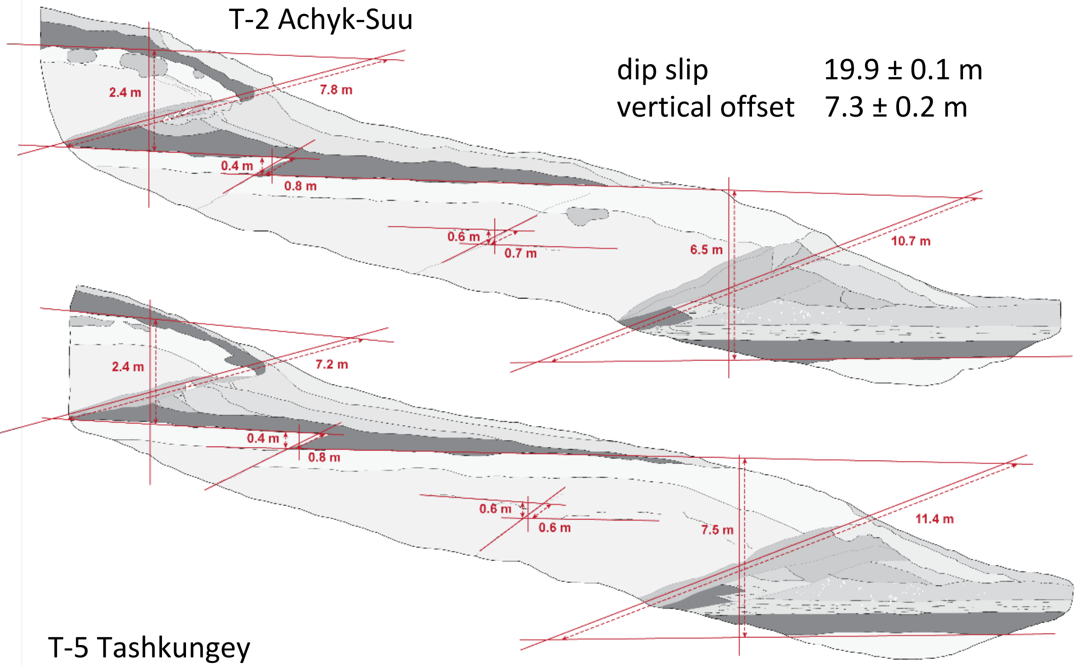
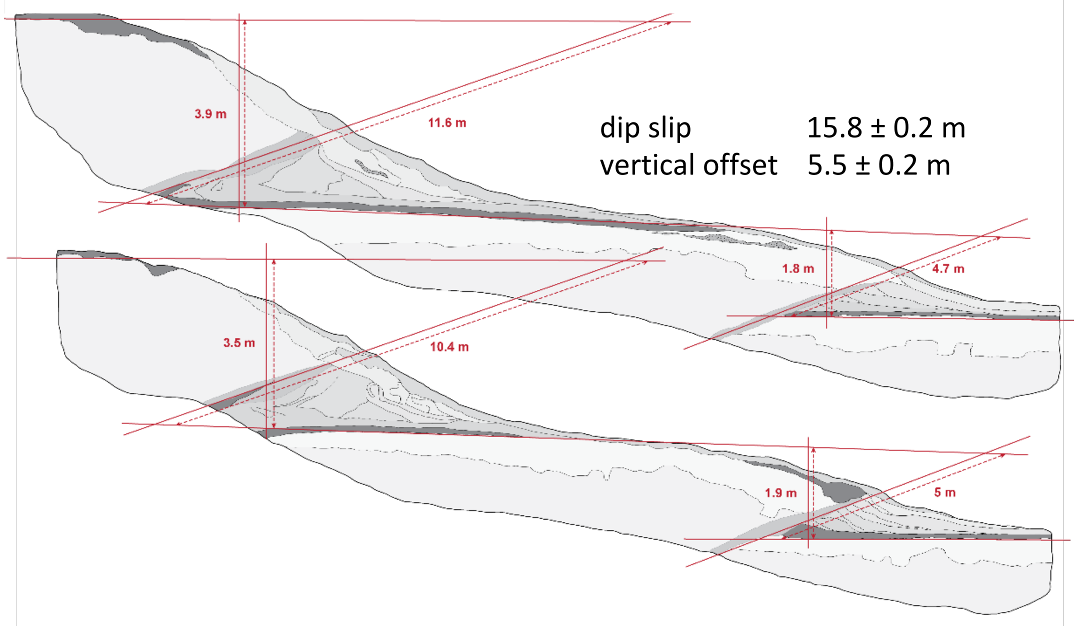
T-2 Achyk-Suu



