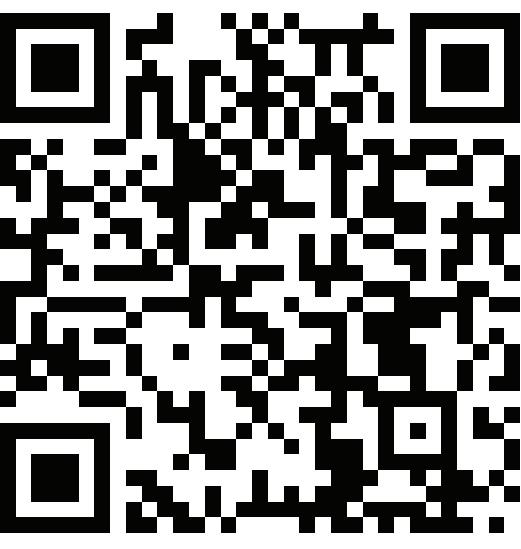


From Iceland to Mars: Fault Scaling and Tectonic Insights from an Earth Analogue

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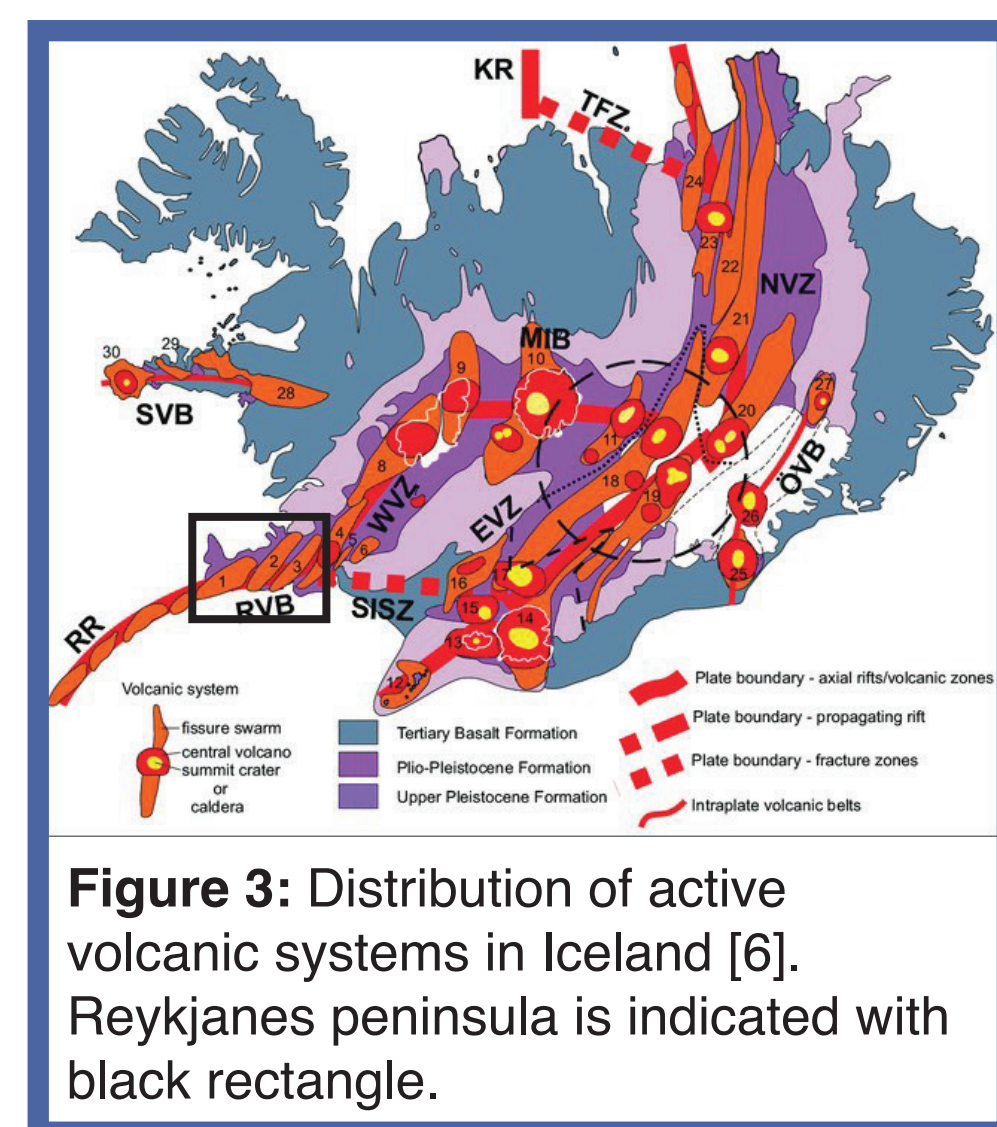
