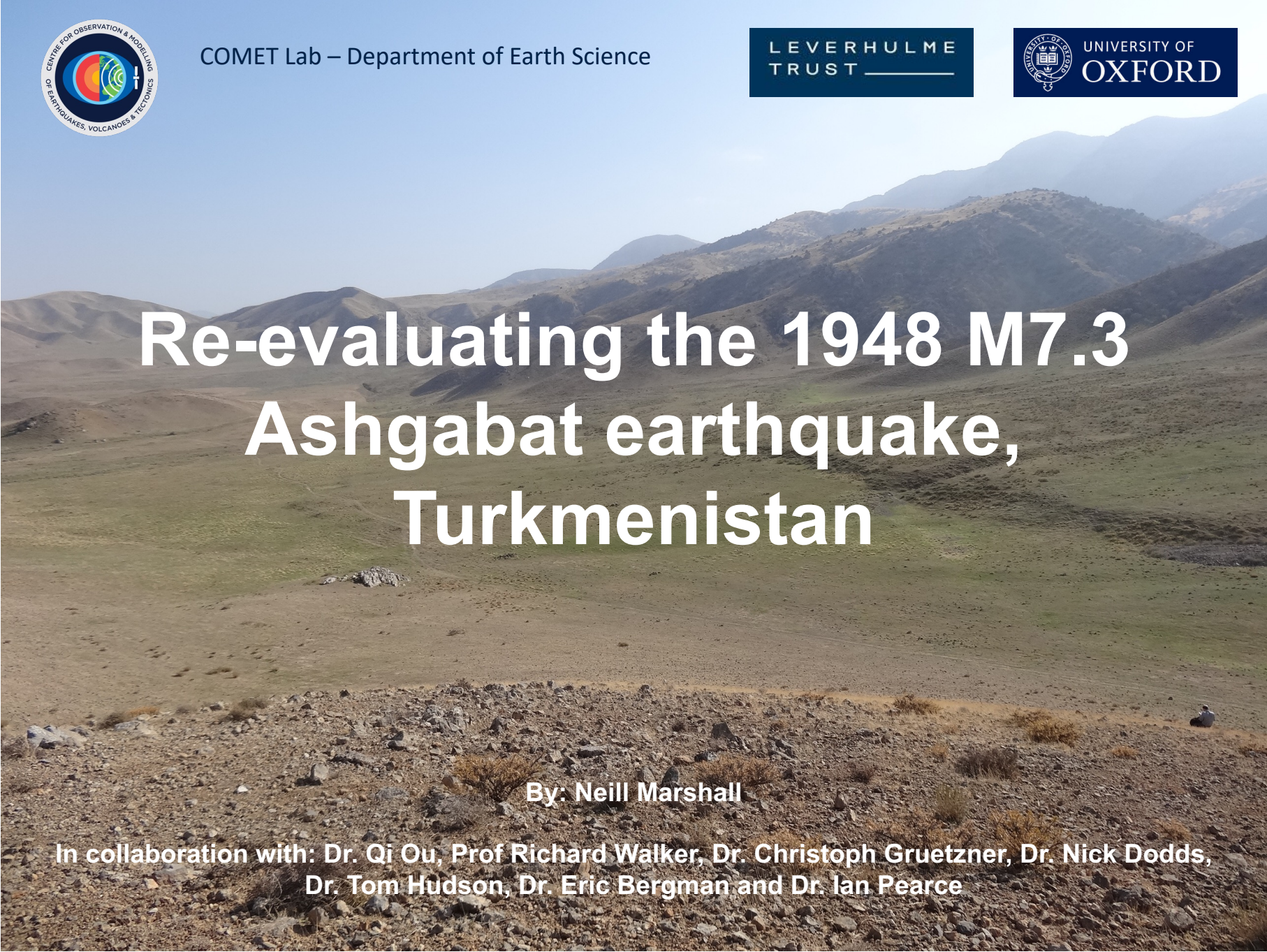


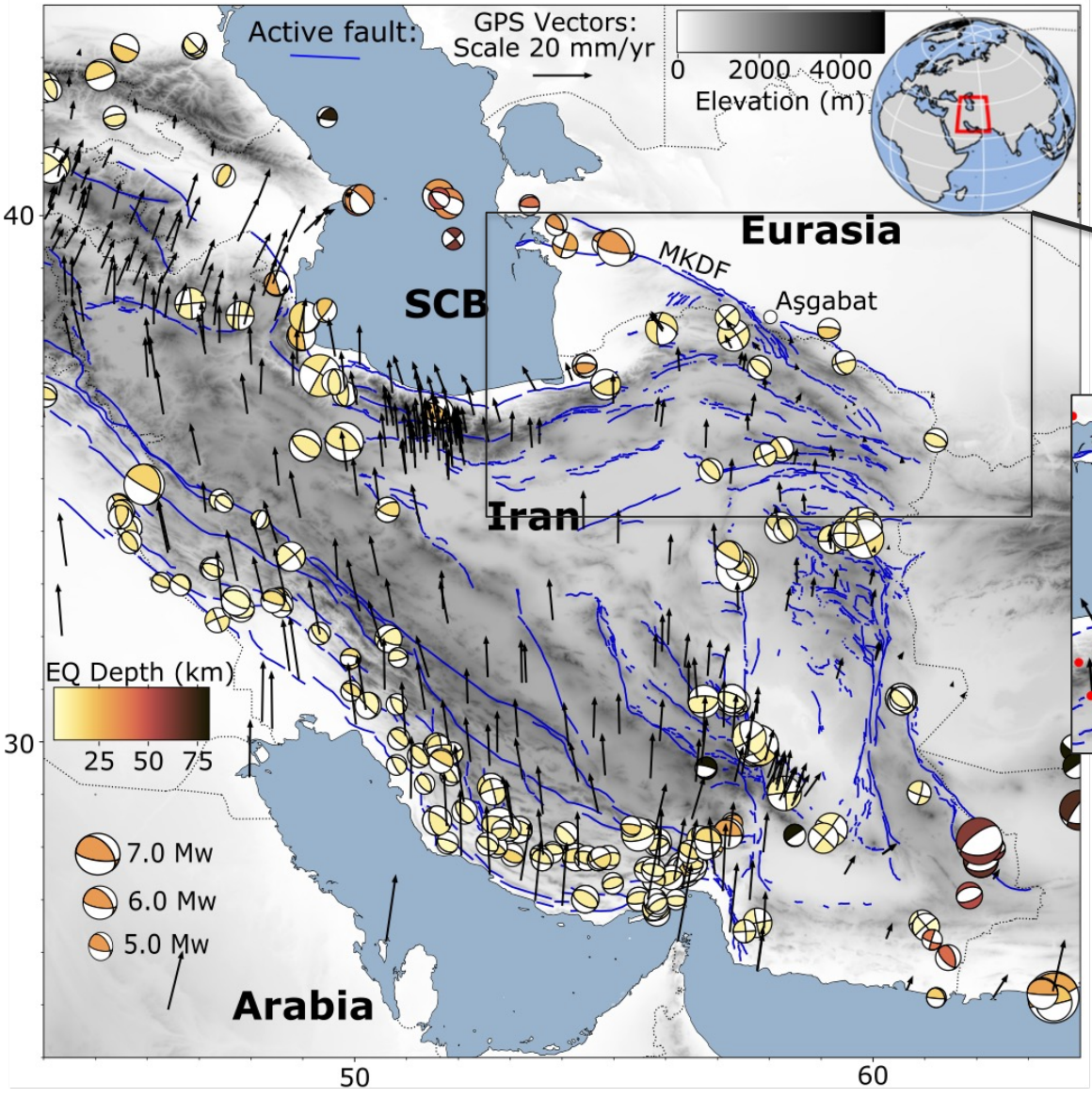
COMET Lab – Department of Earth Science

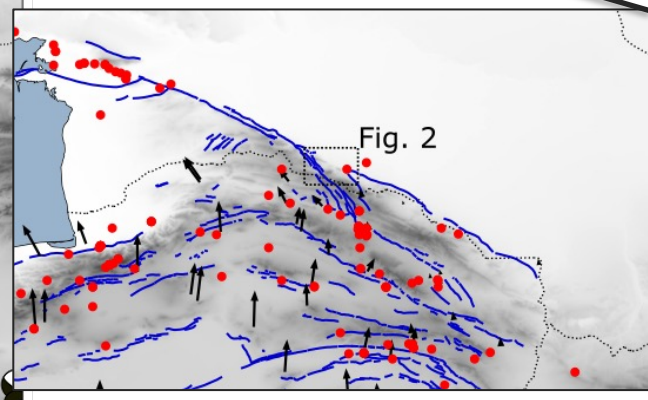
Re-evaluating the 1948 M7.3 Ashgabat earthquake, Turkmenistan

By: Neill Marshall

In collaboration with: Dr. Qi Ou, Prof Richard Walker, Dr. Christoph Gruetzner, Dr. Nick Dodds, Dr. Tom Hudson, Dr. Eric Bergman and Dr. Ian Pearce

An introduction to the regional tectonics – gap in seismicity





Red dots: Historical earthquake locations
3000BC - 1952 (Ambraseys)

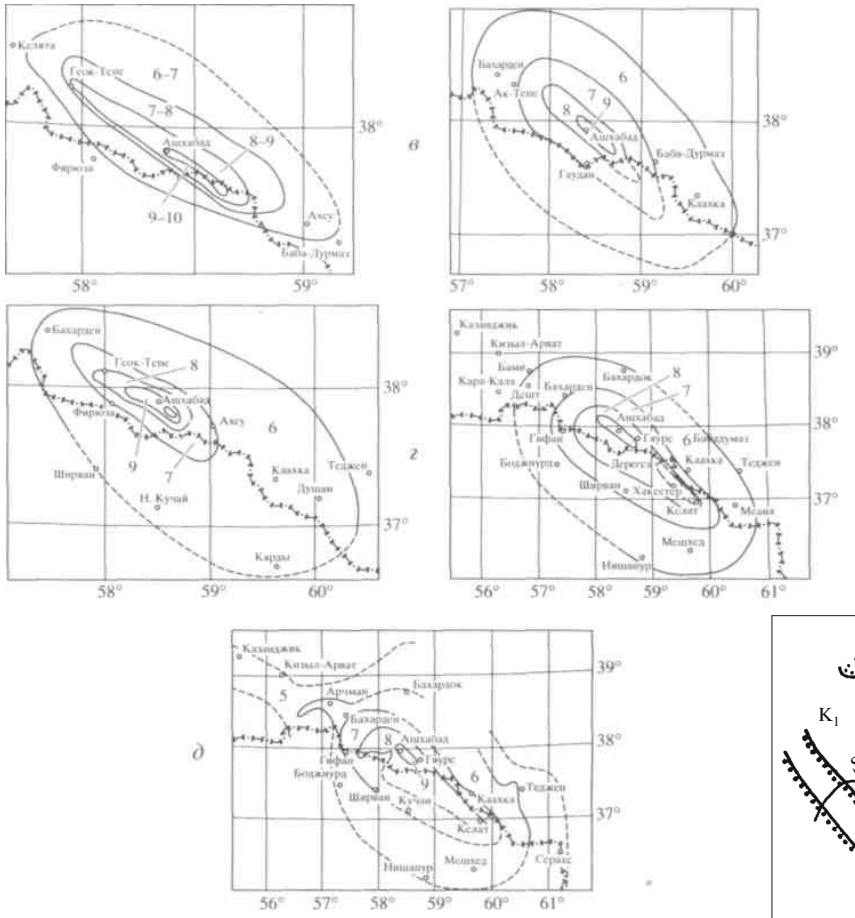
