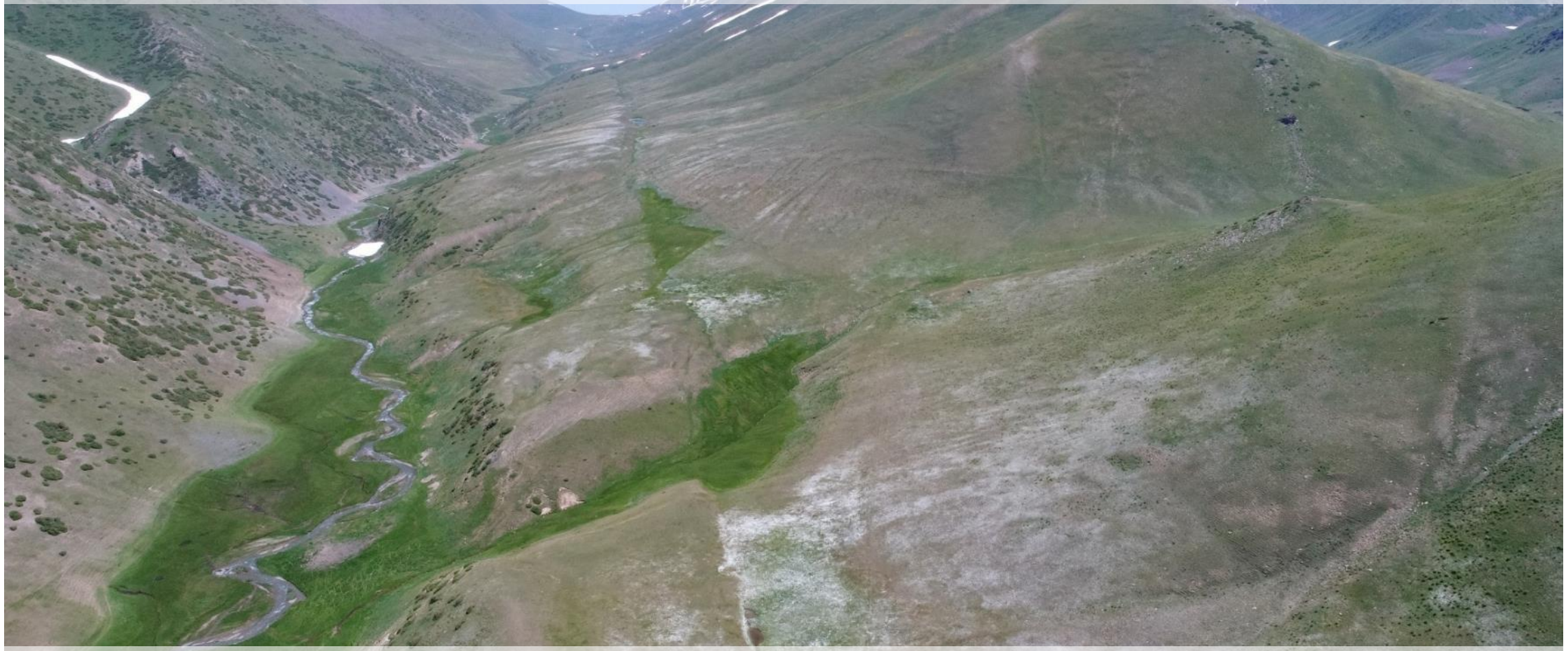
# Rates of slip from multiple quaternary dating methods and paleoseismic investigations along the Talas-Fergana Fault: tectonic implications for the Western Tien Shan Range



**Rizza M.**

**Abdrakhmatov, K., Walker R., Braucher R., Guillou V., Carr A.S. , Campbell G., McKenzie D., Jackson J., Dubois C., Fleury J., Pousse L., Baikulov S., Rahimdinov E. , Tron F. and ASTER Team**

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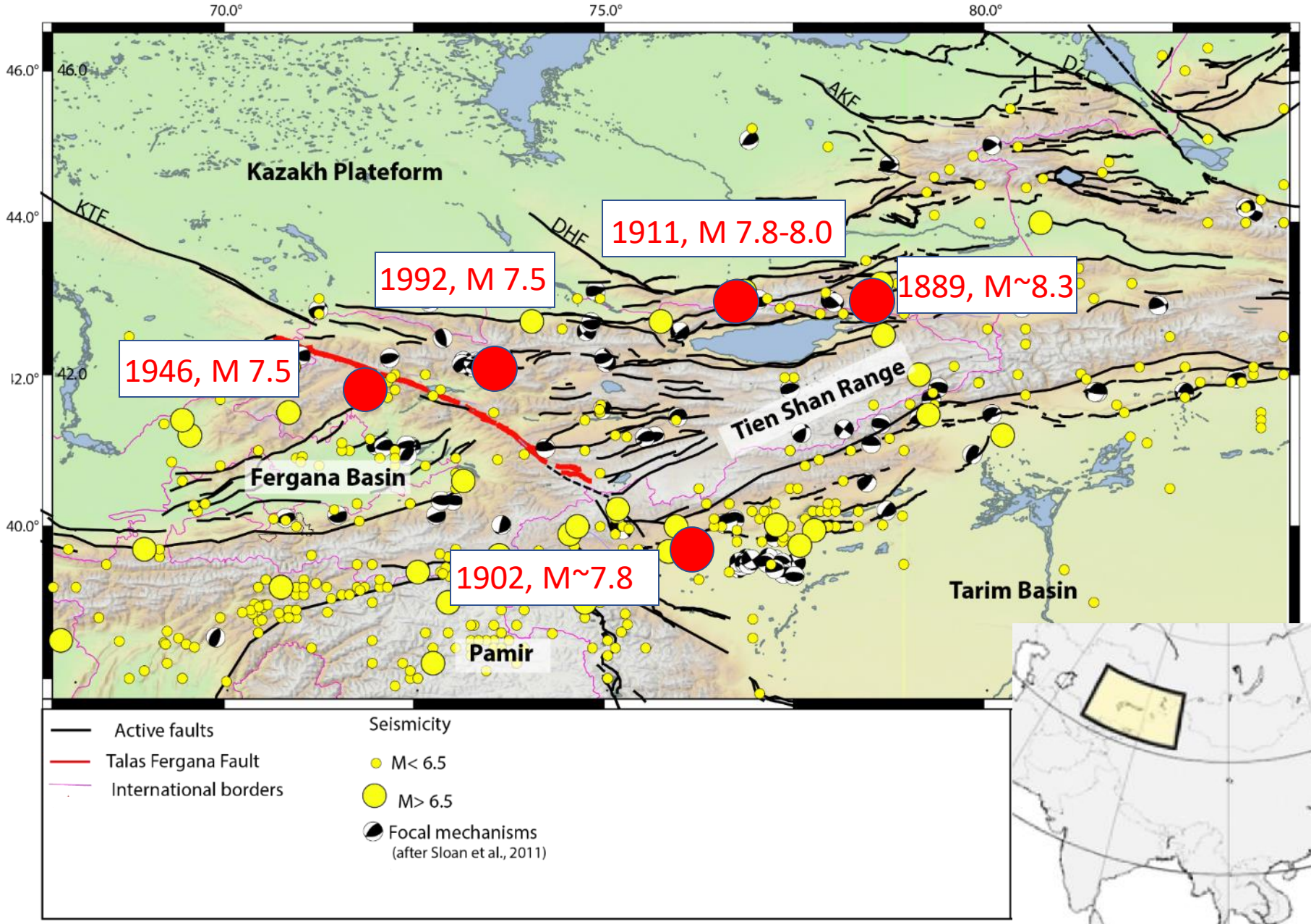
# Tectonic settings

Talas-Fergana Fault

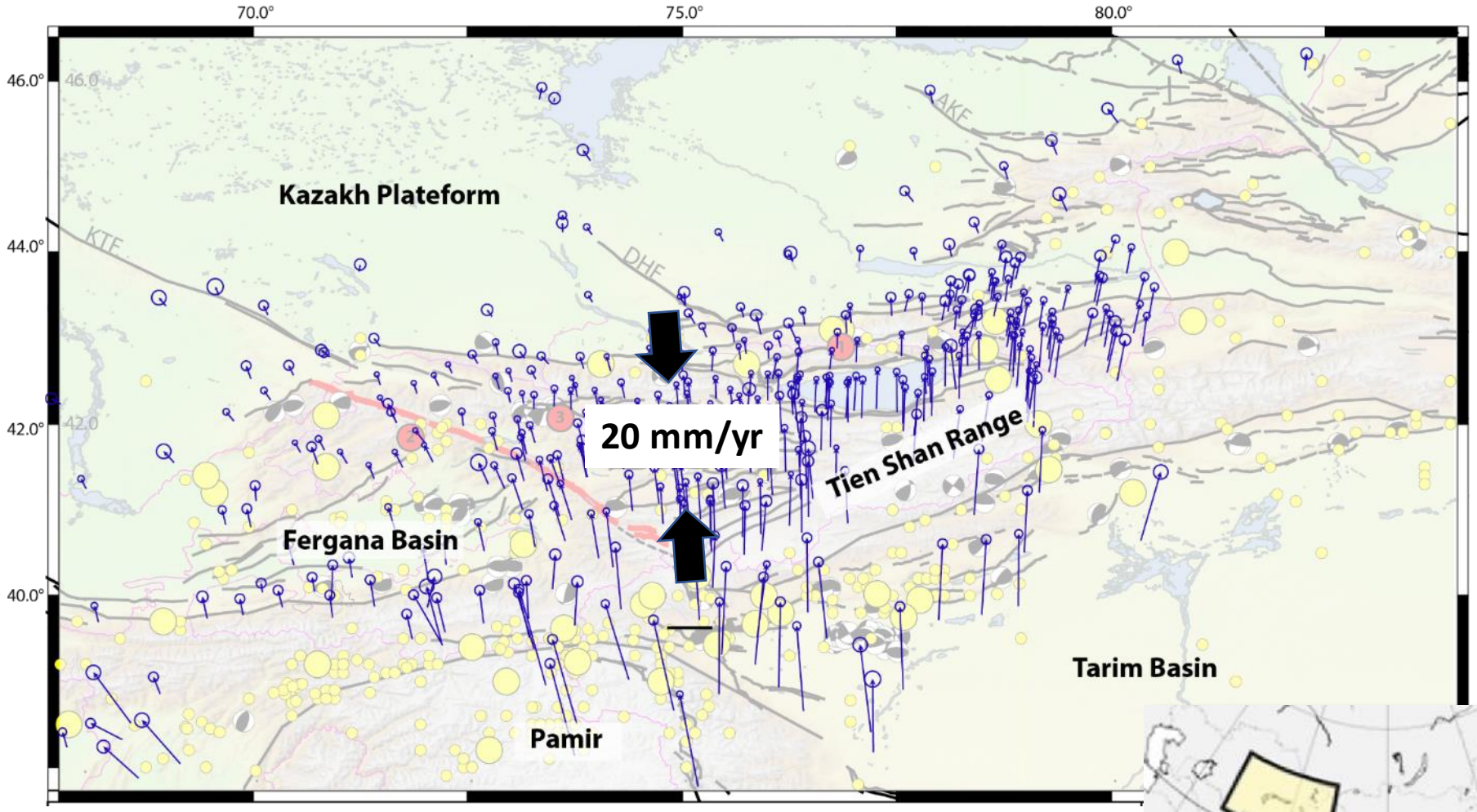




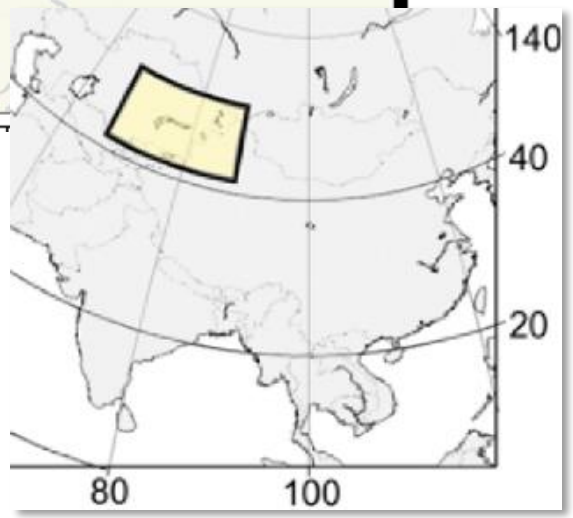


No large earthquakes reported in historical and instrumental periods along the TFF