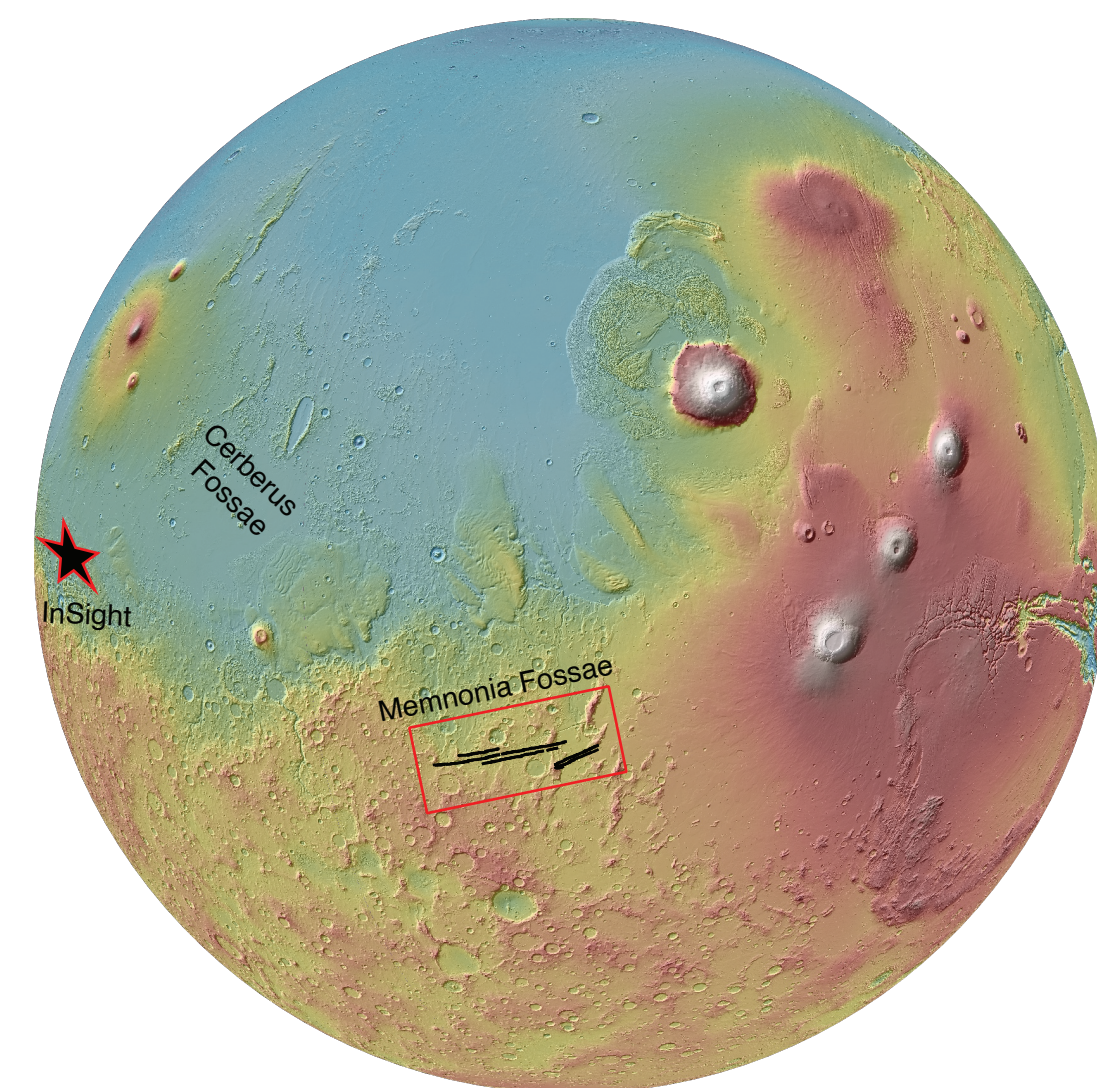
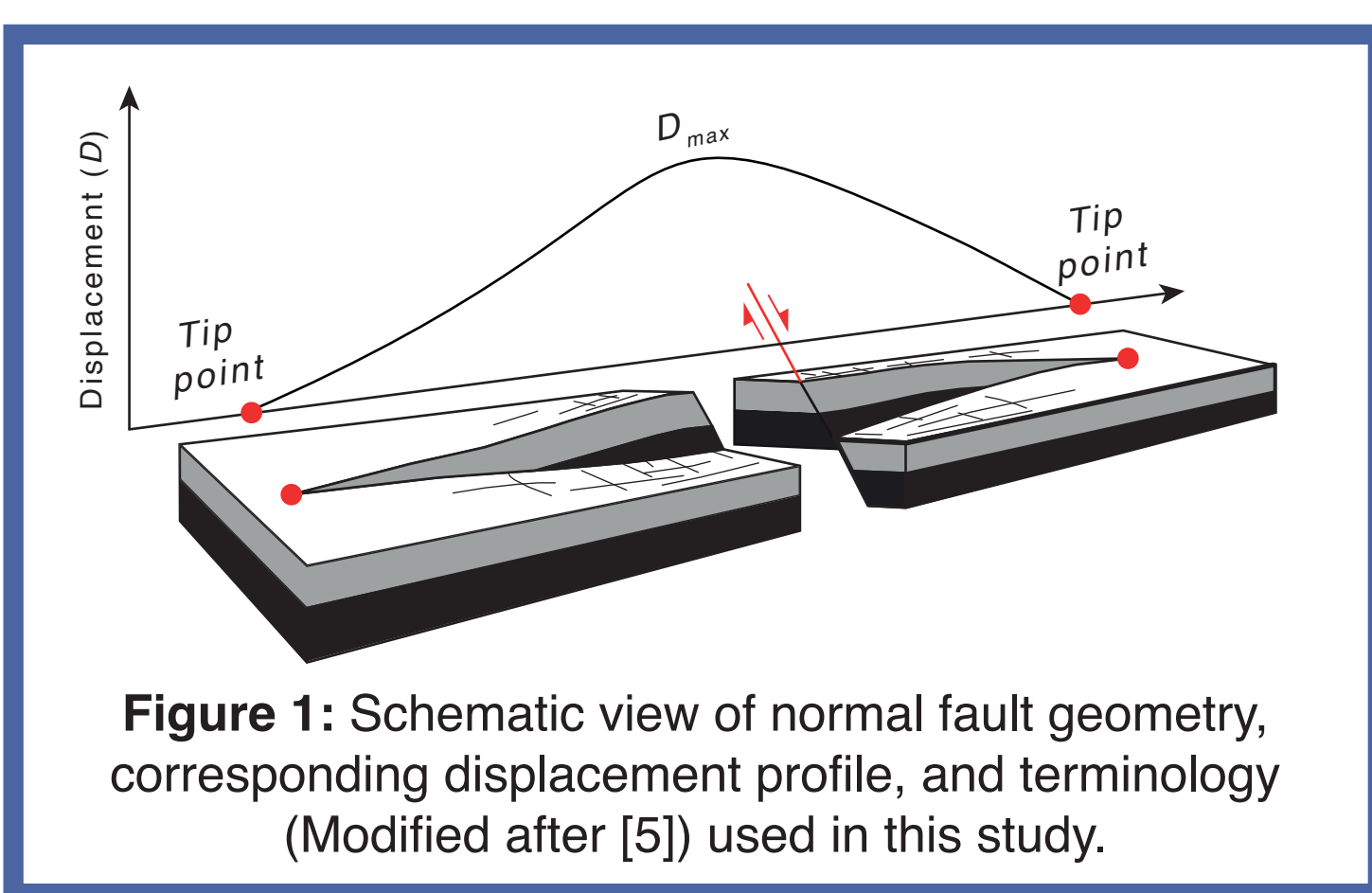
BACKGROUND