Tectonic map of the Arabian/Eurasian plate collision zone. Black arrows represent GPS velocity vectors after Khorrami et al., 2019 relative to Eurasia; beach ball plots show focal mechanism solutions and locations for earthquakes greater than Mw 3.5 between 1917 and 2017 (Wimpenny and Watson, 2020); blue lines show active faults in the region (Walker et al., 2021). Digital Elevation Model (DEM) from SRTM 90m. Main Kopeh Dagh Fault zone – MKDF; South Caspian Basin – SCB.

What do we know about 1948 Ashgabat earthquake?

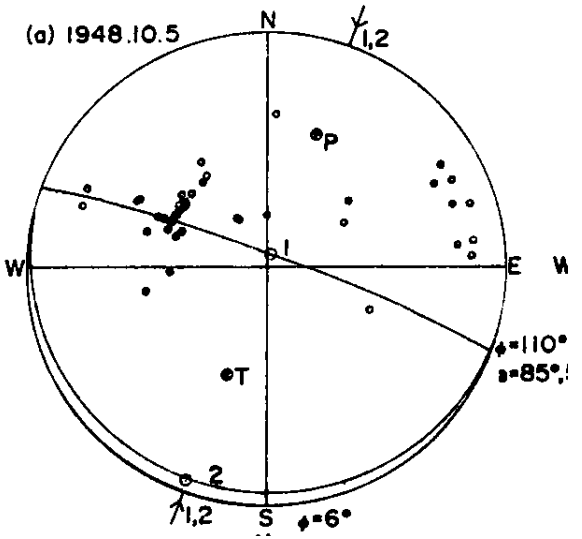
At least 38,000 people killed (could be as many as 120,000) and nearly all brick-built buildings collapsed