# Tectonic settings



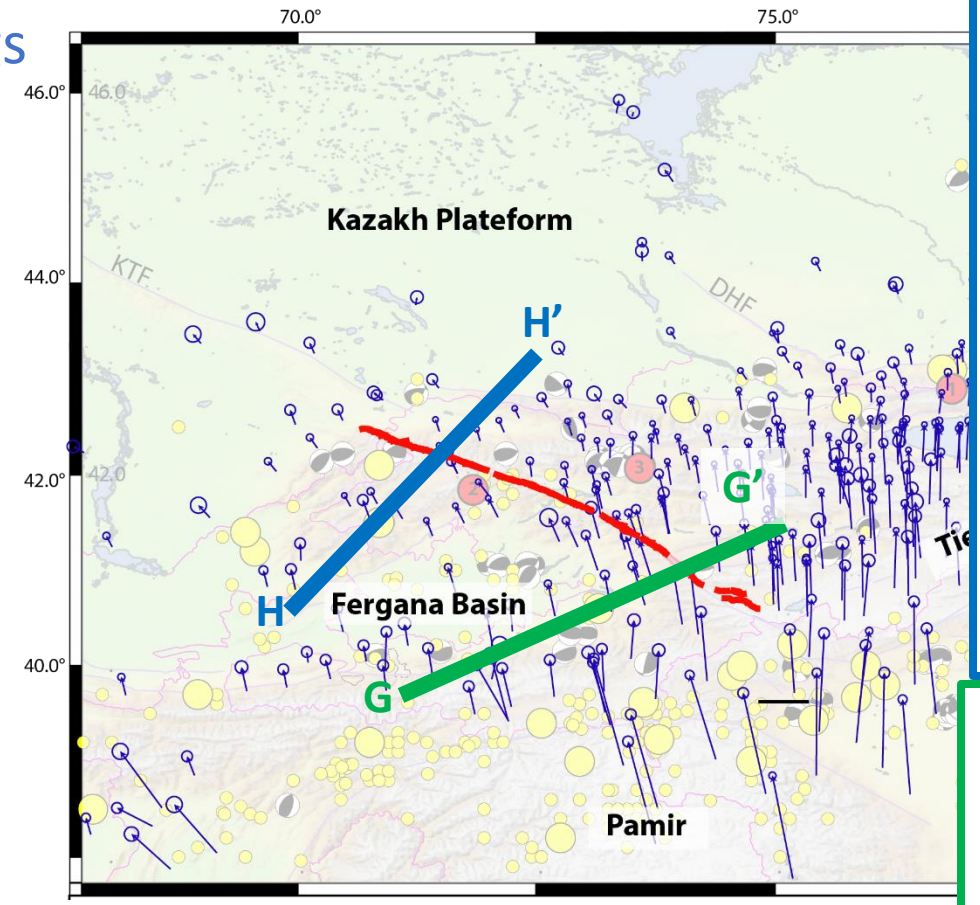

*GPS data from Zubovich et al. (2010)*



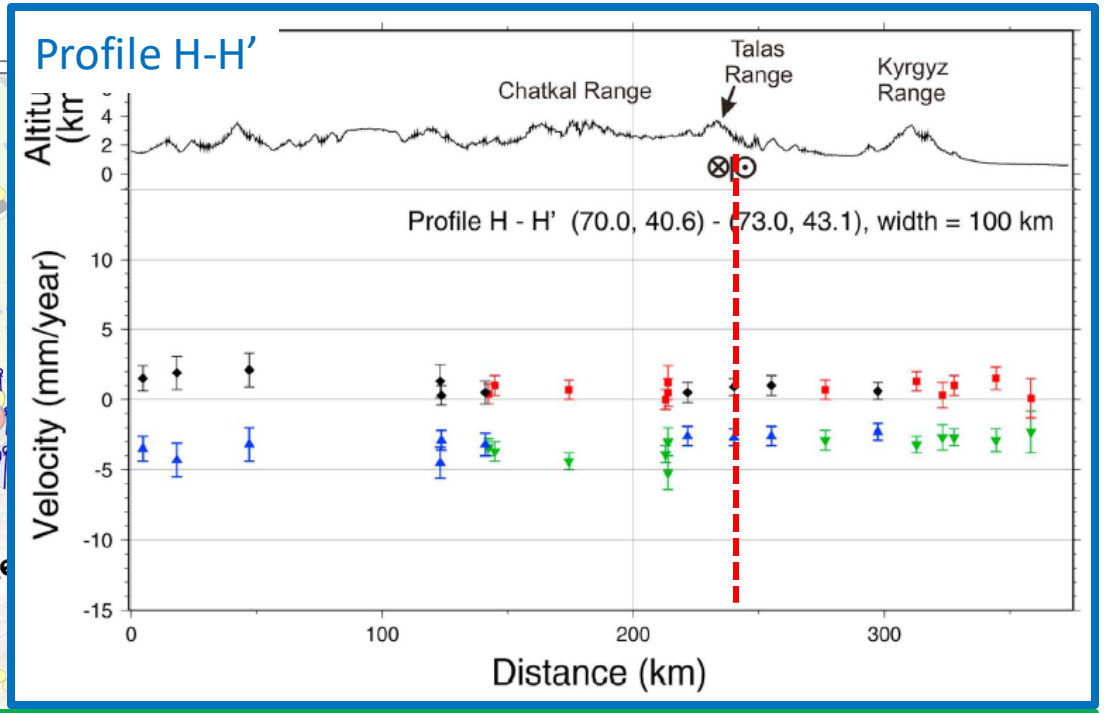

GPS rate across the Range is ~ 20 mm/yr

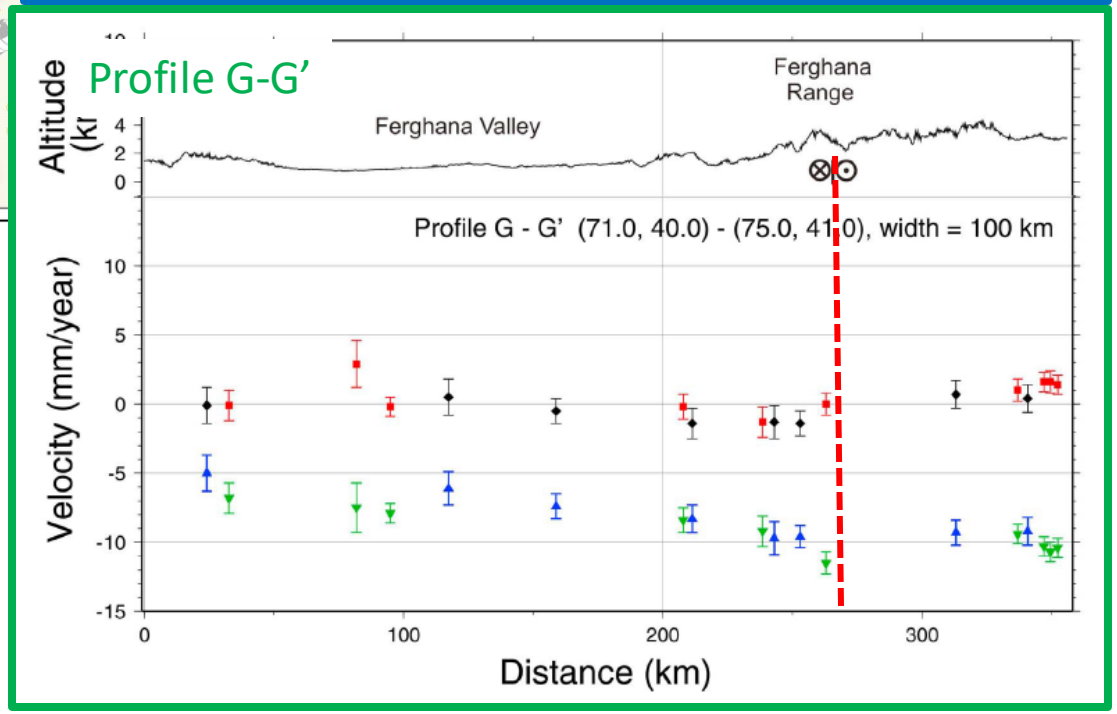
Deformation is accomodated across series of faults with millimetric rates

# Tectonic settings
# GPS rates



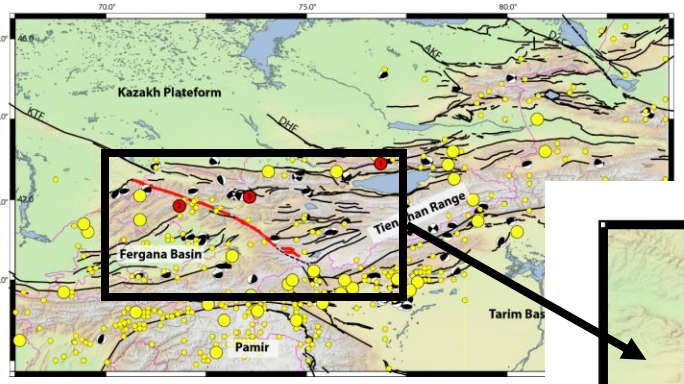

*GPS data from Zubovich et al. (2010)*

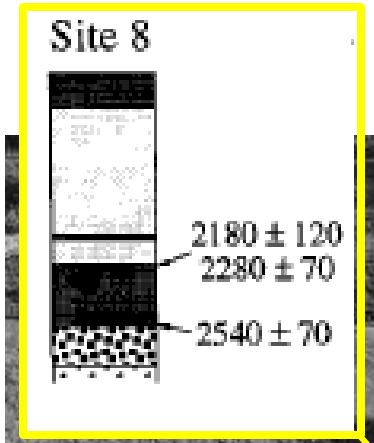



Low GPS rates ~2 mm/yr

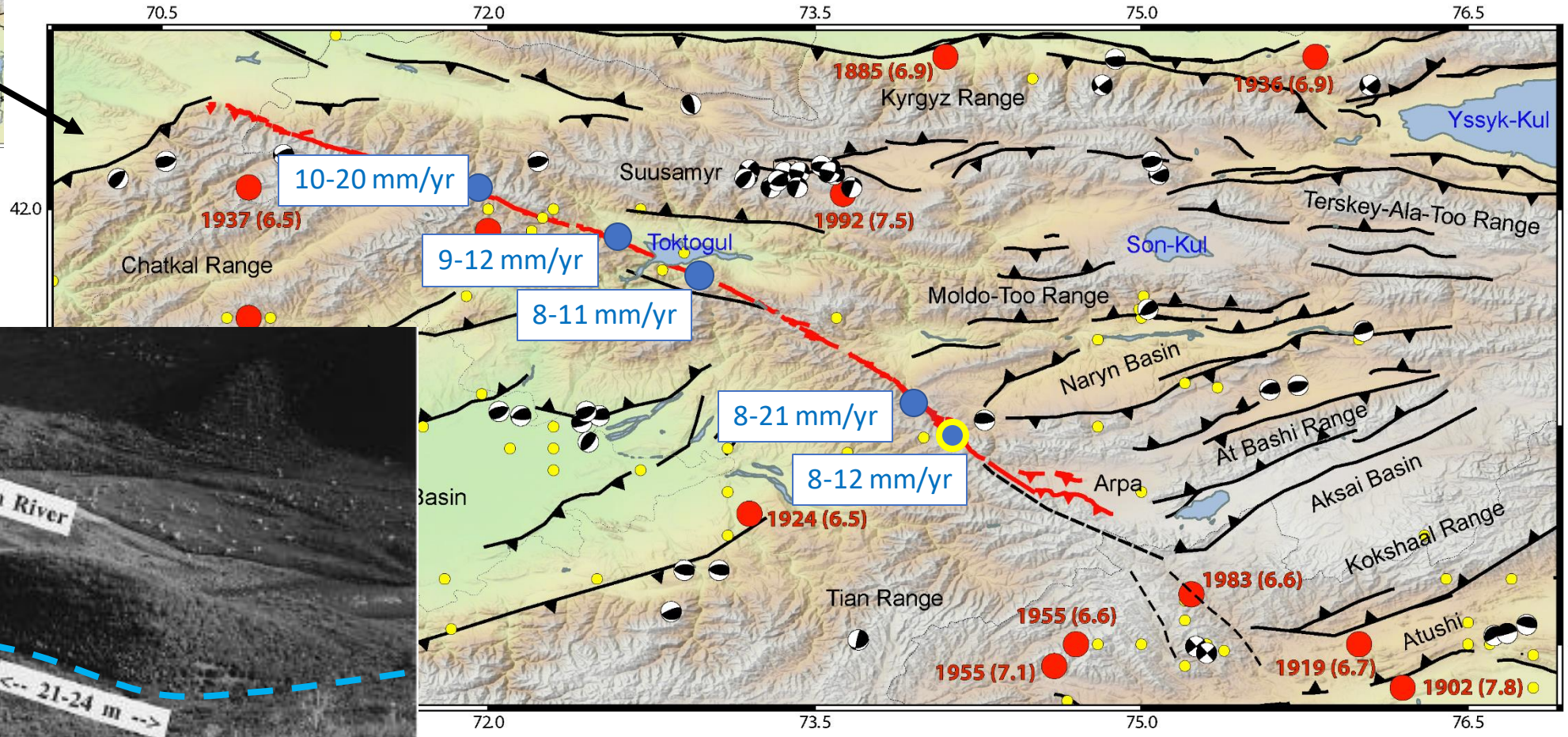
# Tectonic settings – Geological slip rates