- The InSight mission detected marsquakes at Cerberus Fossae [1].
- Interest in Mars tectonics has intensified.
- Cerberus Fossae [2] --> a young extensional fracture system
- Memnonia Fossae (Fig.2) --> similar structural features but preserves a much older tectonic record
- An opportunity to investigate the long-term evolution of fault systems of Mars.

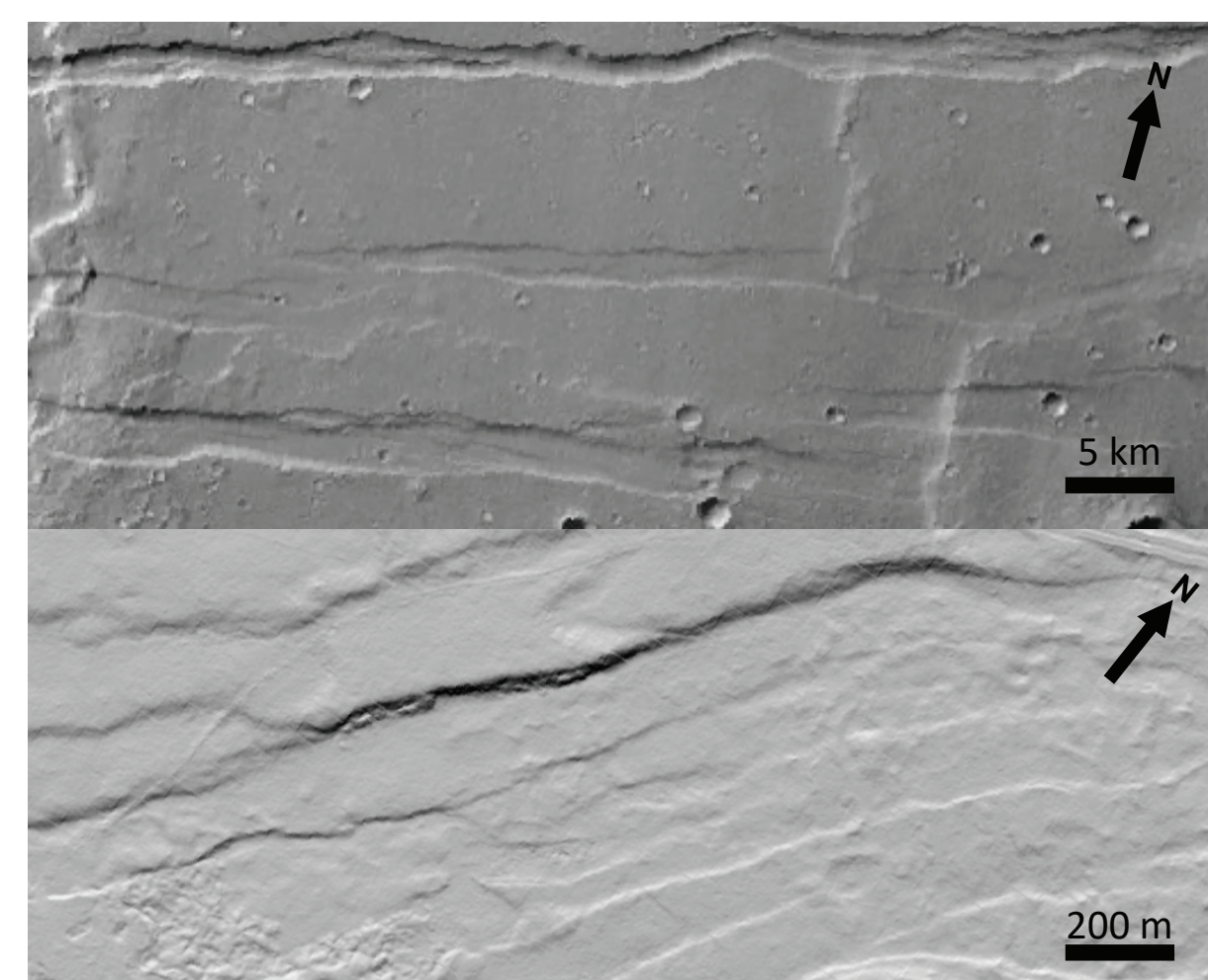
Why? Fault scaling (Fig.1) relationships are key to understanding tectonic deformation [3] especially on planetary bodies where direct geophysical data remain scarce.