Images: https://sites.google.com/a/pvlearners.net/the-1948-ashgabat-earthquake/

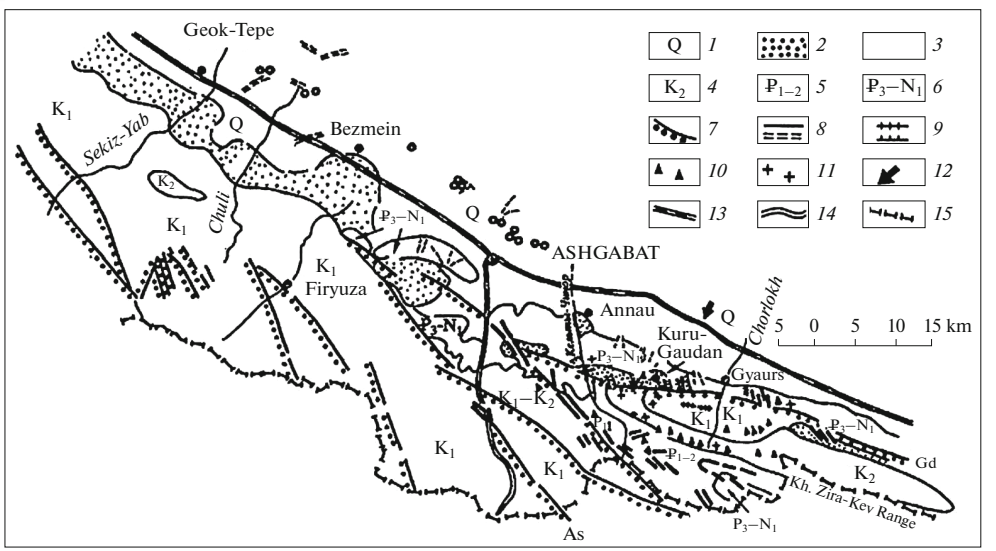
Previous studies debate the cause and mechanism



After A. A. Nikonov 1998 summay of the five different isoseismal maps (references therein).



After McKenzie 1972



After Rogohzin 2012, adapted from Sukacheva & Kazanli 1949

Motivation:

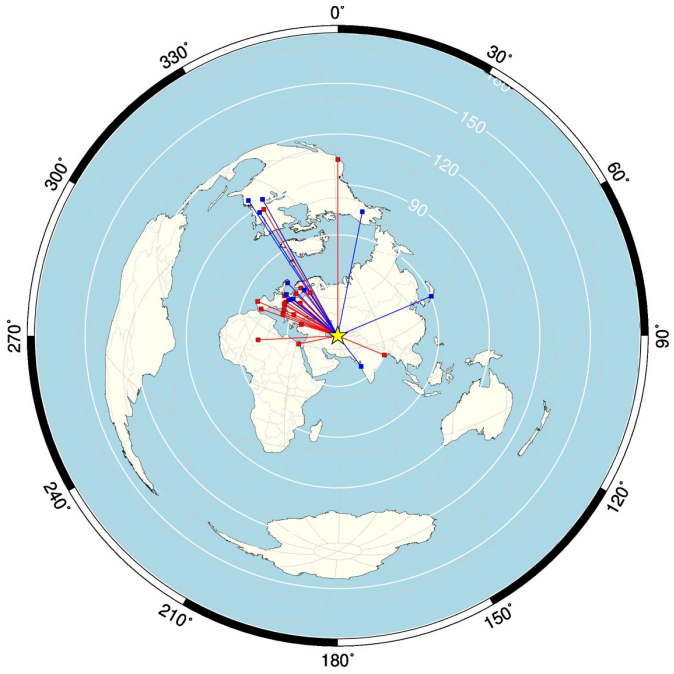
1. Determine the style and location of one of the most destructive earthquakes in the 20th Century.

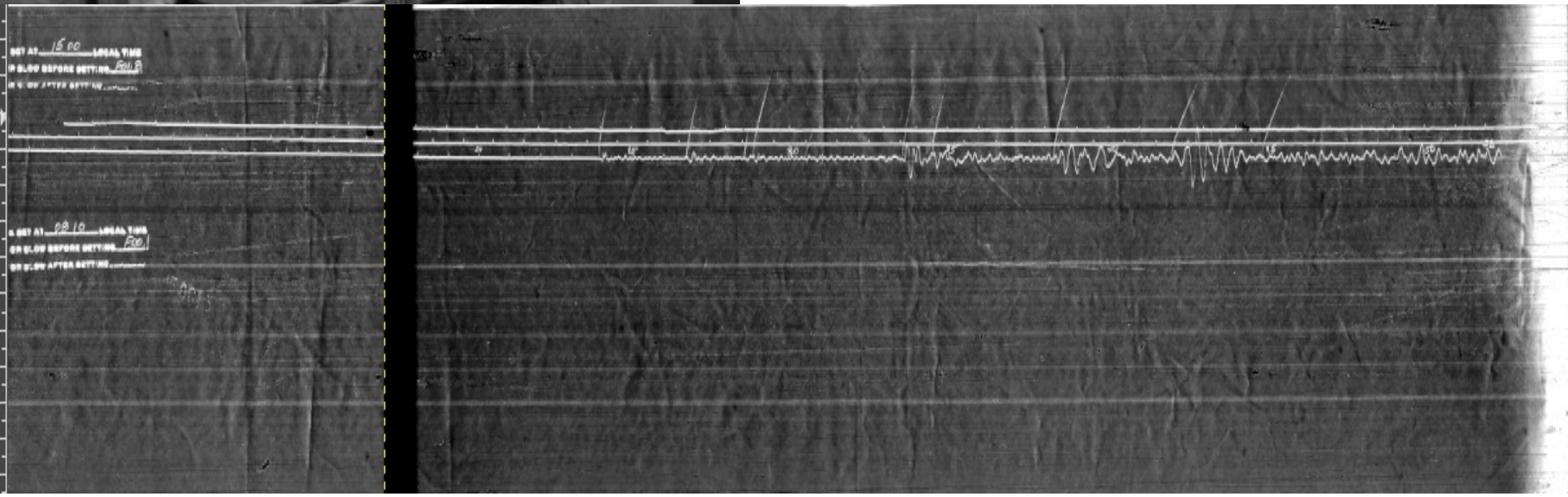
2. What are the implications for seismic hazard assessment?