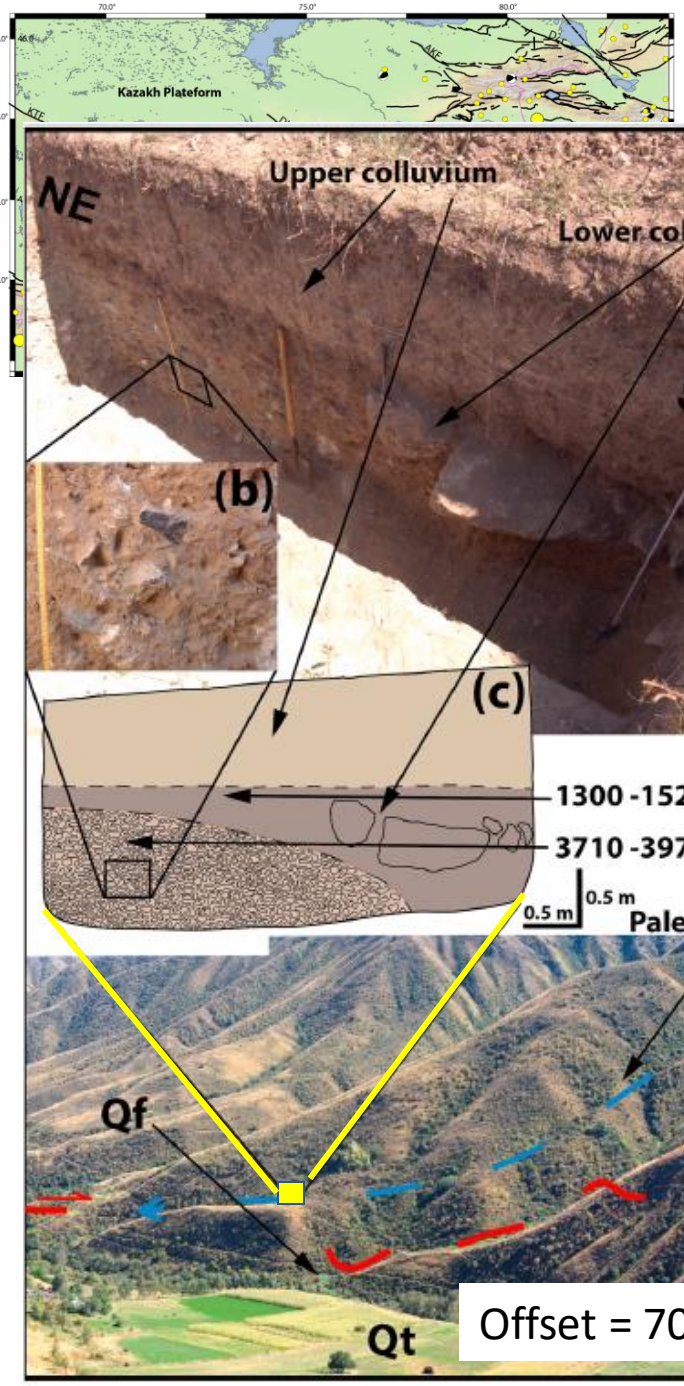


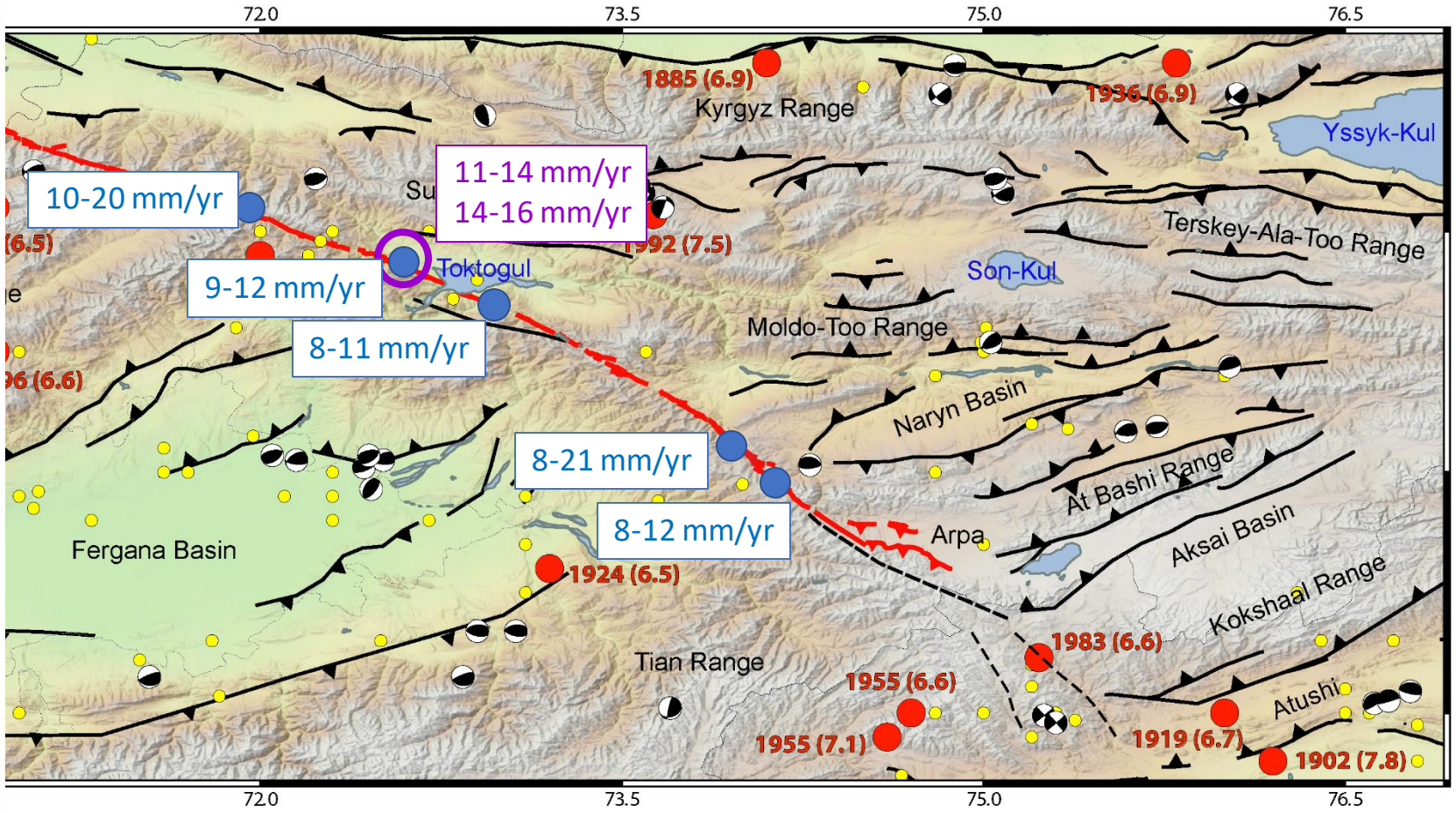





Slip rates determined by Burtman et al., 1996

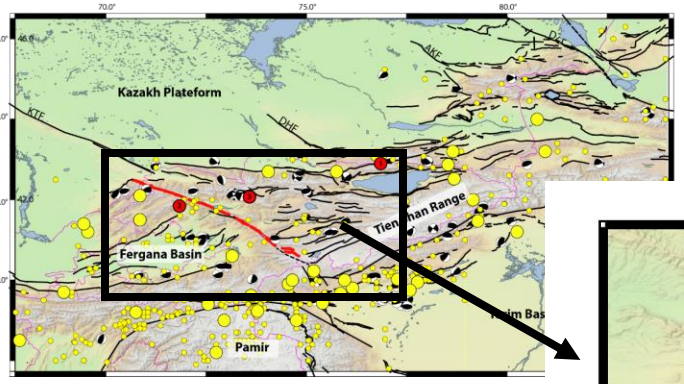
# Tectonic settings – Geological slip rates

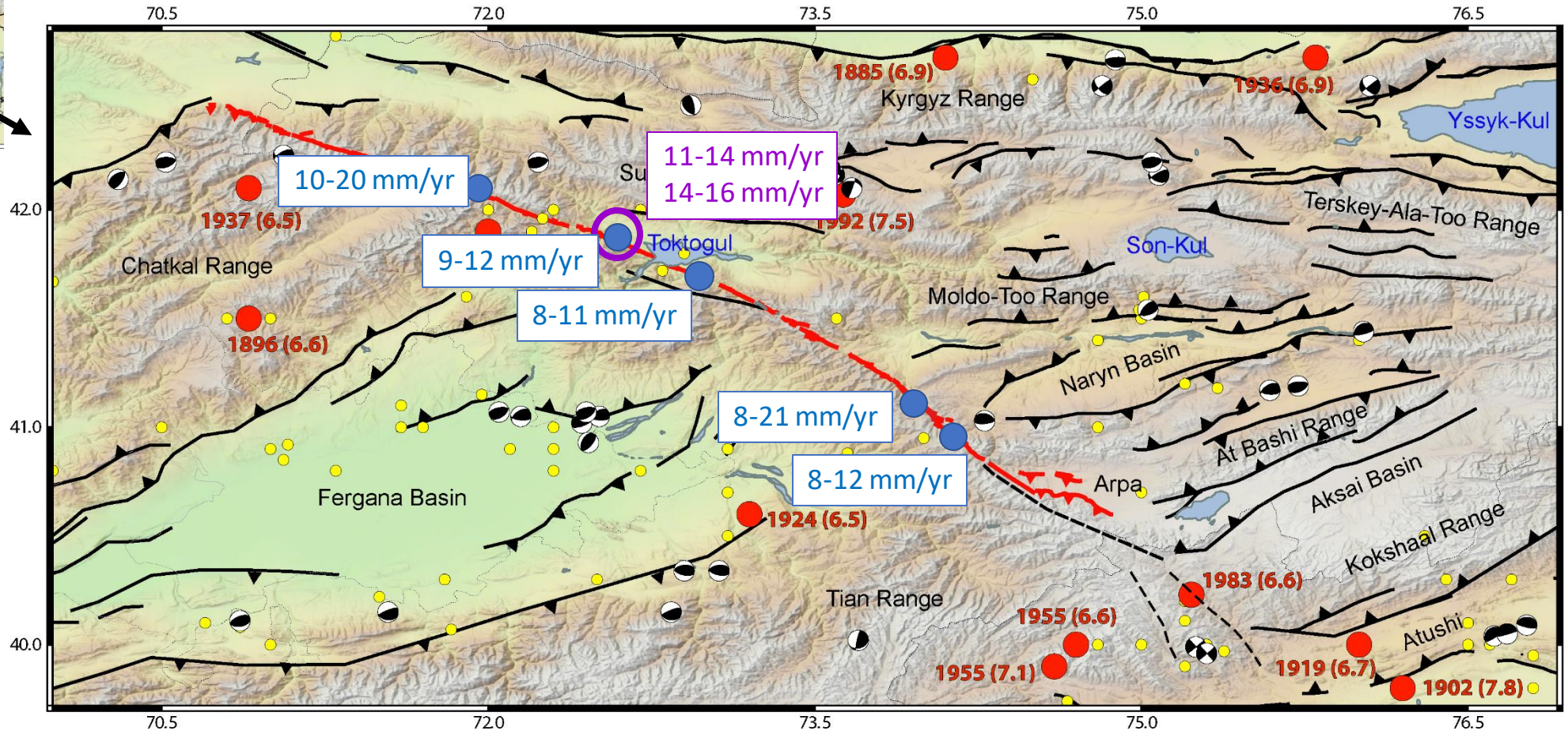



Slip rates determined by Rust et al., 2018

# Mismatch with Geodetic slip rates and seismicity?



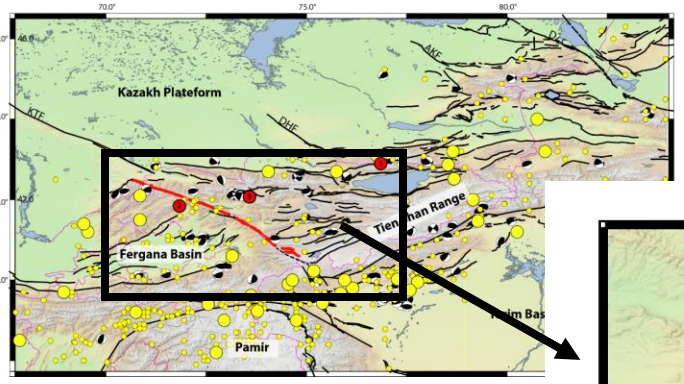



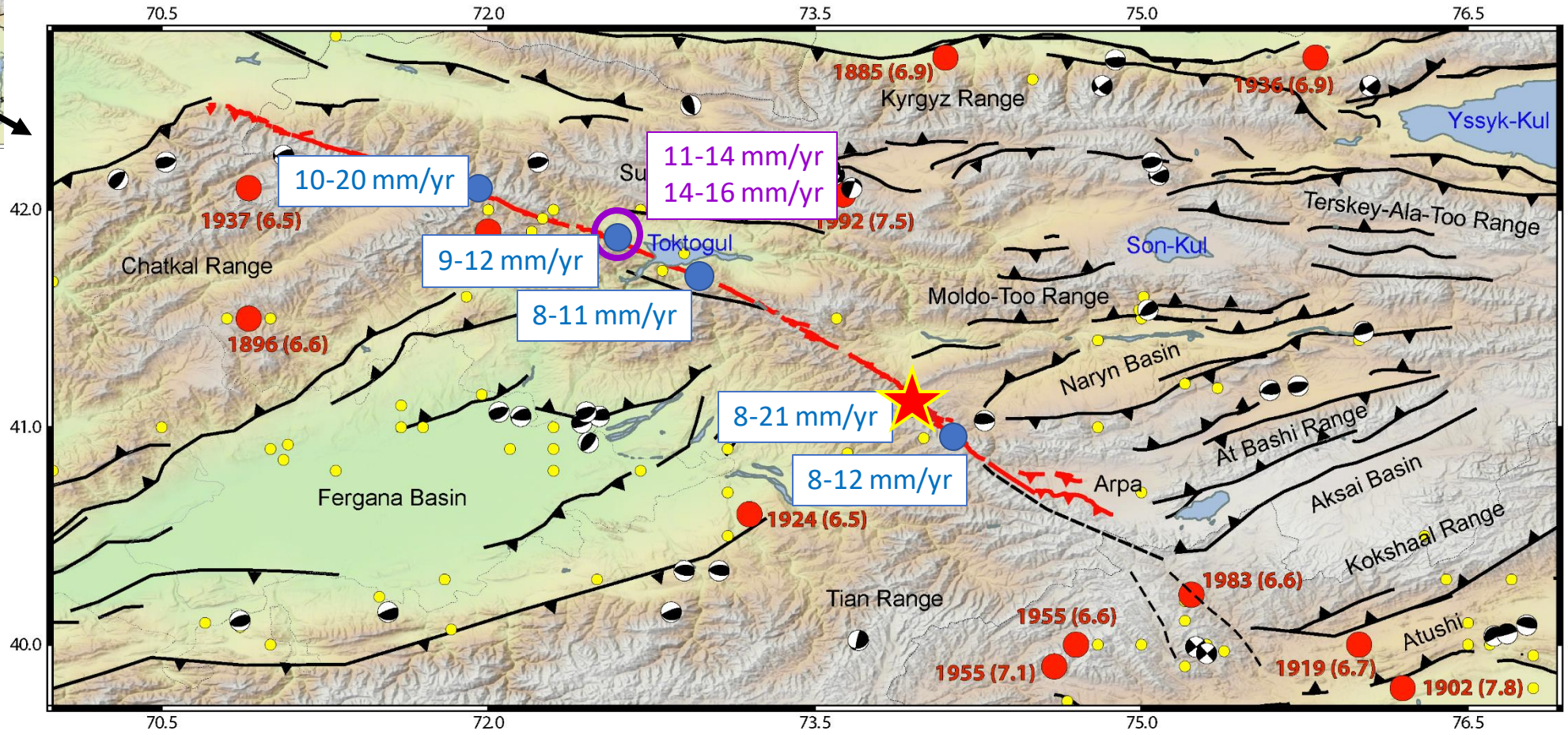

With a slip rate between 11 to 16 mm/yr :

→ Recurrence time between 310 - 450 years (if we consider a characteristic offset of ~5m)