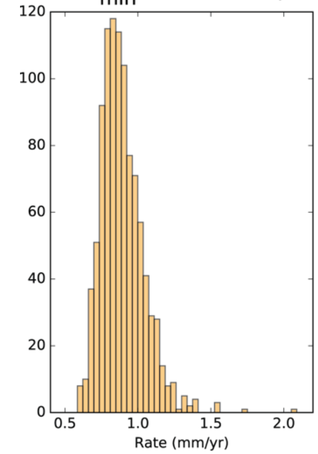
dip slip 19.9 ± 0.1 m
vertical offset 7.3 ± 0.2 m

T-5 Tashkungey

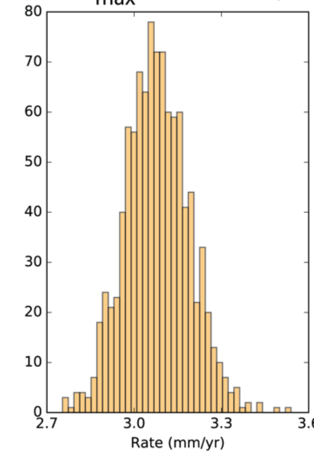


dip slip 15.8 ± 0.2 m
vertical offset 5.5 ± 0.2 m

T-2$_{min}$ 0.9 mm/yr

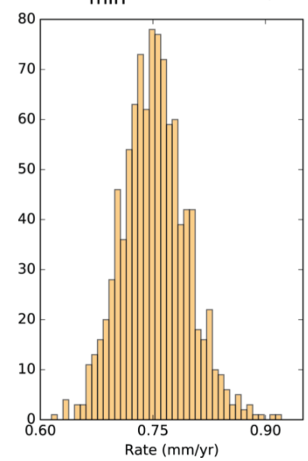


T-2$_{max}$ 3.1 mm/yr

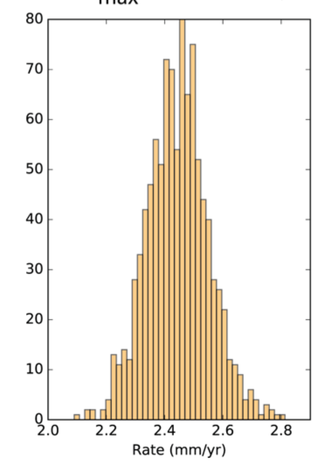


MIN - SLIP RATE - MAX

T-5$_{min}$ 0.8 mm/yr

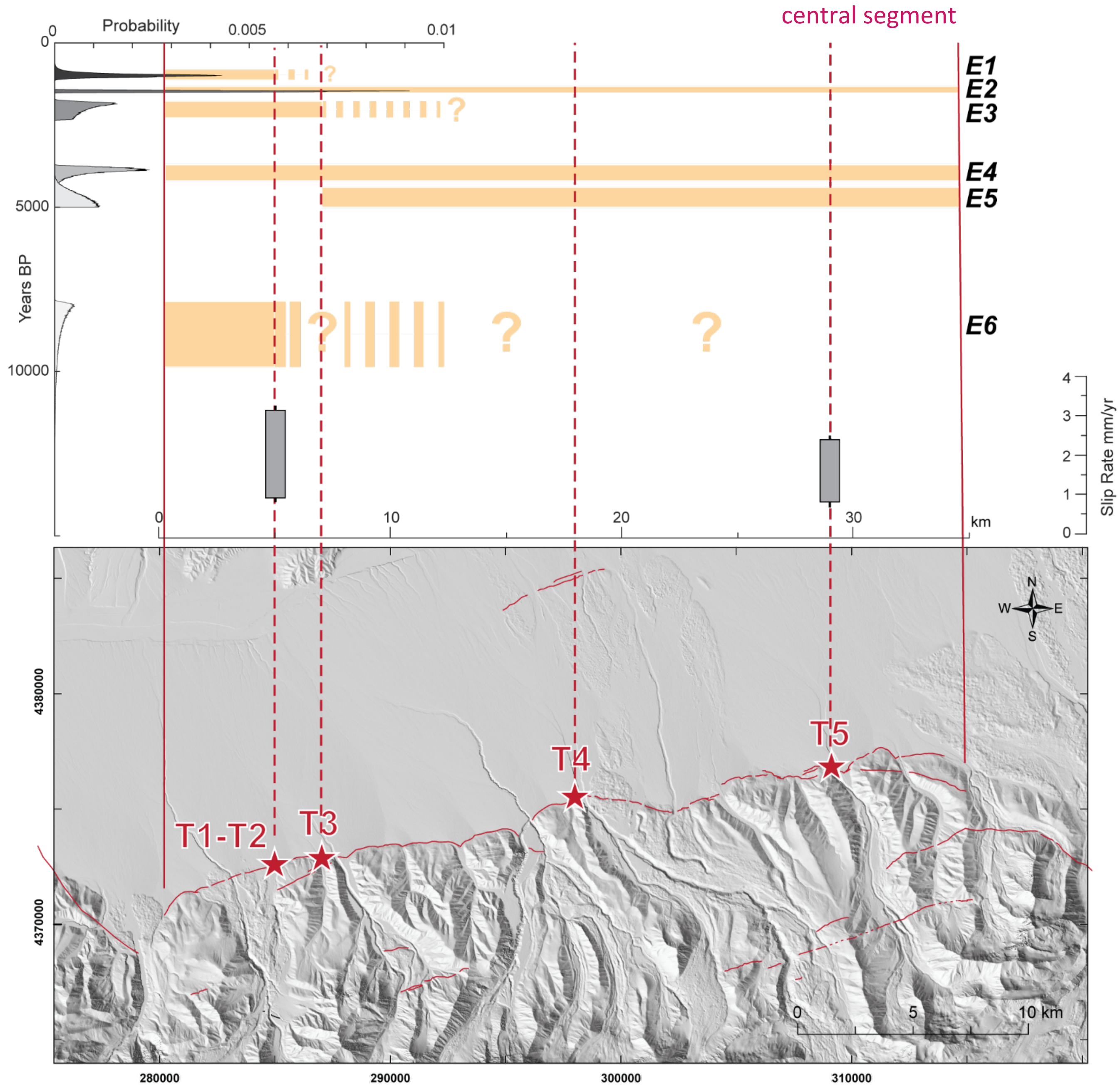


T-5$_{max}$ 2.4 mm/yr



probabilistic calculation: slip rate calculator 0.1.2 by Richard Styron

SUMMARY – segment-wide vs. partial segment ruptures



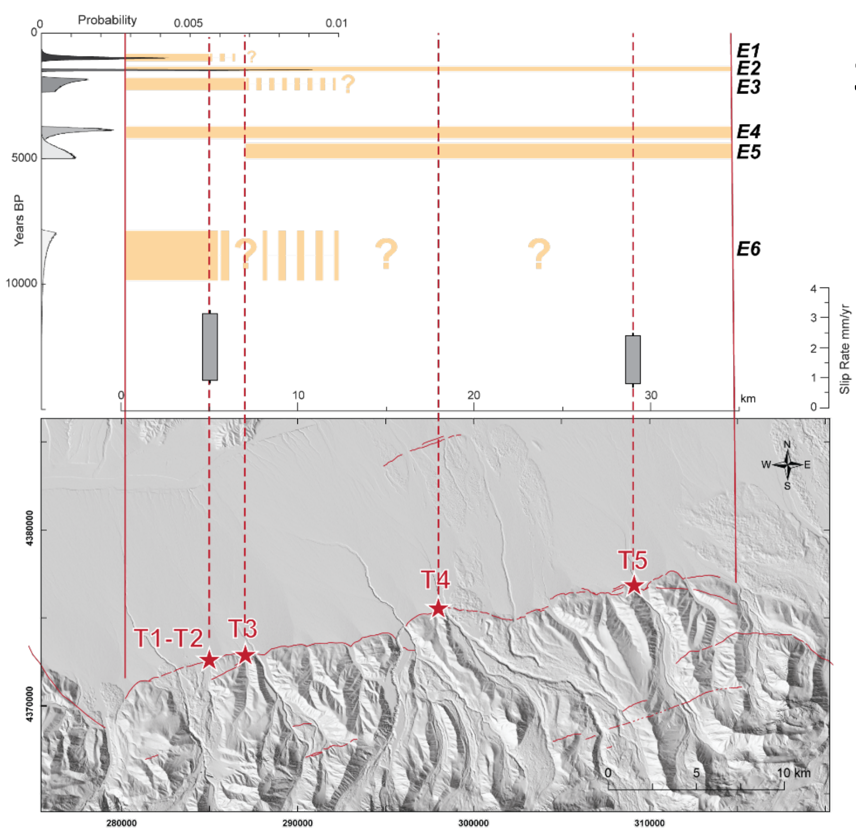
PRELIMINARY CONCLUSIONS

1. **Segment-wide maintenance of seismogenic rupture style**

   - at least 2 earthquakes ruptured along the entire length of the segment:
     E2: 1.4 ka BP and E4: 3.9 ka BP

2. **Partial rupture in the western part of the segment**

   - small earthquakes?
   - tail end of ruptures that initiated in the western segment?



3. **Slip-rate disparity**

   Short-term rate (**10 mm/yr**)
   vs.
   Long-term rate (**1-2 mm/yr**)

   - aseismic creep?
   - how is strain distributed in space an time?

THANK YOU!

EGU2020: Sharing Geoscience Online

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Central Asian Tectonics –Pamir, Tian Shan and Tibet from Paleozoic to Present

07 May, 2020