3. What does this mean for other fault zones?

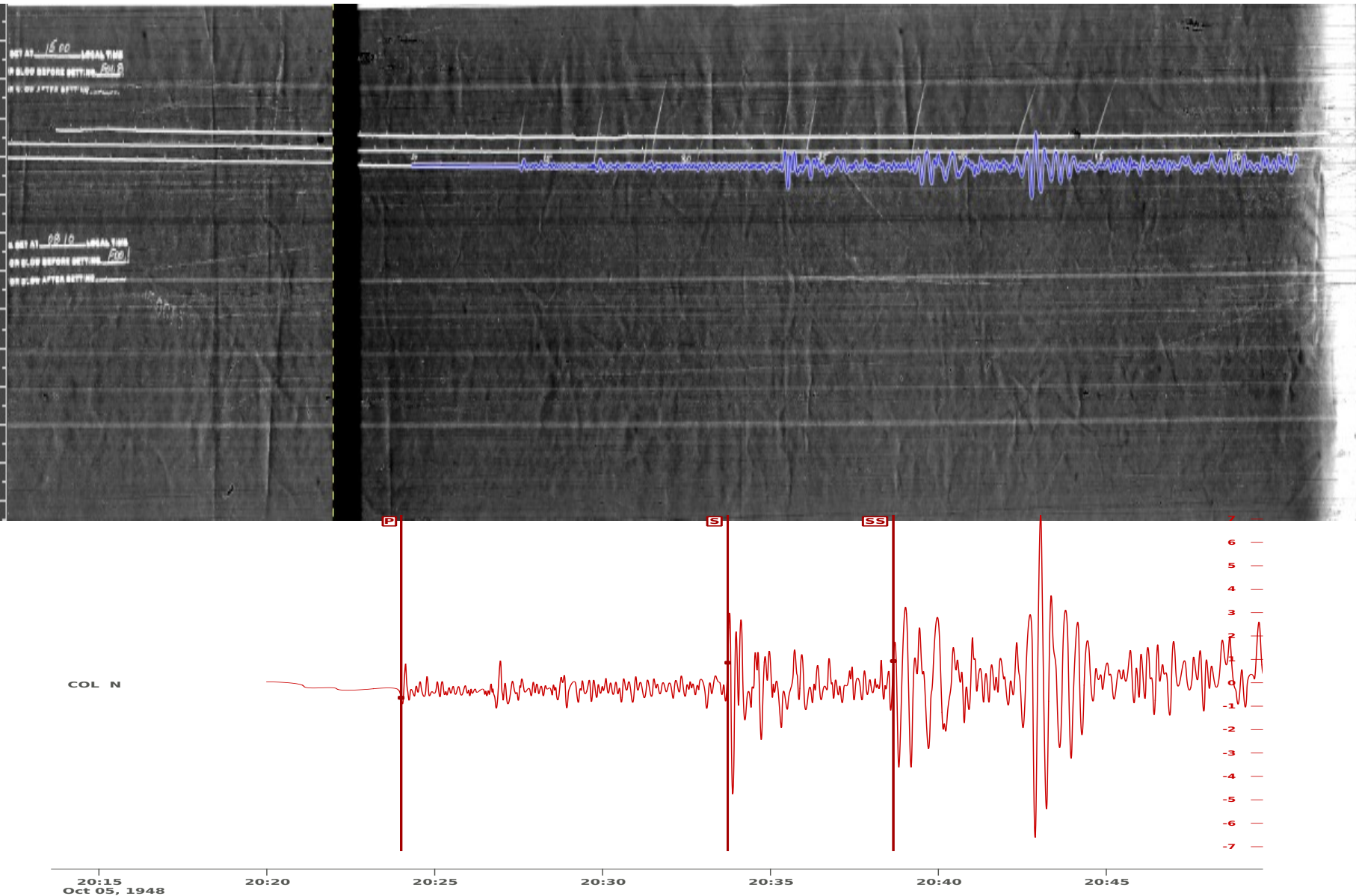
4. What can this earthquake tell us about the regional tectonics?