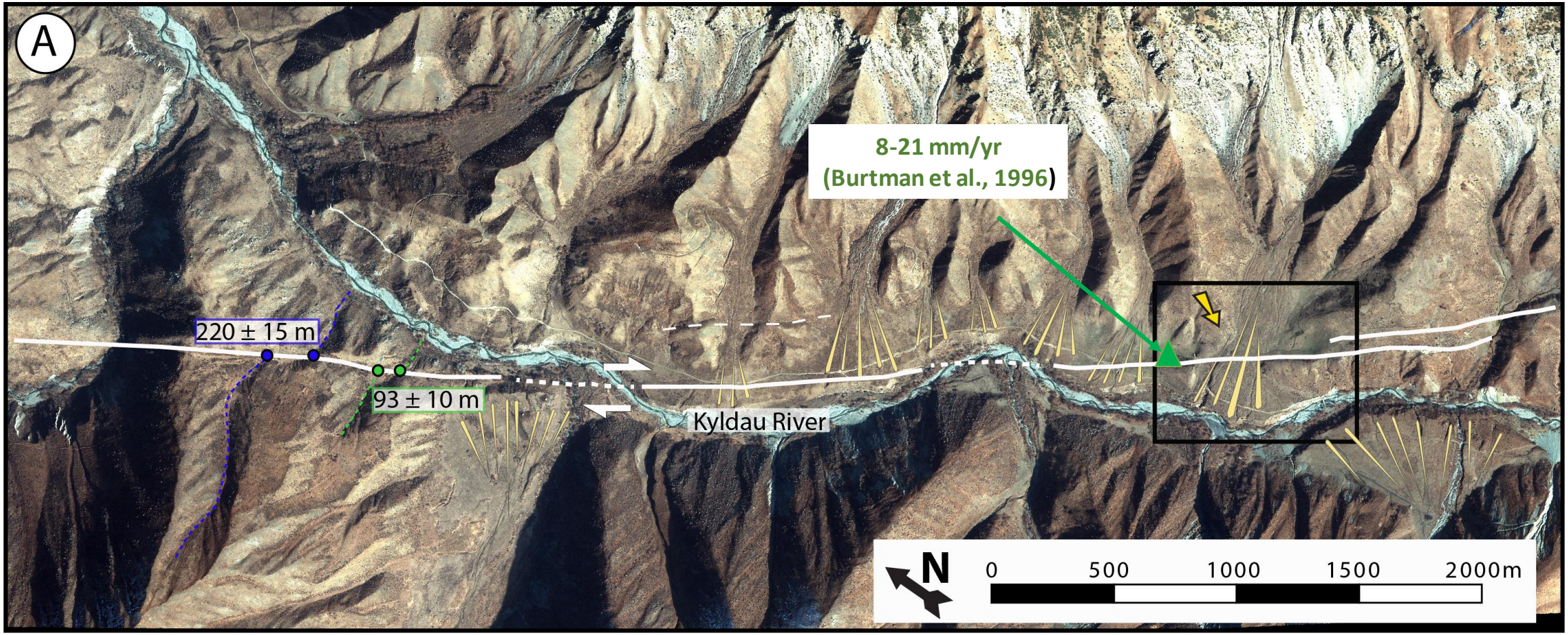
→ Recurrence time between 625 - 910 years (if we consider a characteristic offset of ~10m)

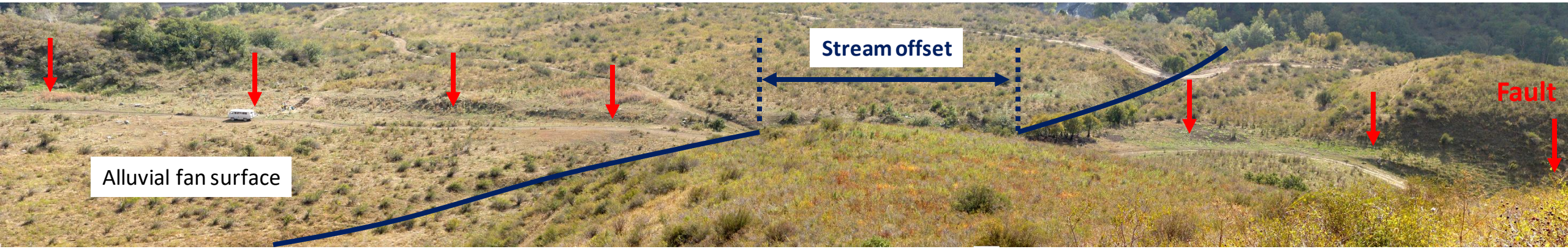
# Mismatch with Geodetic slip rates?




→ New paleoseismic investigations to determine geological slip rates


A
8-21 mm/yr
(Burtman et al., 1996)
220 ± 15 m
93 ± 10 m
Kyldau River
N
0
500
1000
1500
2000m


Stream offset
Fault
Alluvial fan surface

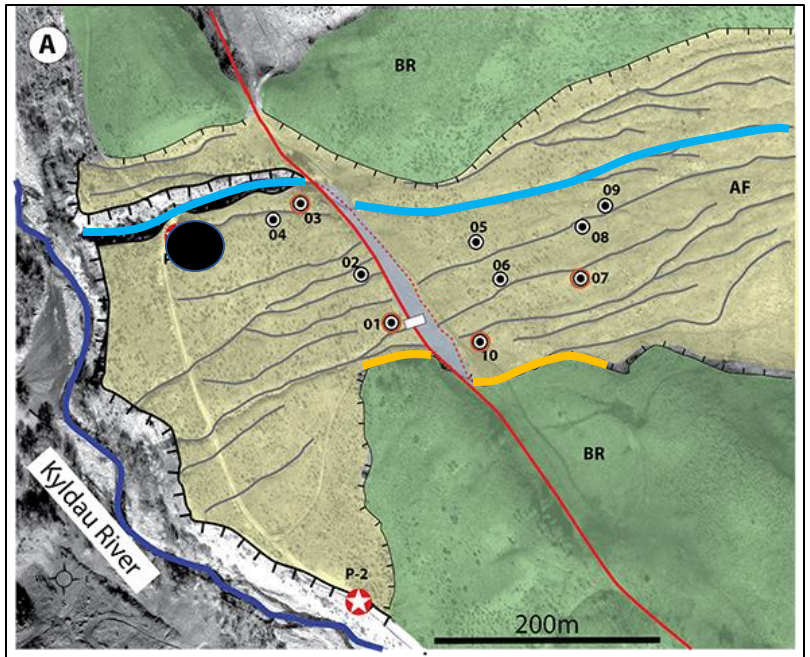
# Quaternary Geochronological dating

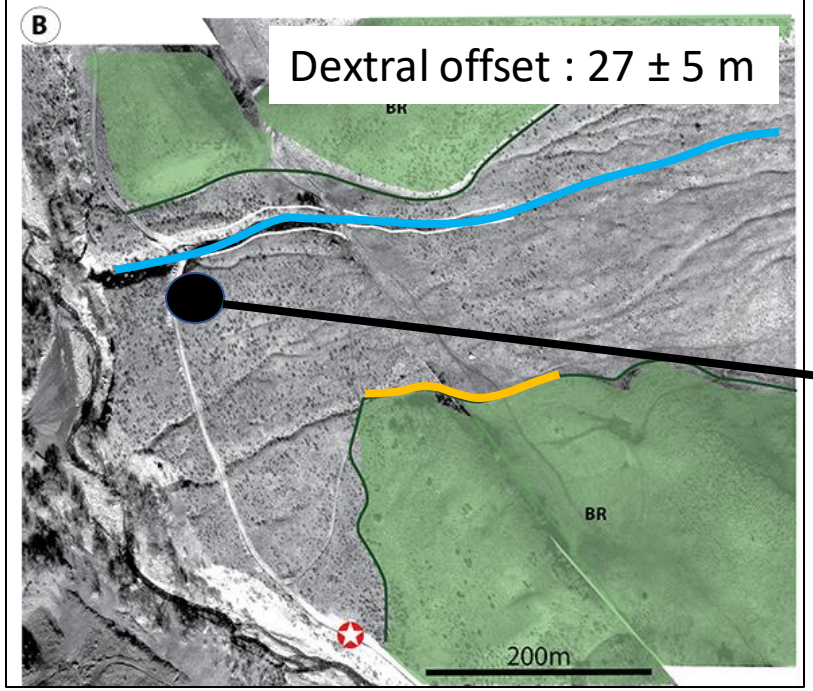
Cosmogenic dating

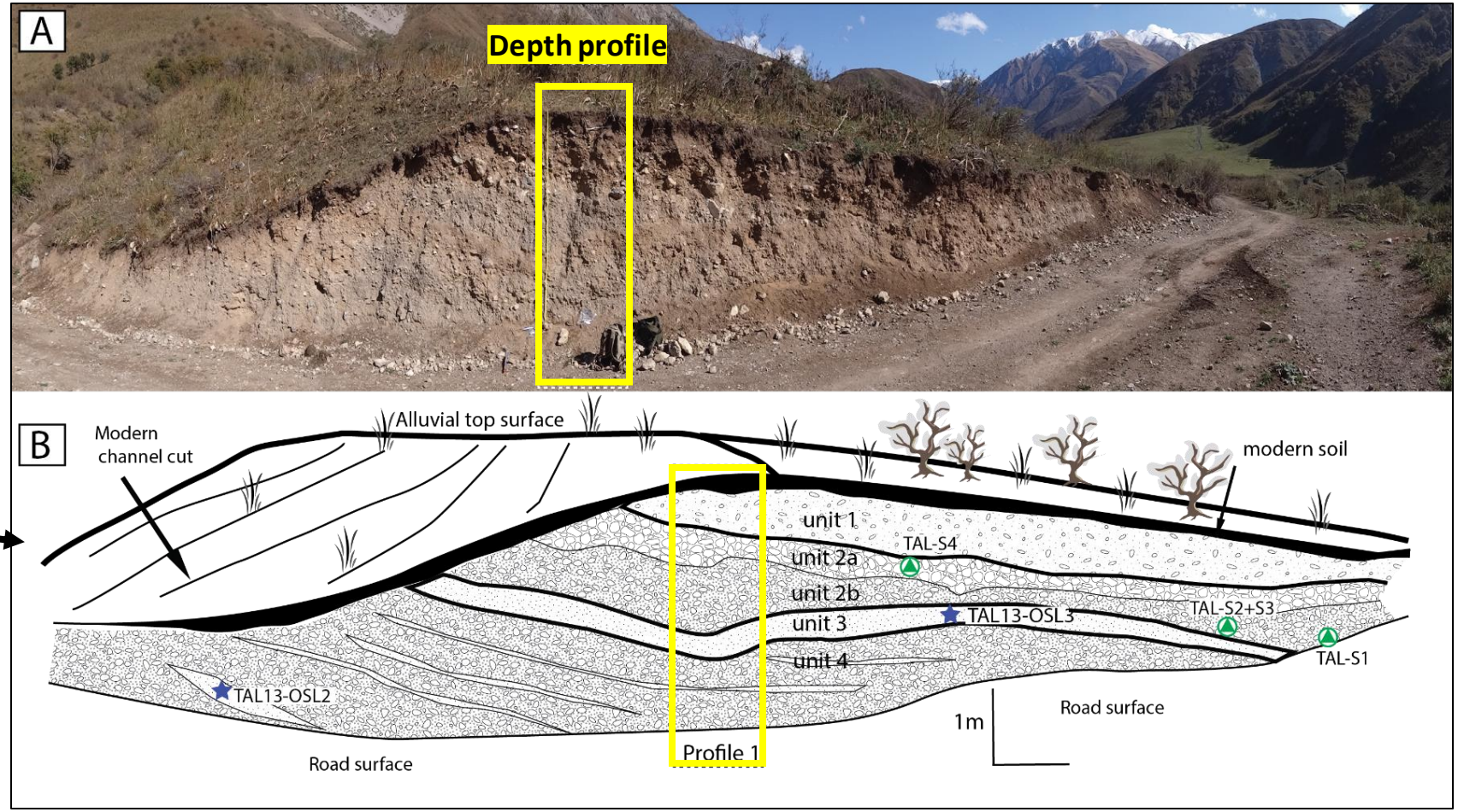
- $^{10}Be$
- $^{26}Al$
- $^{36}Cl$

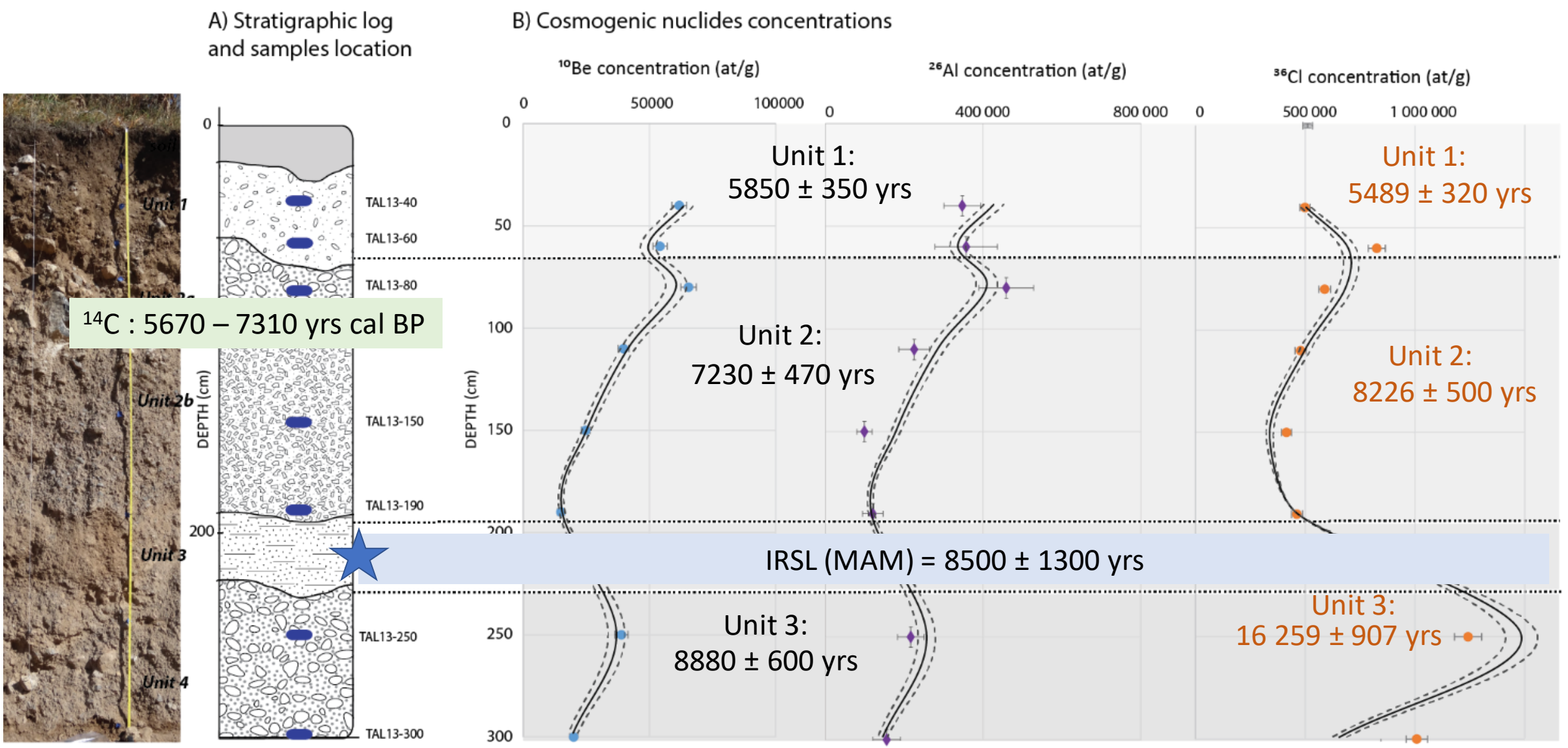
Luminescence dating

$^{14}C$ sampling



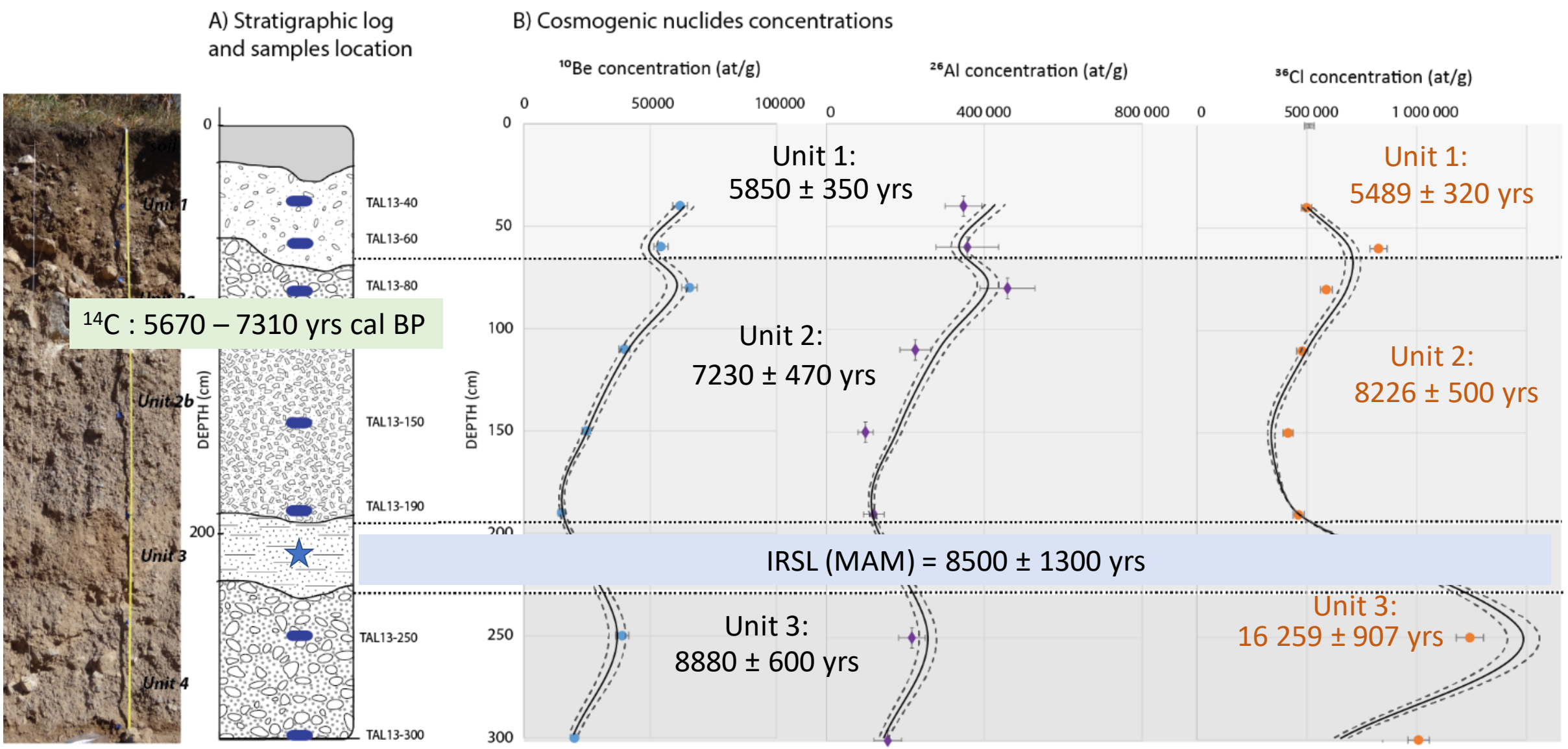






the Cl concentrations between 150 ppm and 305 ppm

TAL13-300 the $^{36}$Cl production by the mechanism of neutron capture represents 67.4 % of the total $^{36}$Cl production