Historic seismic records collected from around the world

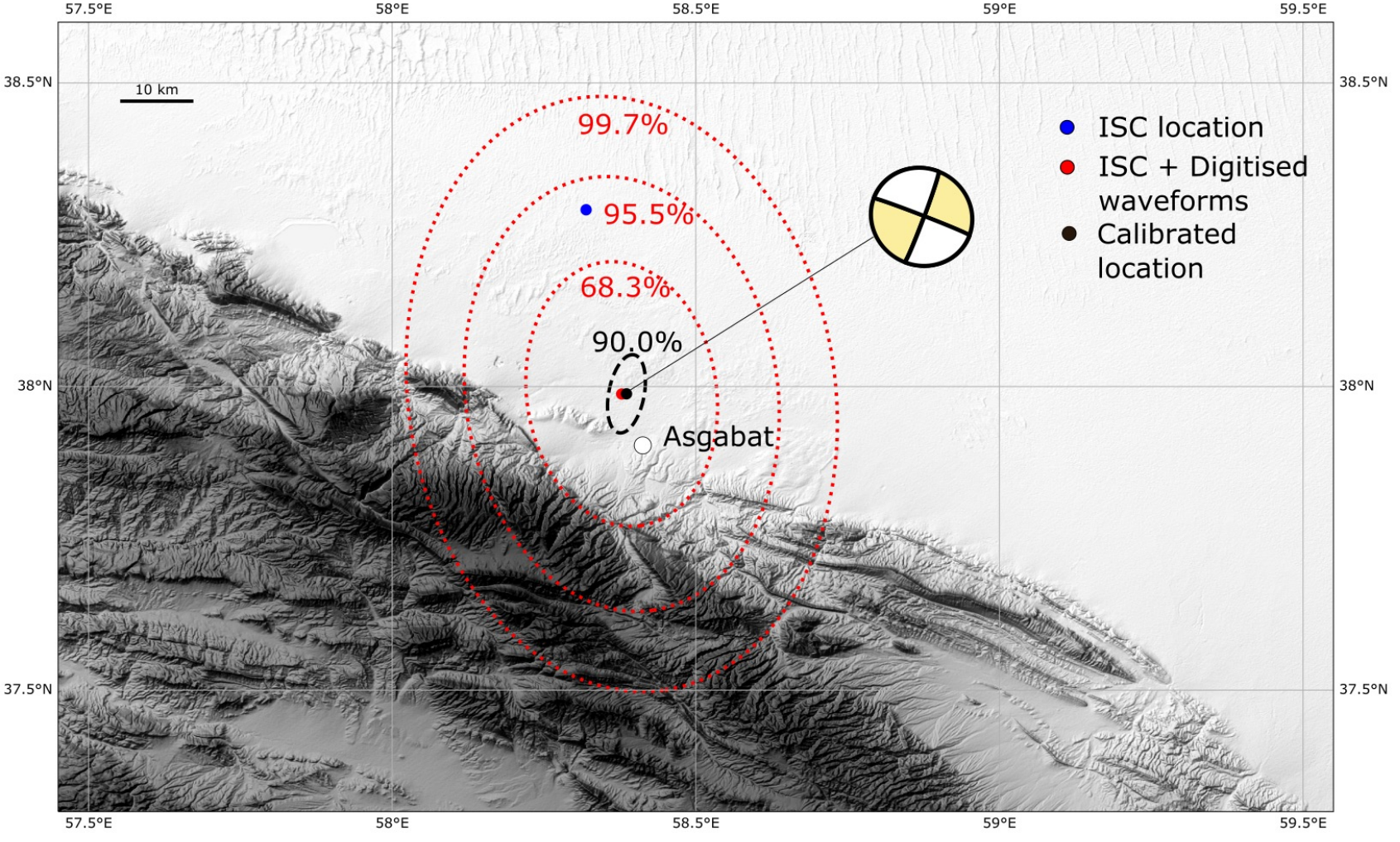




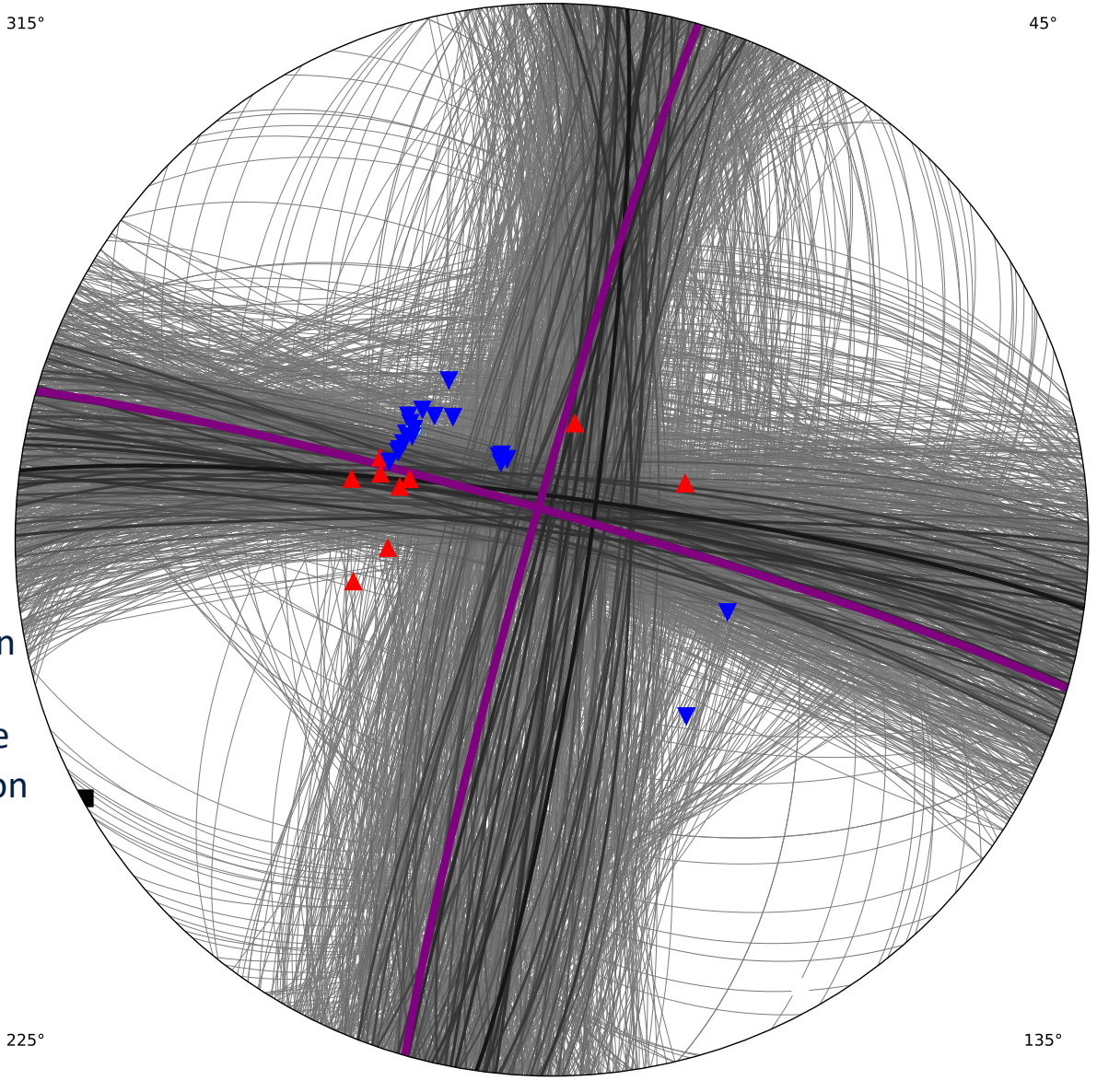
Digitising the paper seismograms



Hypocentres for the 1948 earthquake (10 – 15km depth)

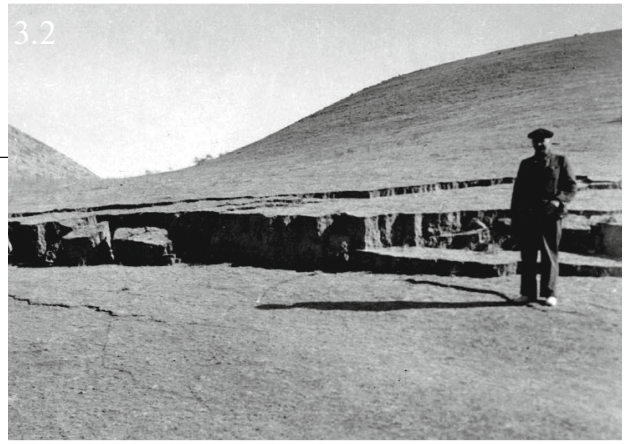


Focal mechanism solutions from first motion – strike slip earthquake

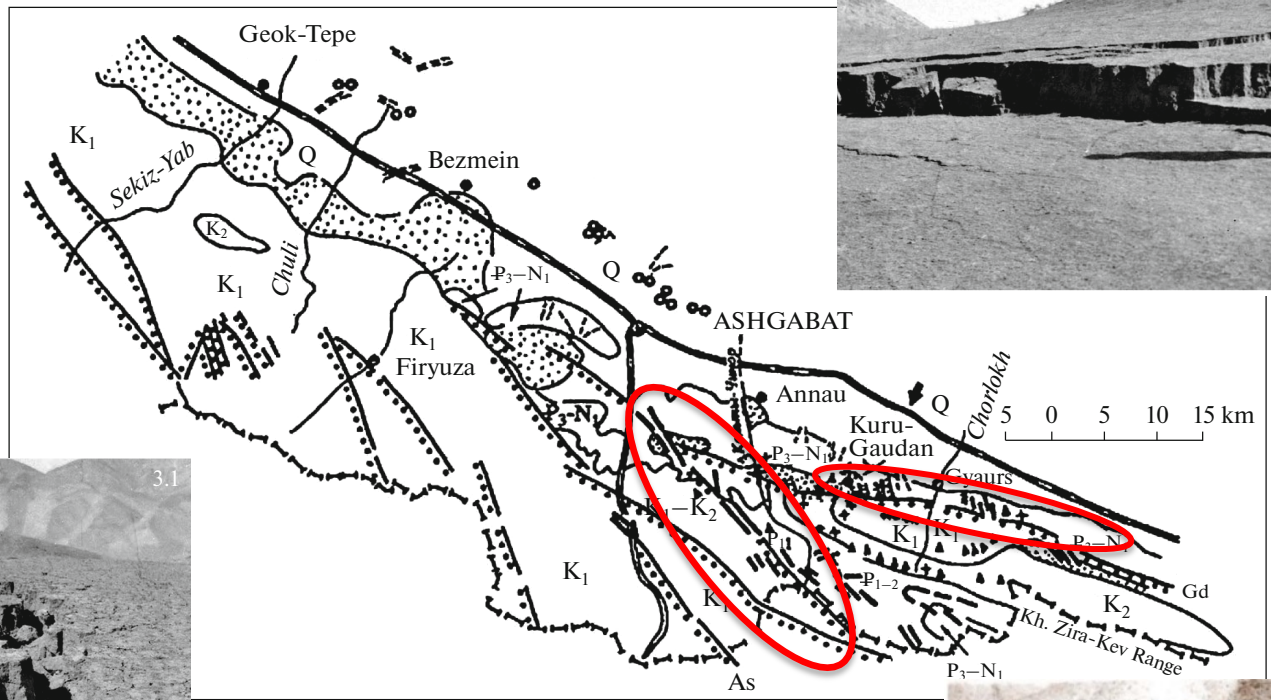


Red: Compression
Blue: Dilation
: Nodal Plane
: Best Solution

What was the surface expression of the Ashgabat earthquake?