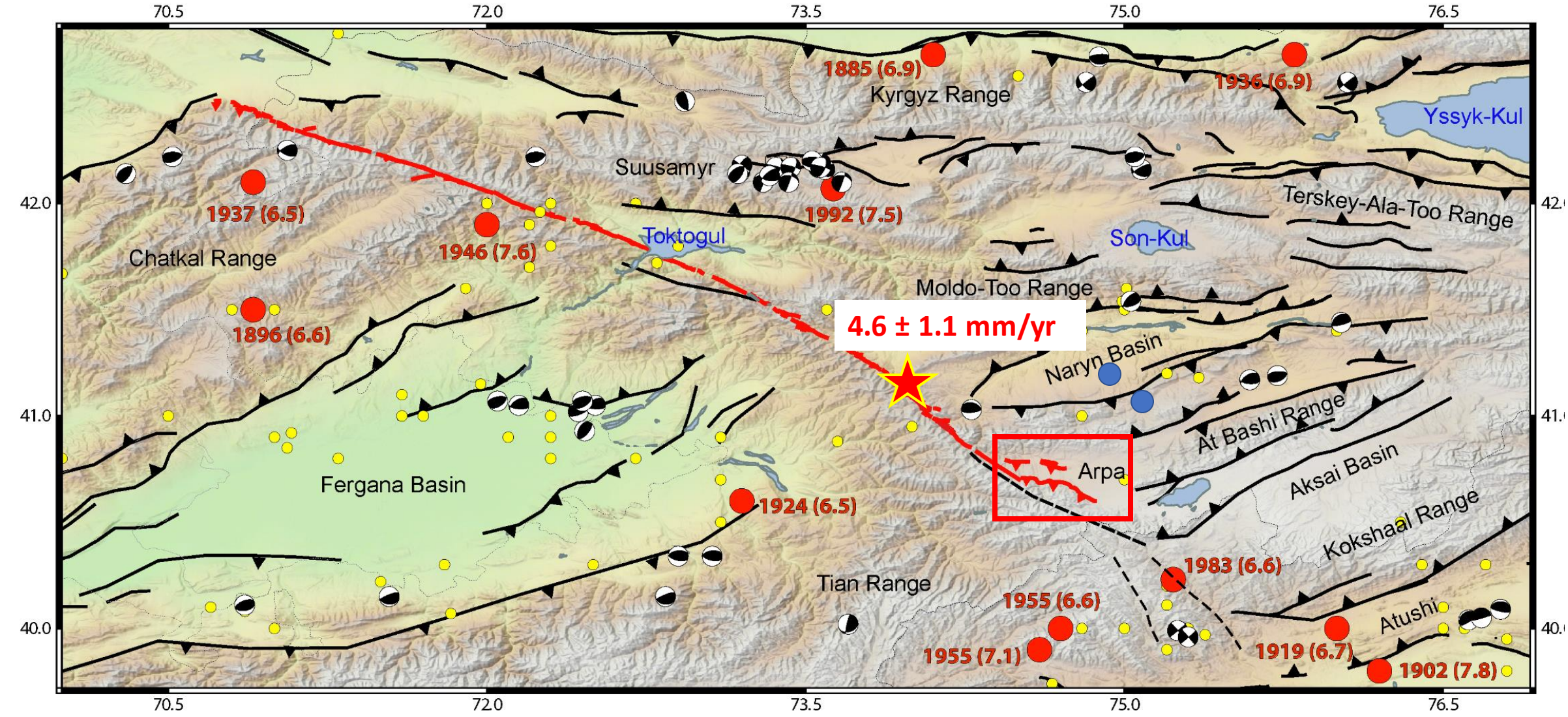
→ overestimation

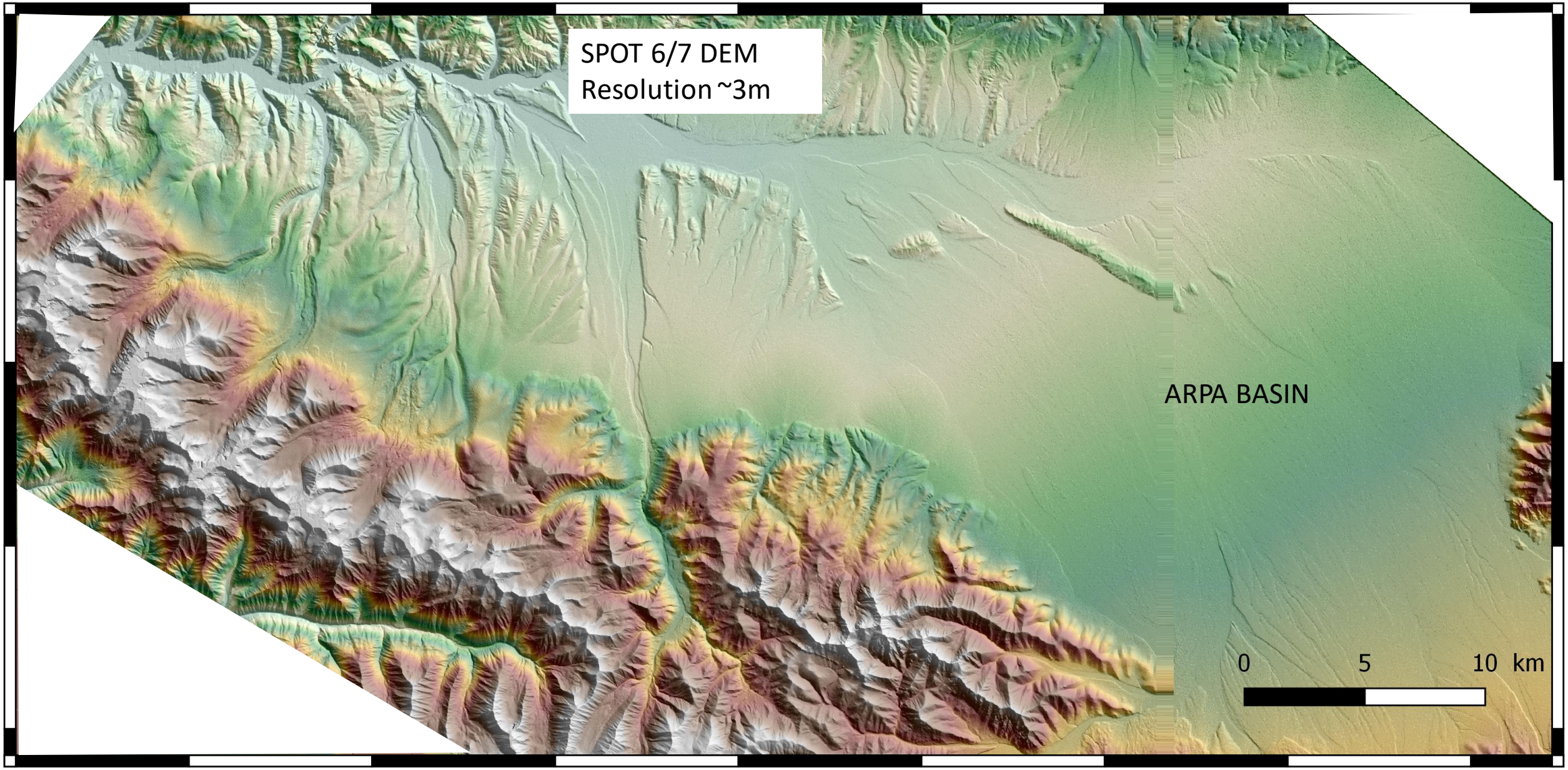


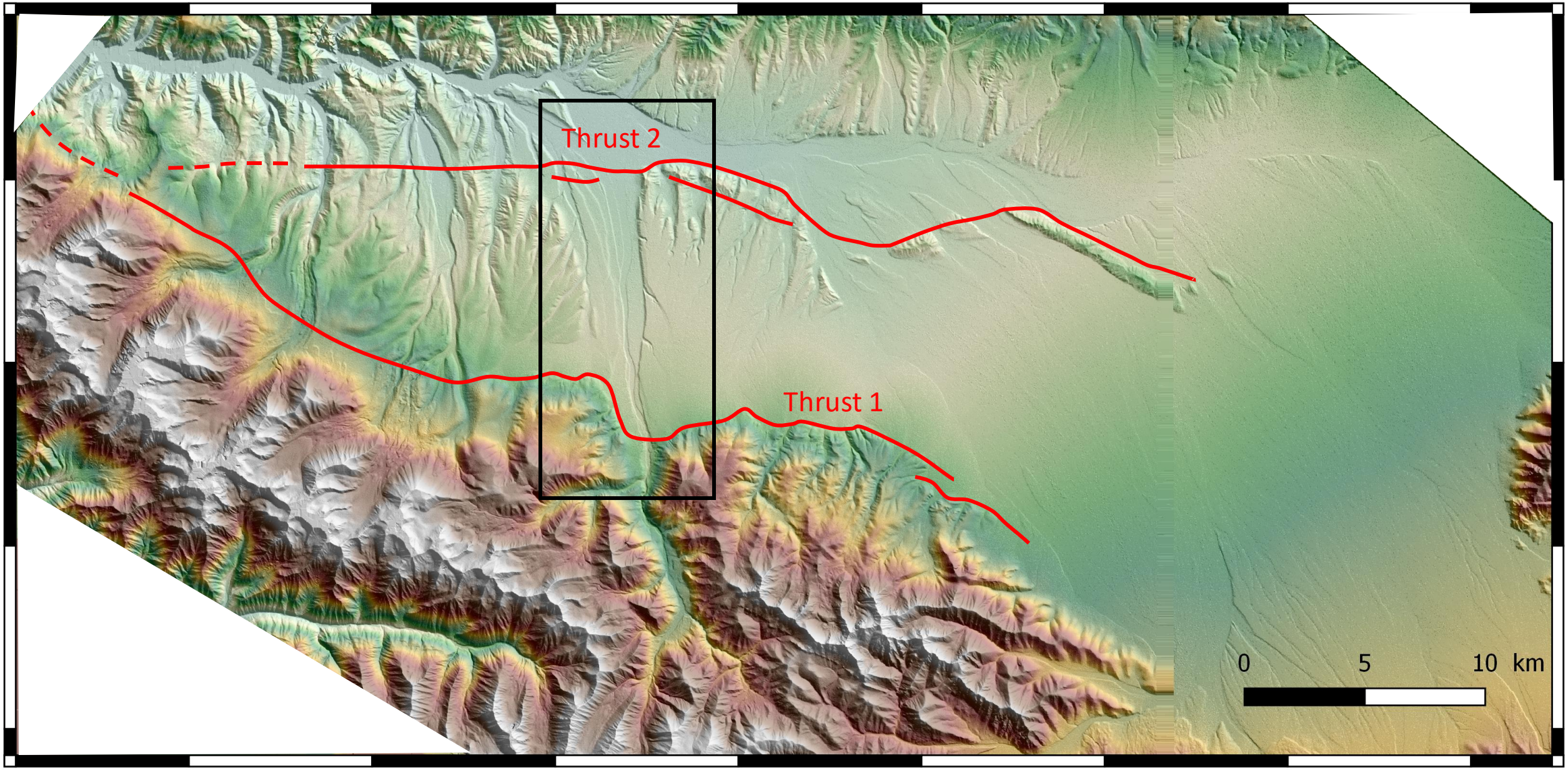

cumulative offset of 27 ± 5 m

1) after the abandonment of the alluvial fan surface (5850 ± 350 yrs) → **maximum slip rate of 4.6 ± 1.1 mm/yr**

2) stream incision is synchronous with the fan aggradation (8880 ± 600 yrs) → **minimum slip rate of 3.0 ± 0.7 mm/yr**

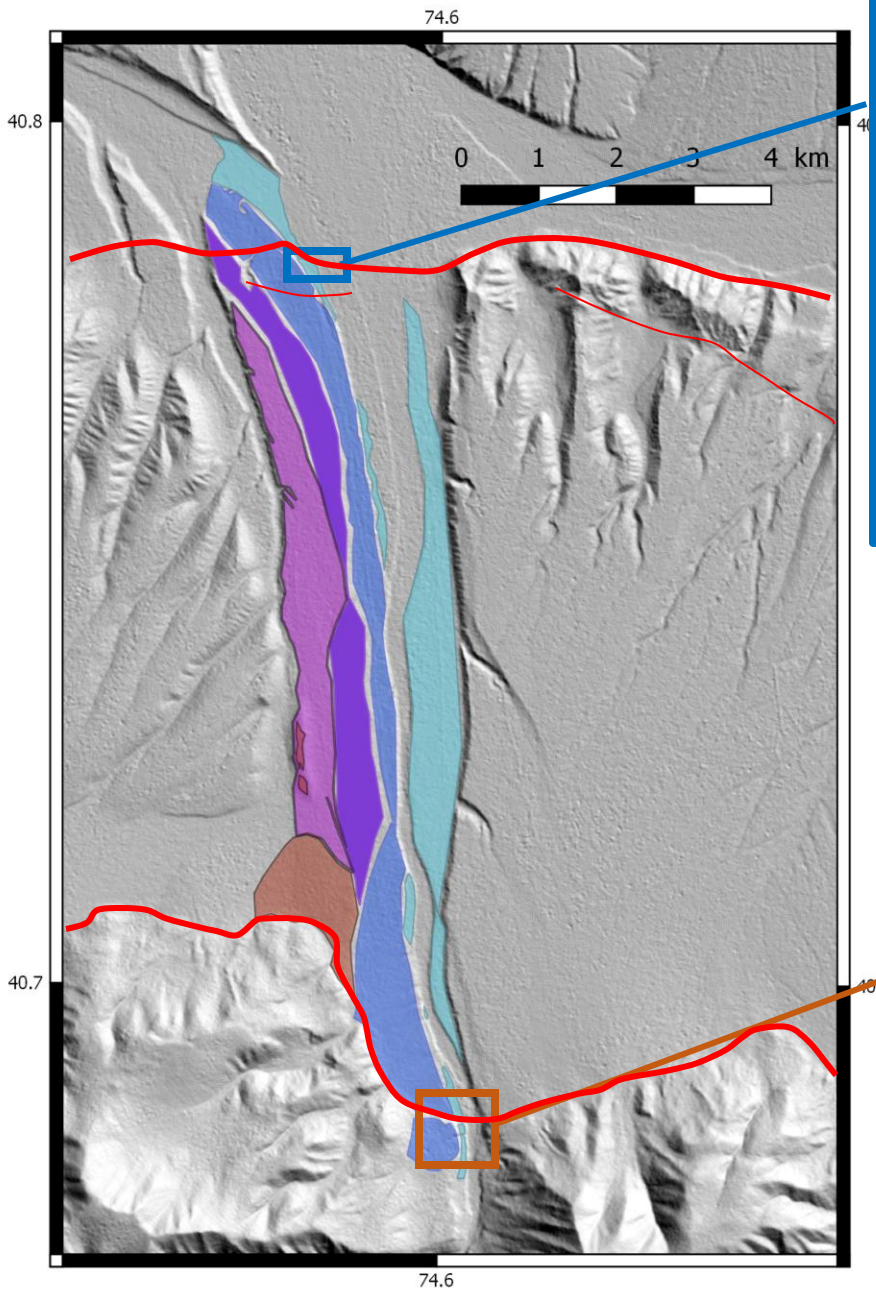

70.5
72.0
73.5
75.0
76.5
42.0
41.0
40.0
1885 (6.9)
Kyrgyz Range
1936 (6.9)
Yssyk-Kul
Suusamyr
1992 (7.5)
1937 (6.5)
1946 (7.6)
Toktogul
Son-Kul
Terskey-Ala-Too Range
Chatkal Range
Moldo-Too Range
1896 (6.6)
4.6 ± 1.1 mm/yr
Naryn Basin
At Bashi Range
Arpa
Aksai Basin
Fergana Basin
1924 (6.5)
Kokshaal Range
1983 (6.6)
Tian Range
1955 (6.6)
Atushi
1955 (7.1)
1919 (6.7)
1902 (7.8)

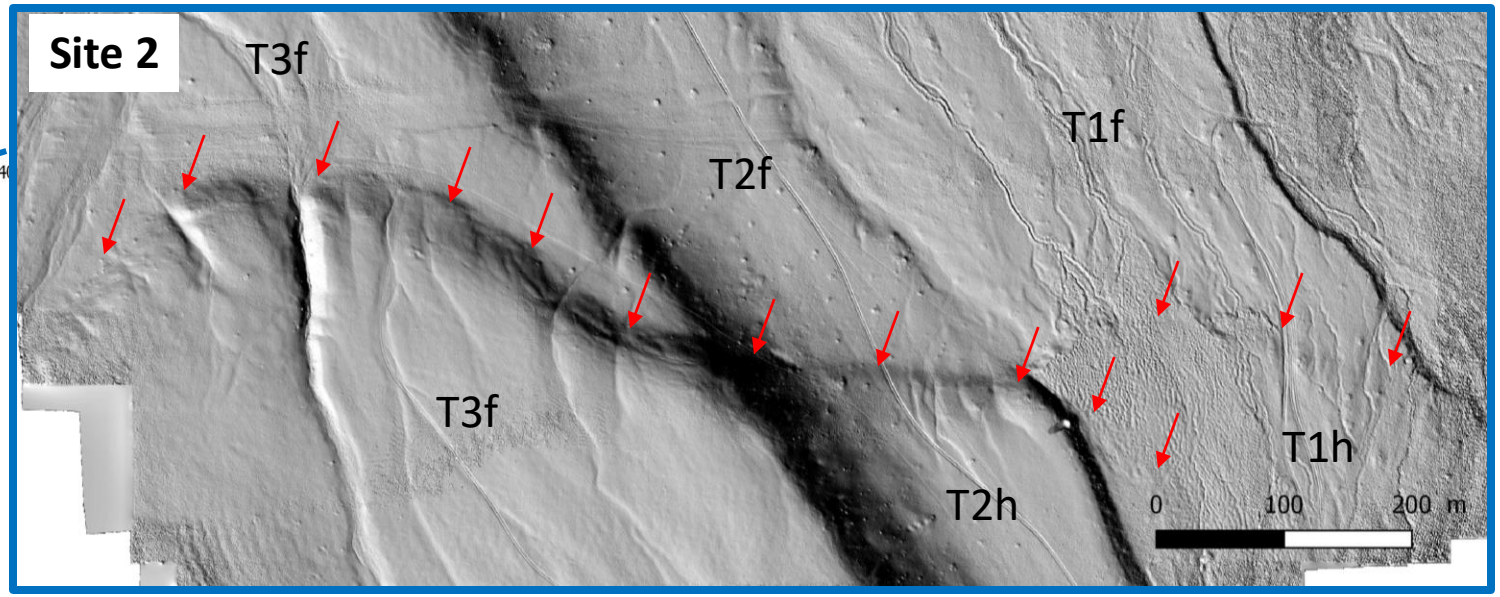

SPOT 6/7 DEM
Resolution ~3m
ARPA BASIN
0
5
10 km

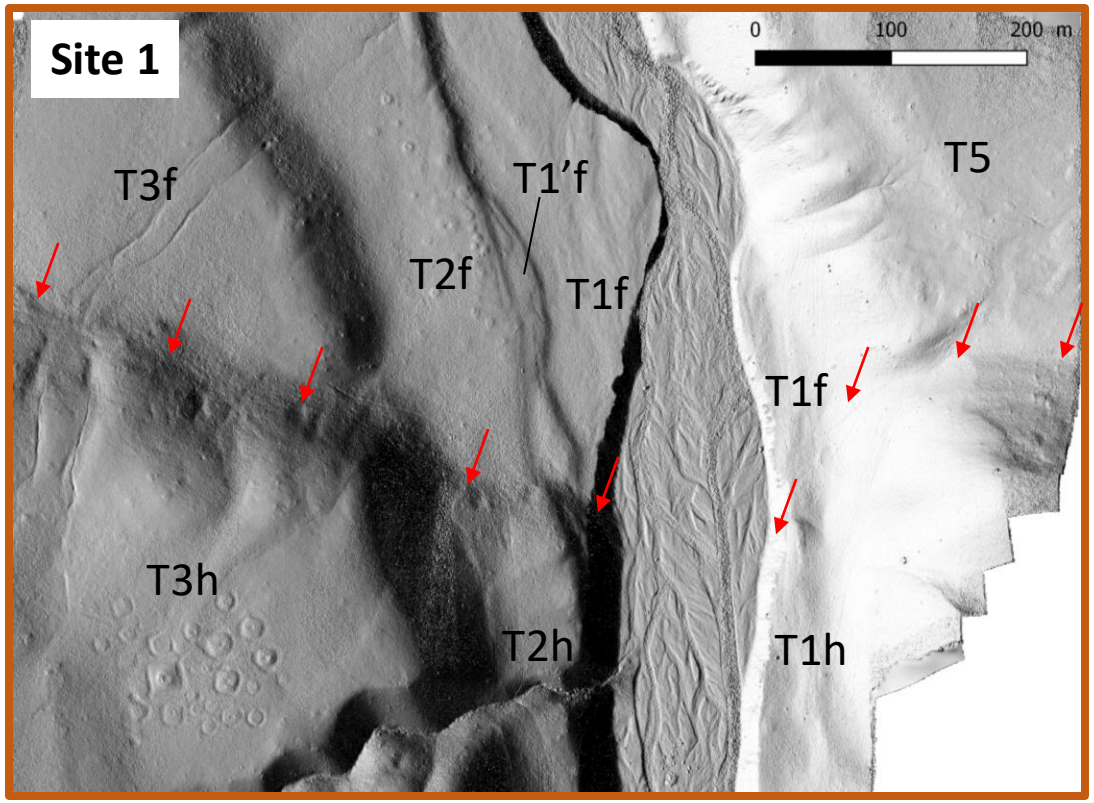



→ Thrust faults not mapped

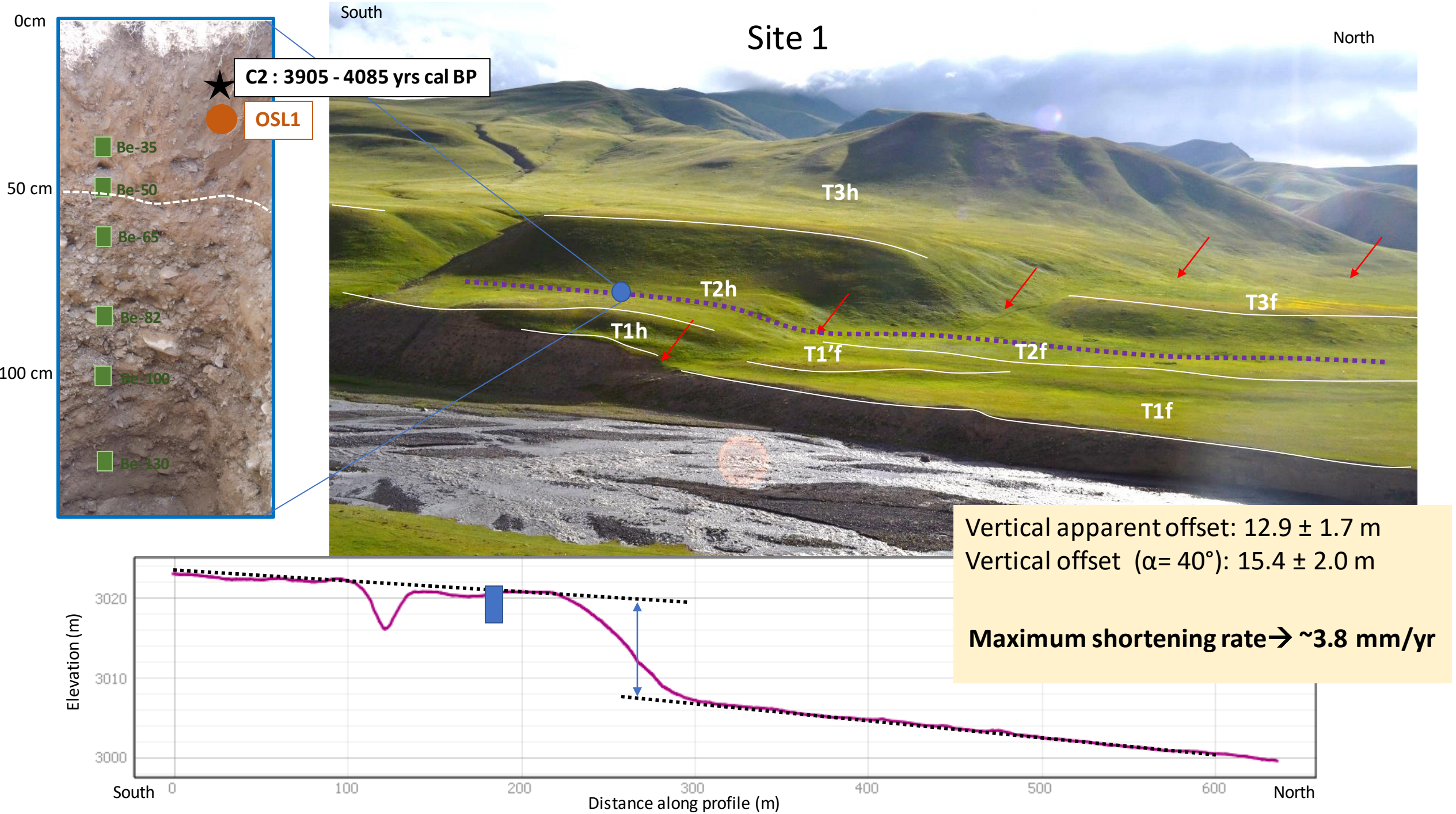
→ Fault termination of the Talas-Fergana Fault

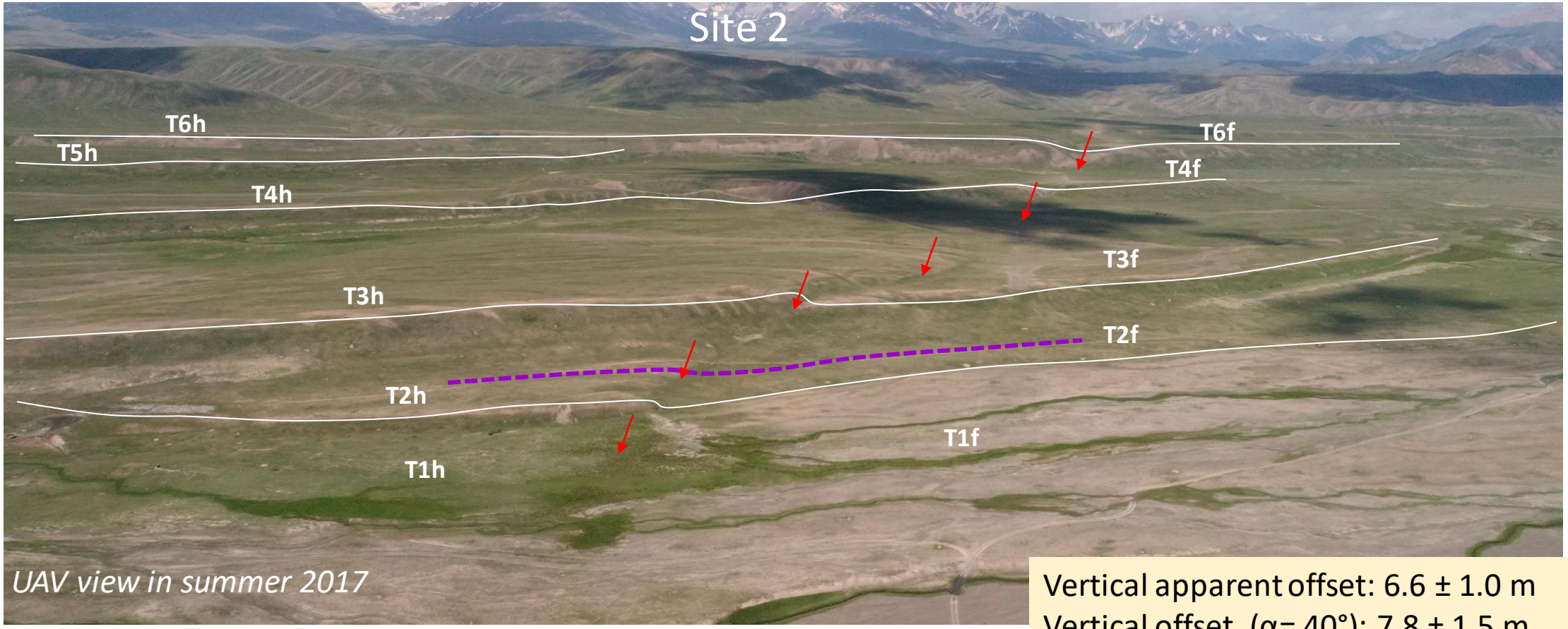



UAV-based DEM
(10cm/pixel)

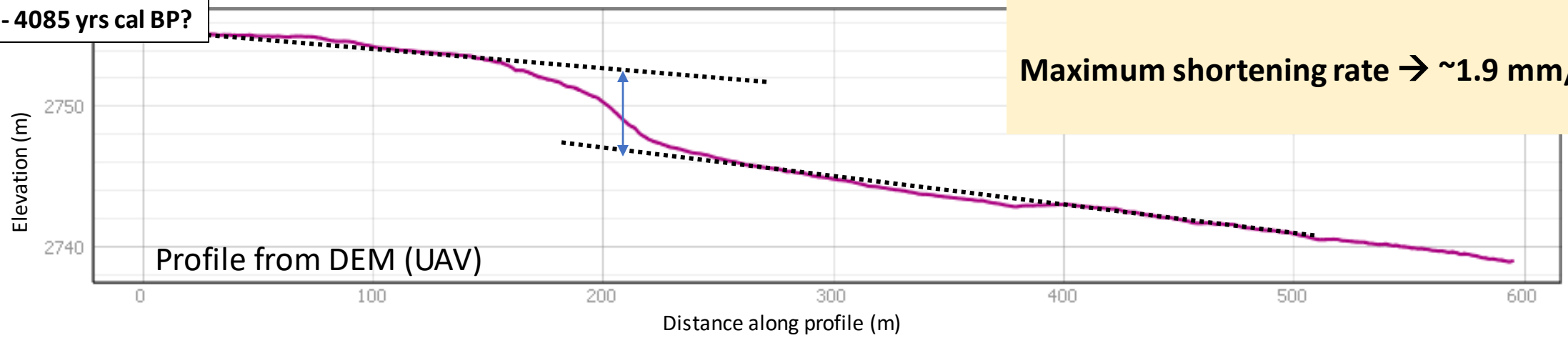

Site 1
South
North
0cm
50 cm
100 cm
C2 : 3905 - 4085 yrs cal BP
OSL1
Be-35
Be-50
Be-65
Be-82
Be-100
Be-130
T3h
T2h
T1h
T1'f
T2f
T3f
T1f
Vertical apparent offset: 12.9 ± 1.7 m
Vertical offset (α= 40°): 15.4 ± 2.0 m
Maximum shortening rate→ ~3.8 mm/yr
Elevation (m)
3020
3010
3000
South
0
100
200
300
400
500
600
North
Distance along profile (m)



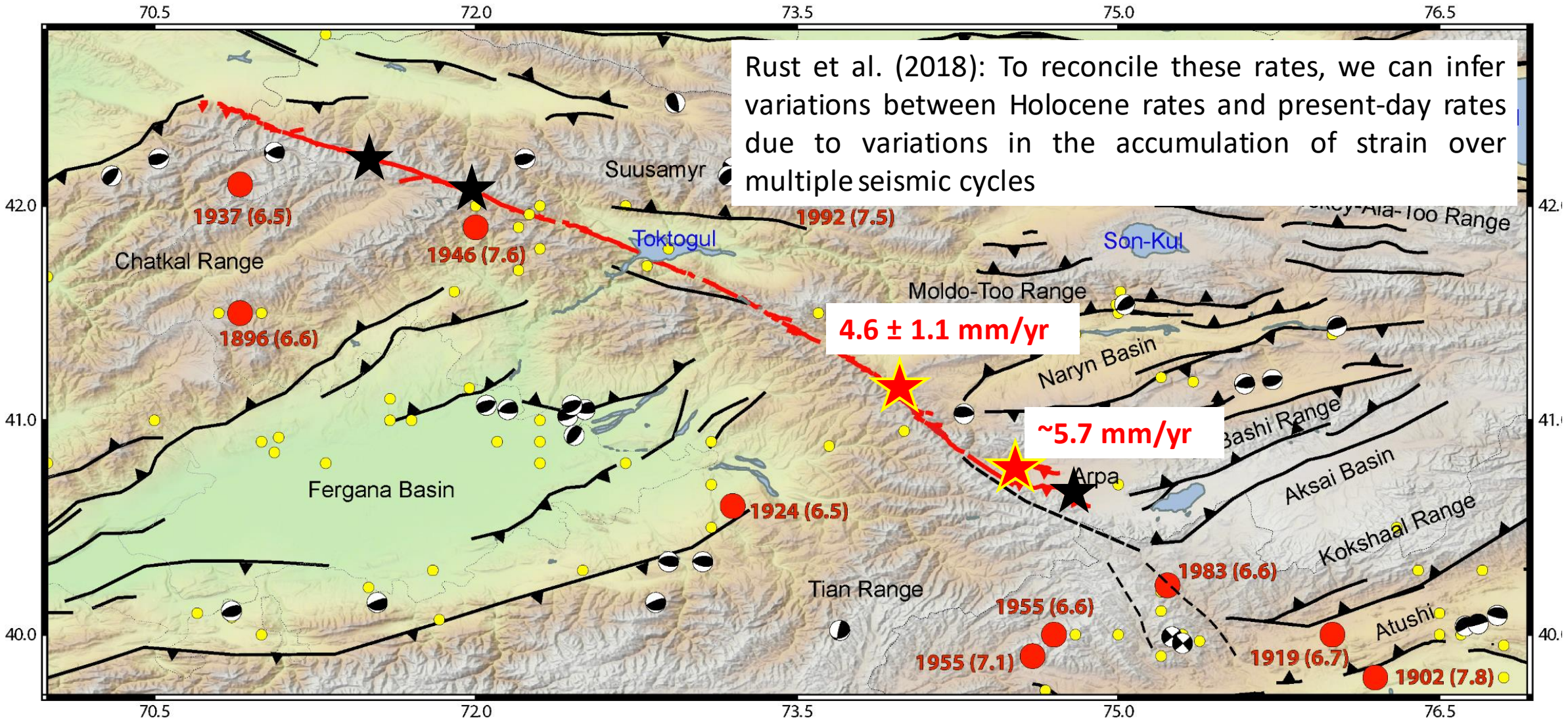

Vertical apparent offset: 6.6 ± 1.0 m
Vertical offset (α= 40°): 7.8 ± 1.5 m

**Maximum shortening rate → ~1.9 mm/yr**

**3905 - 4085 yrs cal BP?**



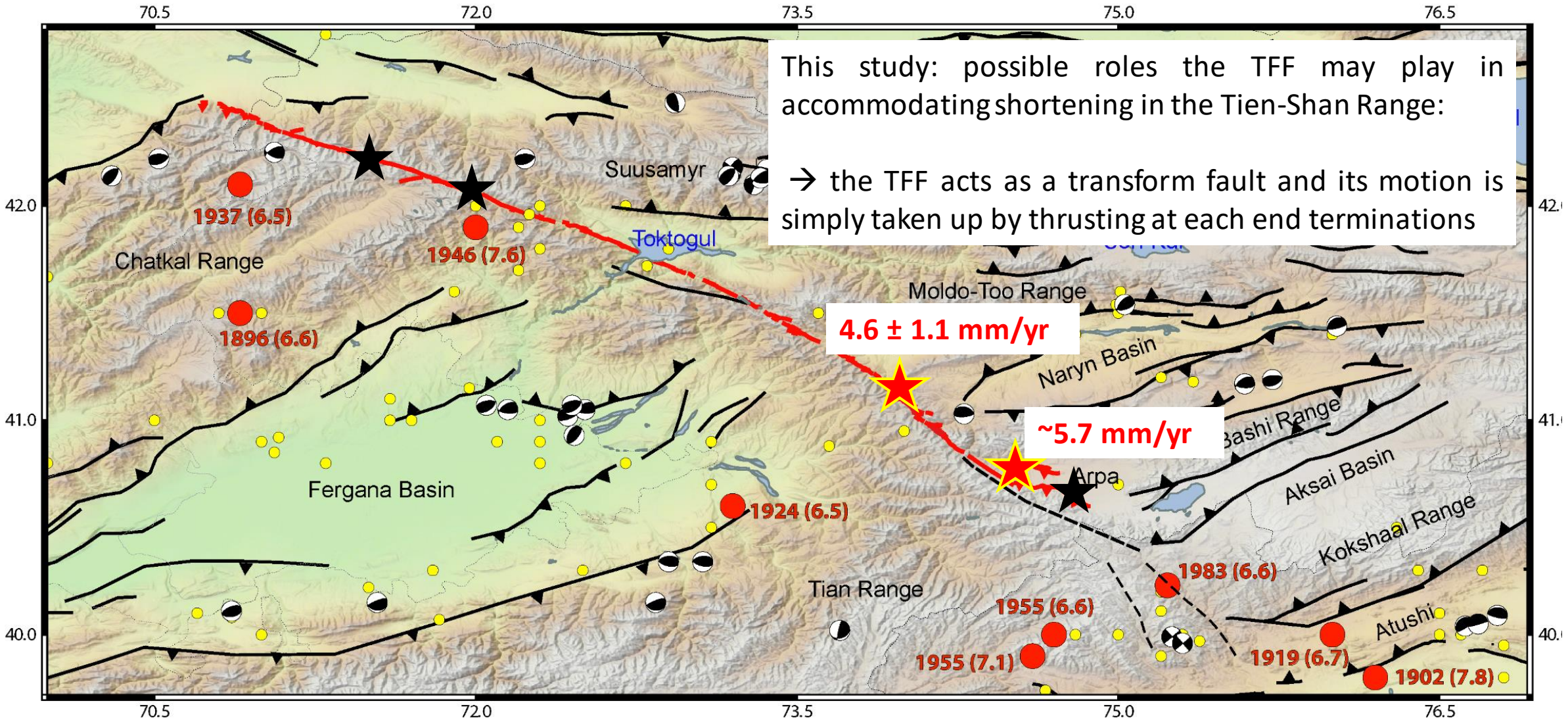
# Mismatch with Geodetic slip rates (2 mm/yr) ?