After Sidorin, 2019

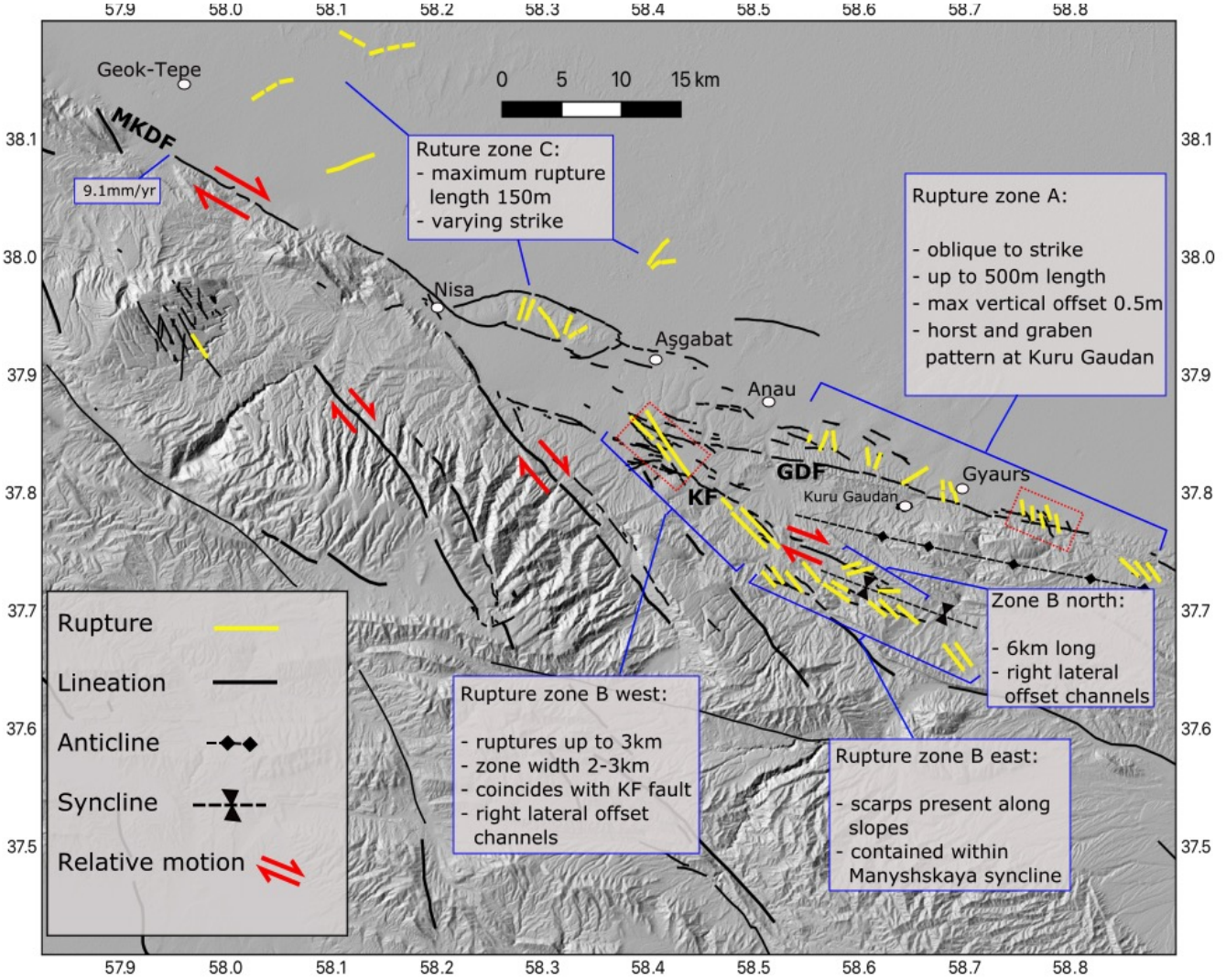


After Rogohzin 2012, adapted from Sukacheva & Kazanli 1949

After Sidorin, 2019

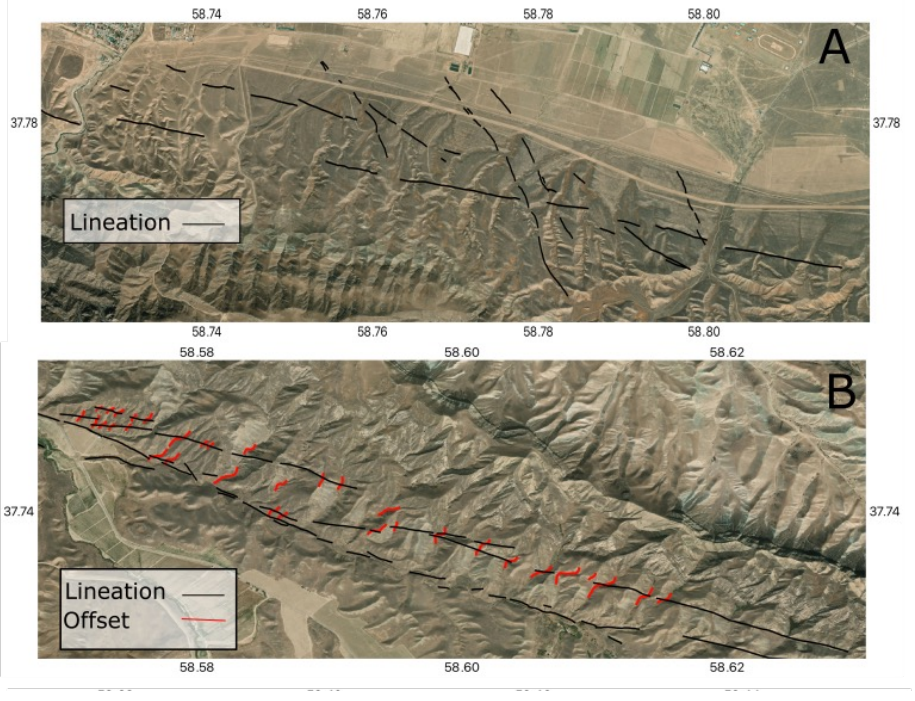
After Nalivkin, https://books.google.co.uk/books?id=avvZkoUSmAC