★ Work in progress – pending quaternary dating (***GATE project- AMIDEX***)

★ Geological slip rates

# Mismatch with Geodetic slip rates (2 mm/yr) ?

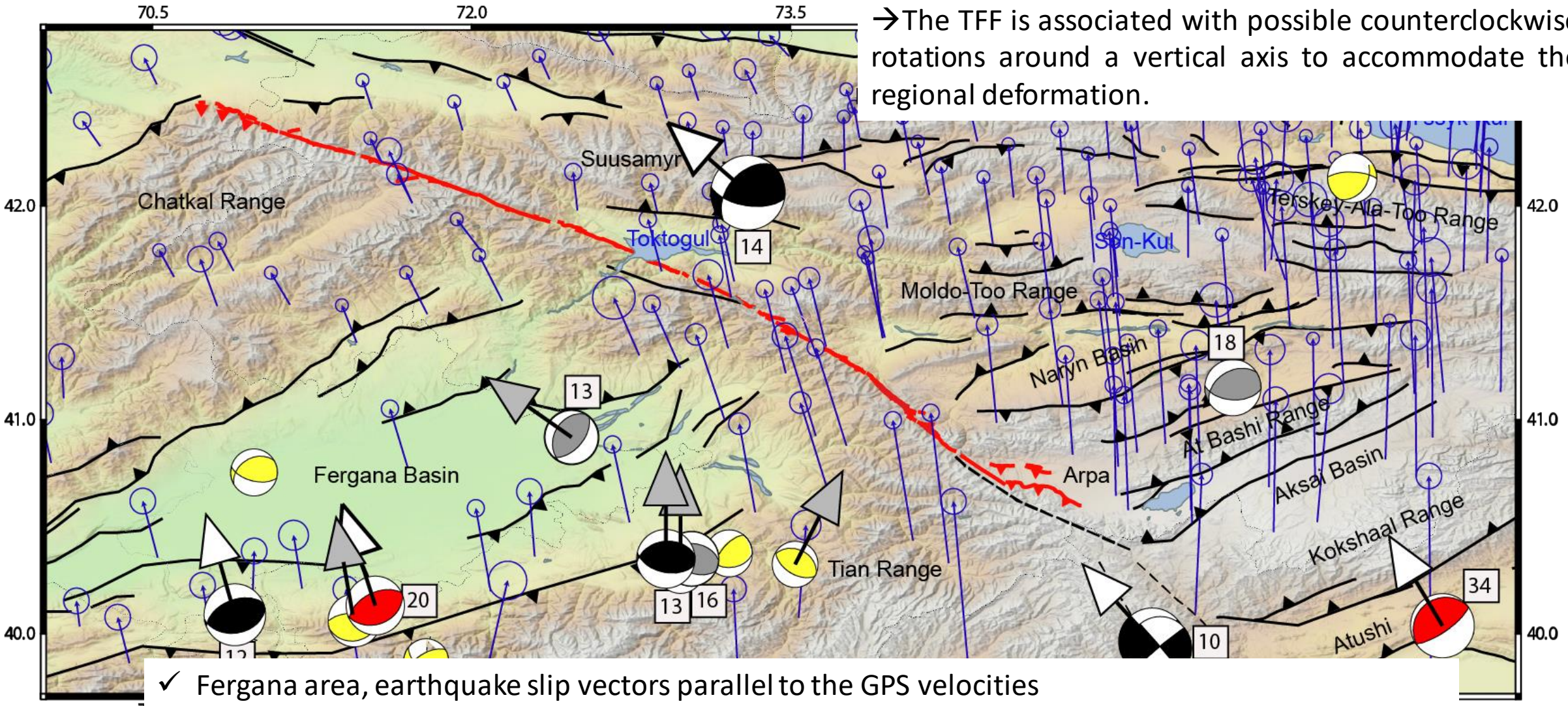



Work in progress – pending quaternary dating (***GATE project- AMIDEX***)

Geological slip rates

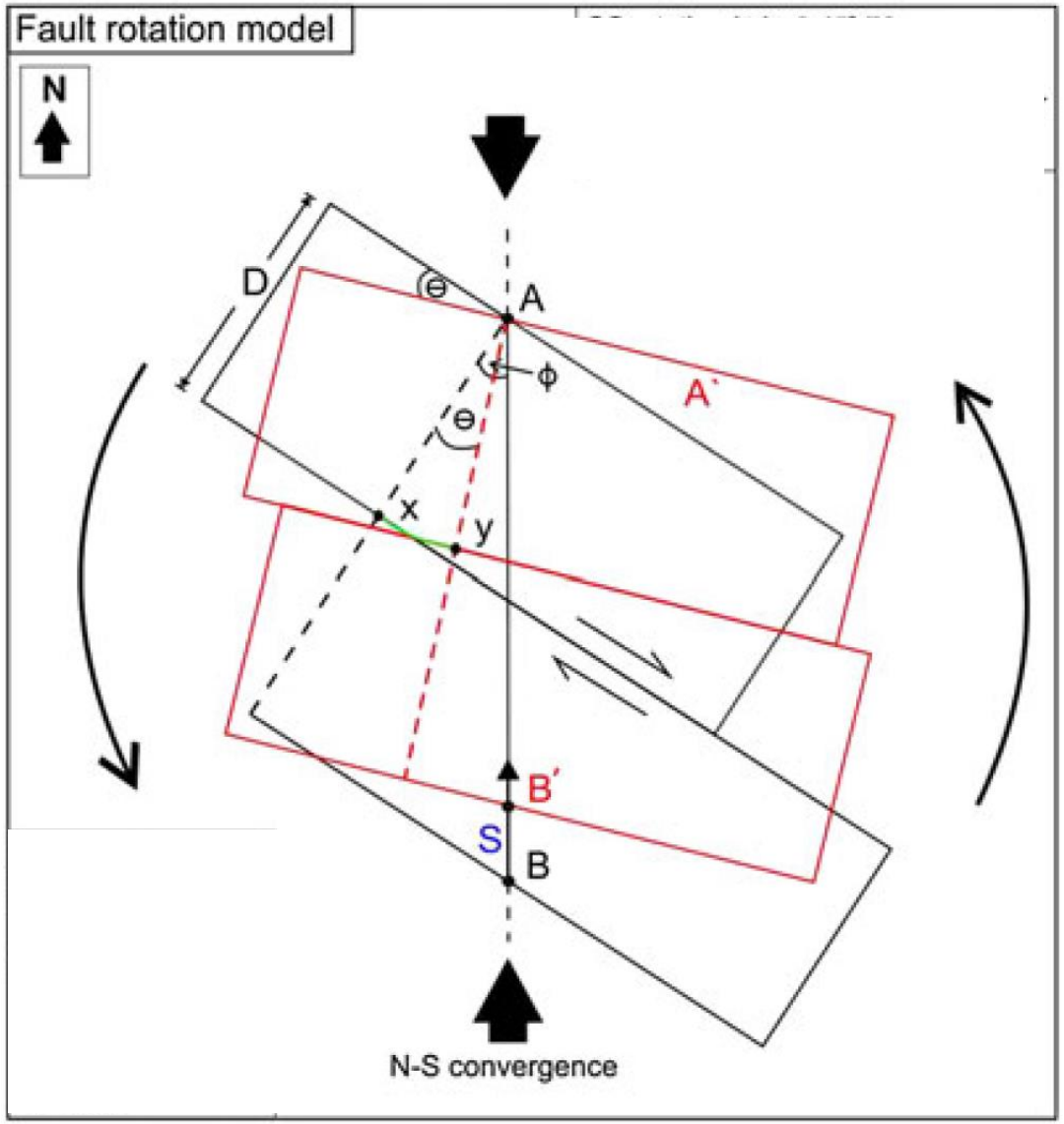
# Mismatch with Geodetic slip rates (2 mm/yr) ?

→The TFF is associated with possible counterclockwise rotations around a vertical axis to accommodate the regional deformation.




- ✓ Fergana area, earthquake slip vectors parallel to the GPS velocities
- ✓ earthquake slip vectors rotate to become parallel to the TFF fault either side of the fault itself
- → may imply that the strike-slip motion along the TFF is very small (<1mm/yr)
- → or that block rotations may take place across the TFF system.

# Testing a fault rotation model …

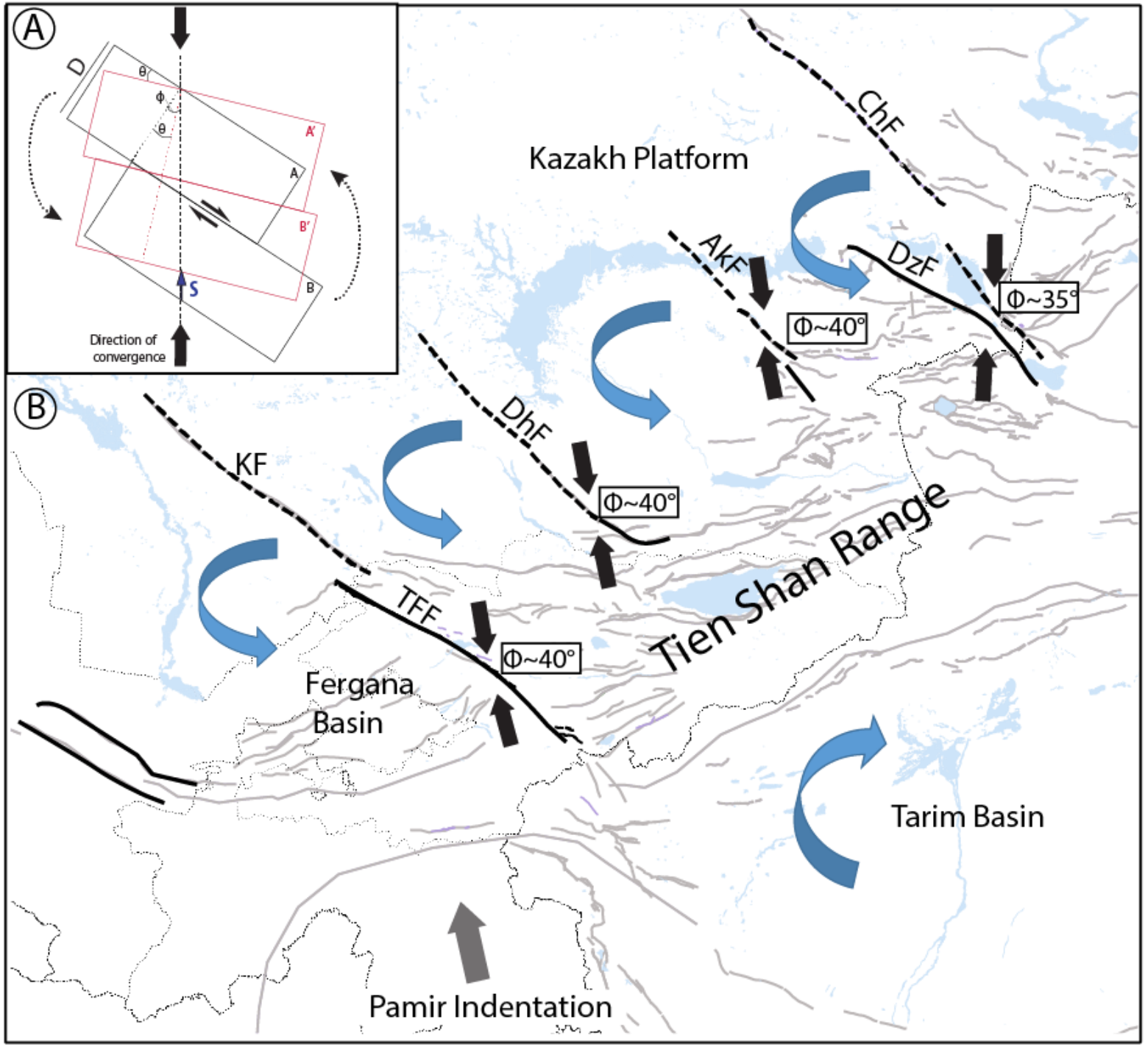



**After Campbell et al., 2013**

We assume :

- No volume change
- S = 2 mm/yr (GPS rate, Zubovich et al., 2010)
- D = 150 km
- Φ = 40° (angle between TFF and GPS vector azimuth)
- CC rotation ( θ) = 0.73°/Ma (Reigber)

→ **Model requires a total slip-rate of 4.5-5.2 mm/yr**




## Conclusions

- ❑ We reconcile geodetic and geological slip rates
- ❑ Speculative model with possible fault rotation processes distributed along ~2500 km reactivating the Karatau-TFF and Dzhungarian-Chingiz fault systems.
- ❑ more geological slip rates are needed along all major strike-slip faults (Dzhalair-Naiman, Aktas) distributed across the Kazakh platform to better constrain and validate fault rotation models.
- ❑ only two studies examine recent activity on those strike-slip faults (Campbell et al., 2015; Hollingsworth et al., 2016).
- ❑ This geodynamic view → implications for seismic hazards in the Tien-Shan
- ❑ We may underrate the probability for large earthquakes along these major strike-slip faults.