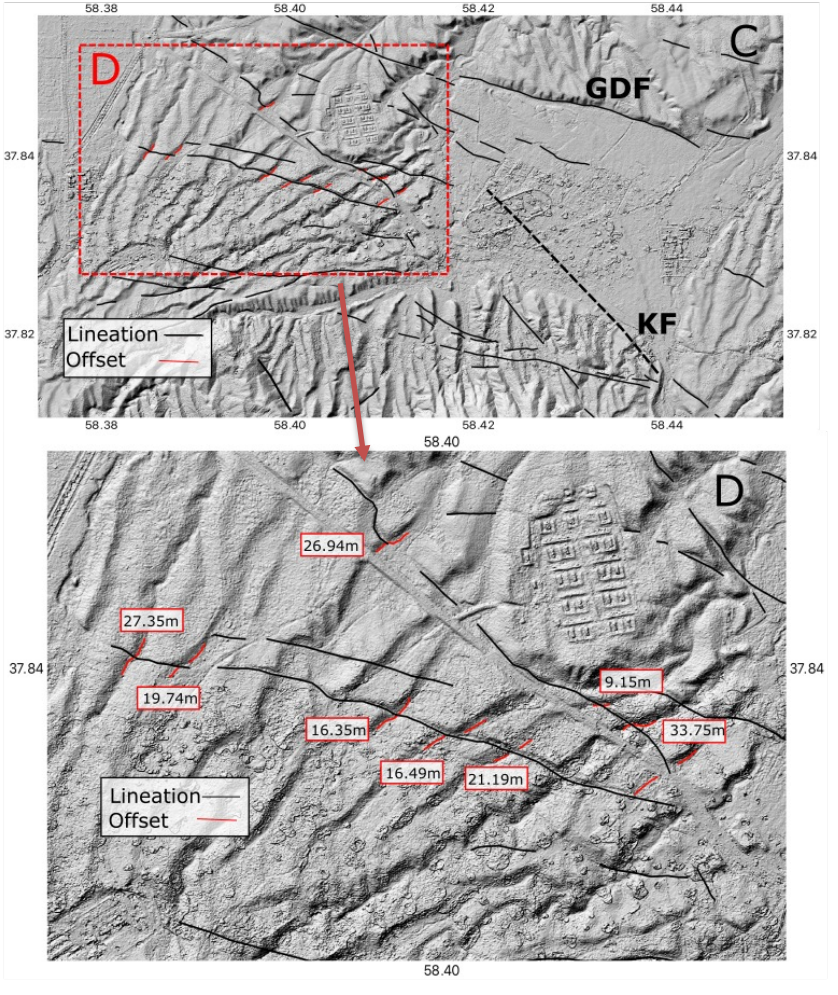
Surface ruptures are concentrated in three zones



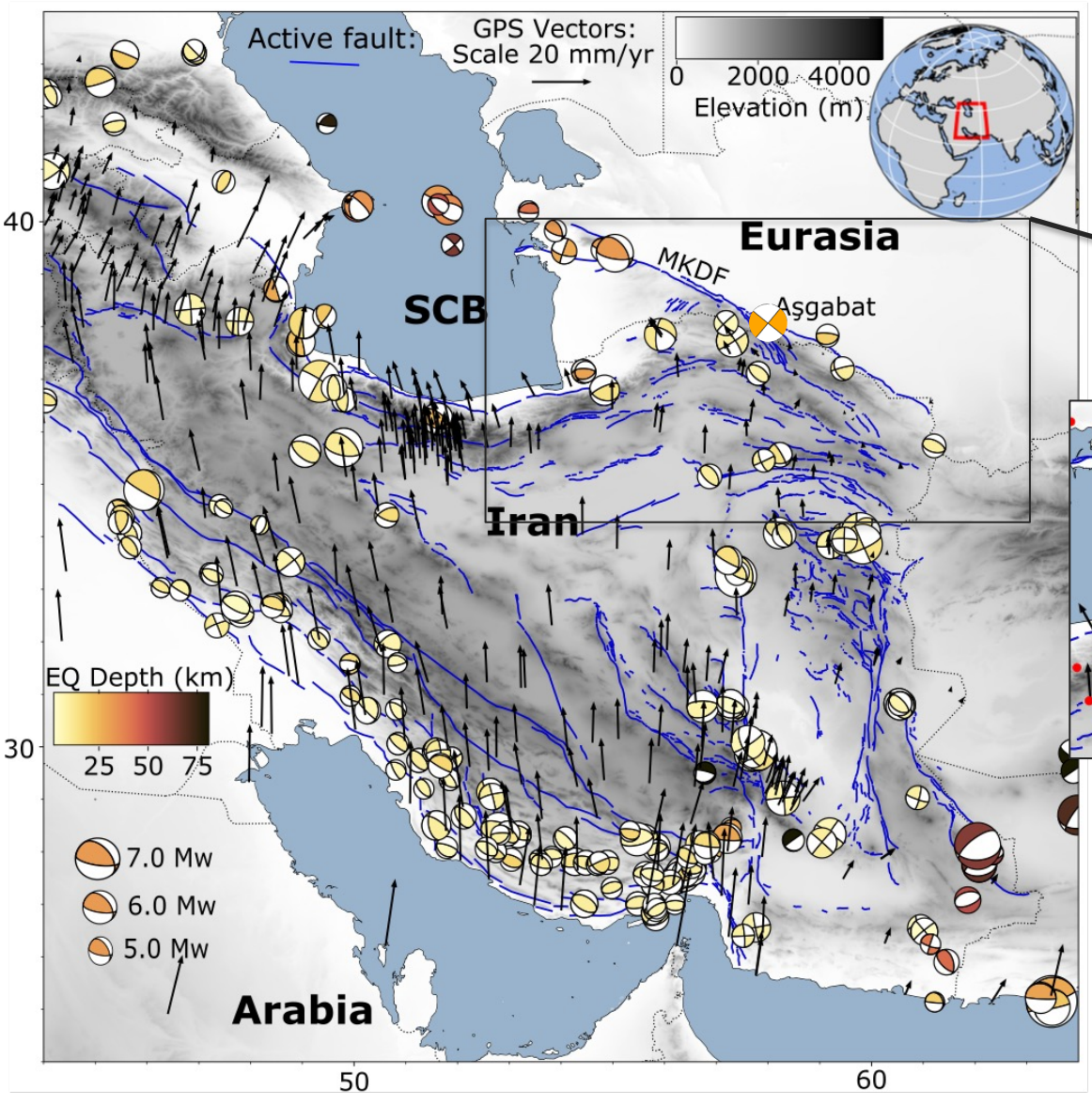
Possible multiple fault rupture in this earthquake?

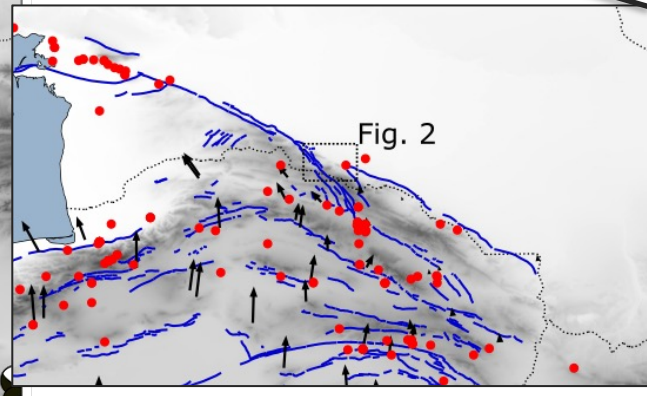
Offsets in river and stream channels indicate right-lateral motion





Regional tectonics – gap in seismicity on MKDF





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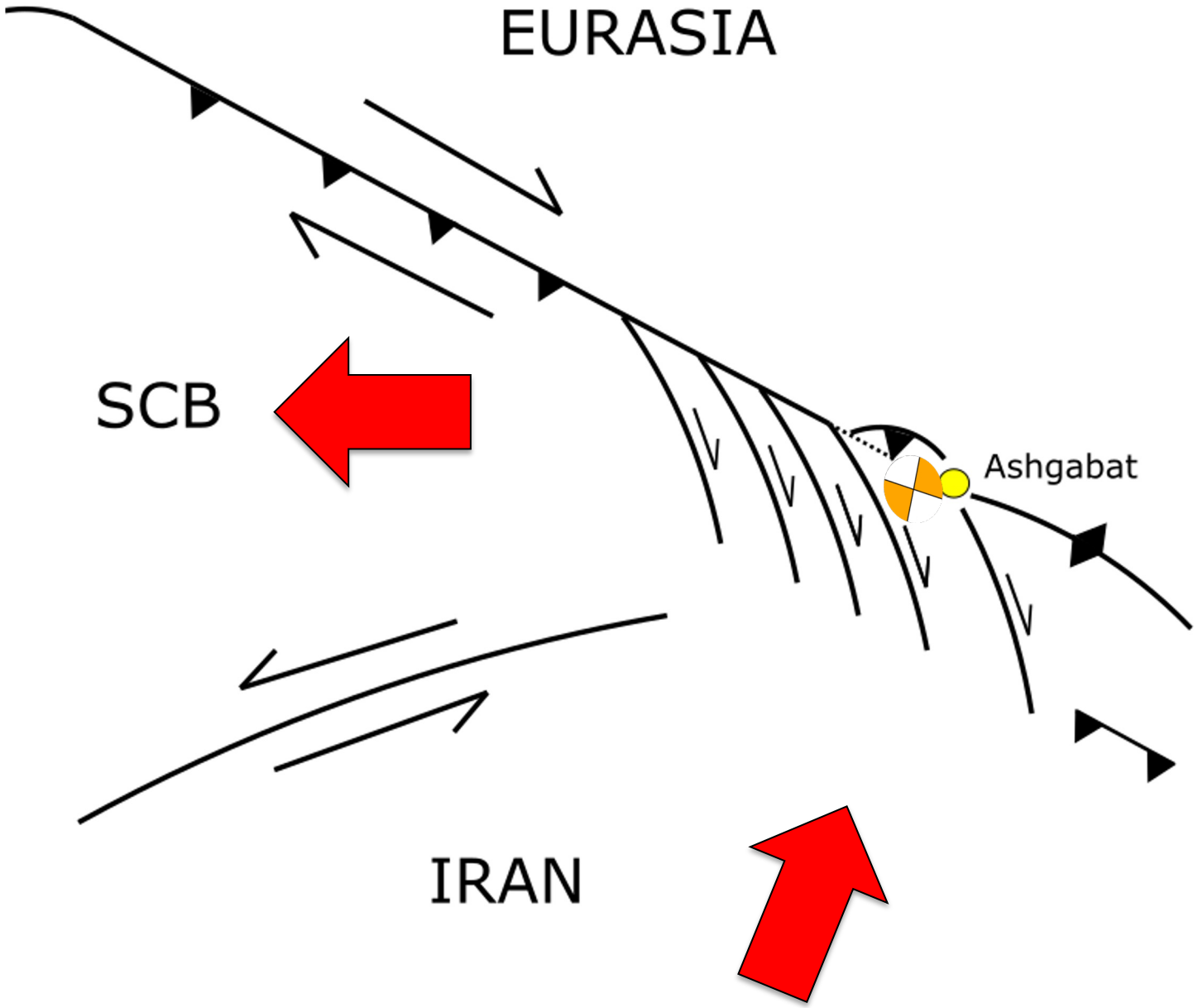

EURASIA
SCB
Ashgabat
IRAN

Conclusions

1. 1948 Ashgabat earthquake was a right lateral strike-slip, not a reverse earthquake.

2. The fault that caused the earthquake was not the Main Kopeh Dagh Fault.

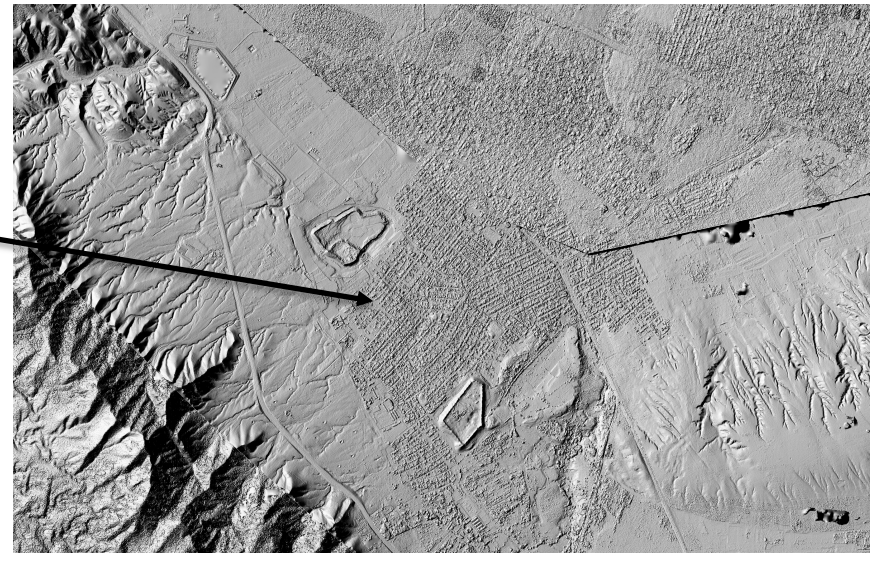
3. Multiple secondary faults ruptured in this event.

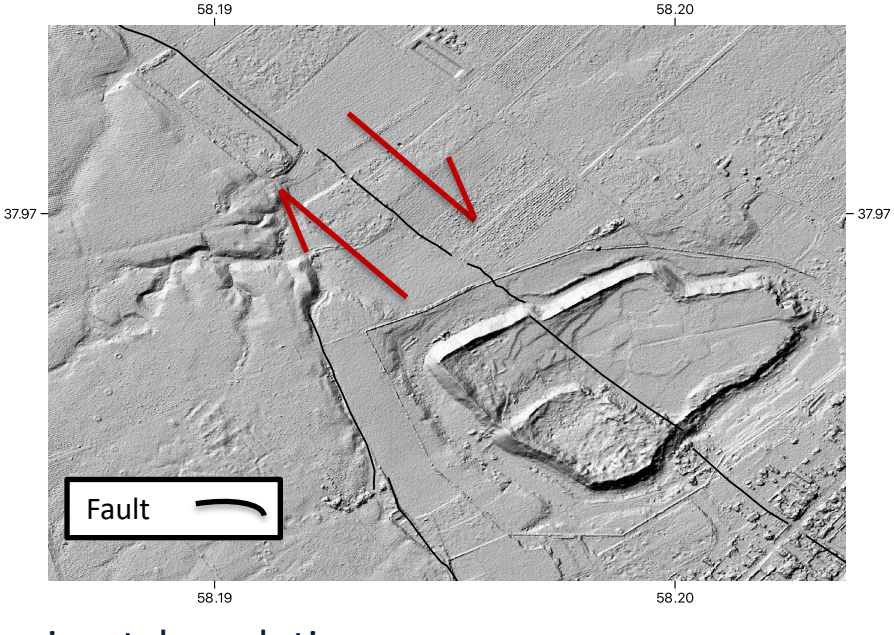
4. Tectonically right-lateral strike-slip faulting is accommodating some of the shortening caused by the Arabian-Eurasian plate collision.

5. Important to note what didn’t happen in this earthquake

Parthian Empire capital hit by earthquake?

After Benjamin, C. 2018





Worldview 3 stereo imagery gives 50cm horizontal resolution