Problem: Limited high-resolution topographic data in planetary science [4].

Approach: Terrestrial analogues (Reykjanes, Iceland, Fig.3) and learn from that.



Memnonia Fossae, Mars Context Camera (CTX)



Reykjanes, Iceland, Earth Arctic DEM

Both locations share:

- comparable lithologies (basalts)
- dike intrusions
- extension

DATA & METHODS

Previously we investigated 100 faults in Memnonia Fossae, Mars.

On Reykjanes, field investigations (Fig.5) included structural measurements from 74 faults and fractures across 180 sites, documenting strike, dip, opening, throw, shear, and extension vectors.

To complement these measurements, we employed ArcticDEM data (Fig.7) and high-resolution drone imagery (Fig.8), which significantly improved the topographic detail.

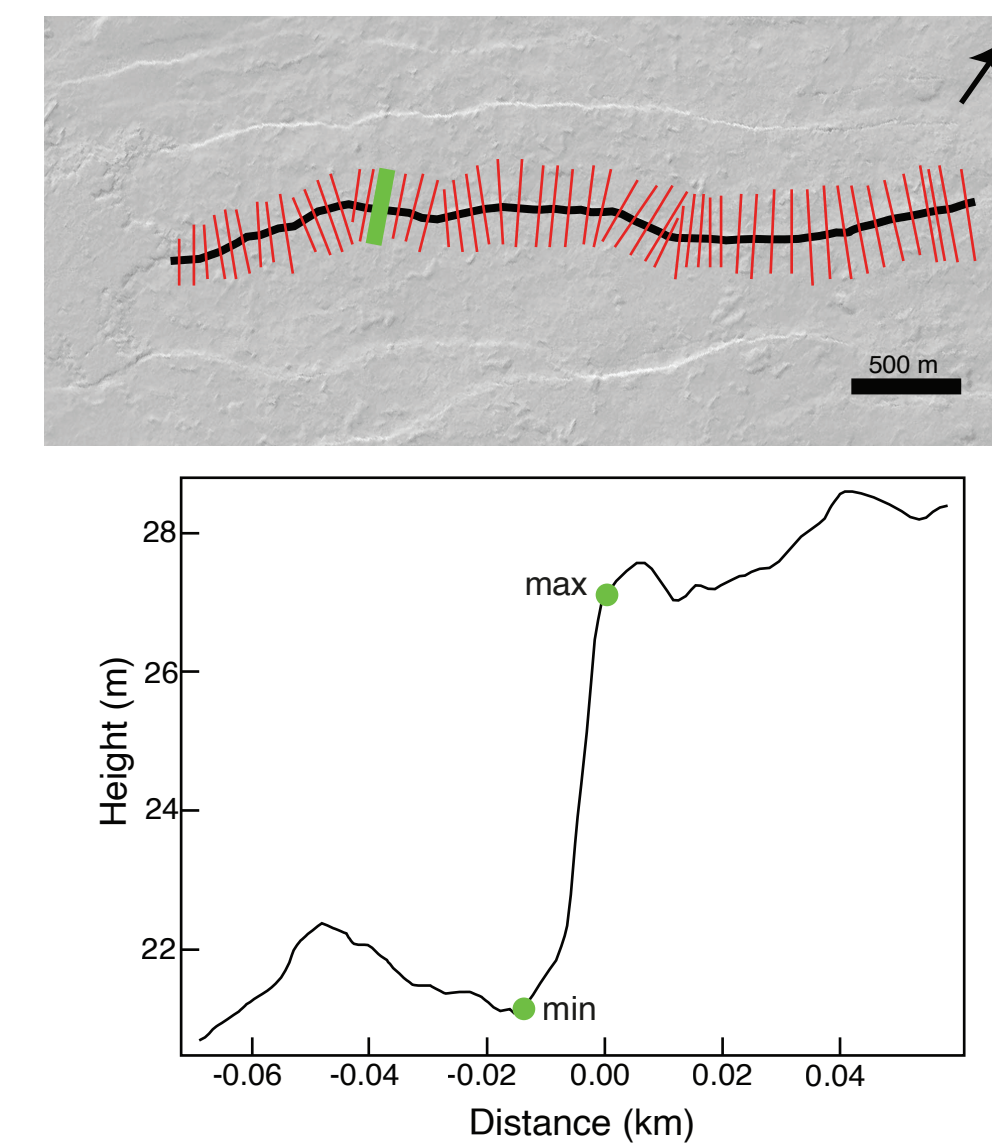


Figure 5: A normal fault observed in Reykjanes fieldwork. **Figure 6:** Dmax/L ratio measurements for the Reykjanes faults.

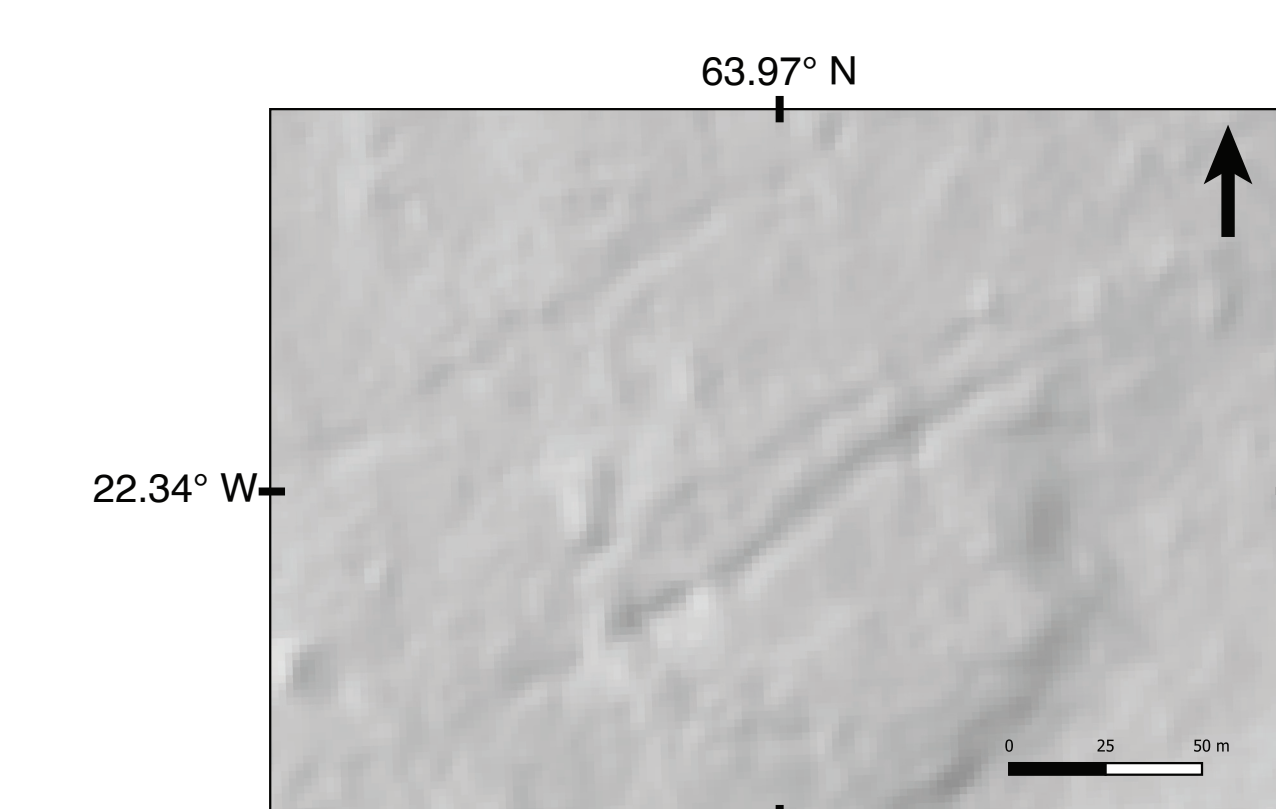


Figure 7: Arctic DEM - remote sensing data

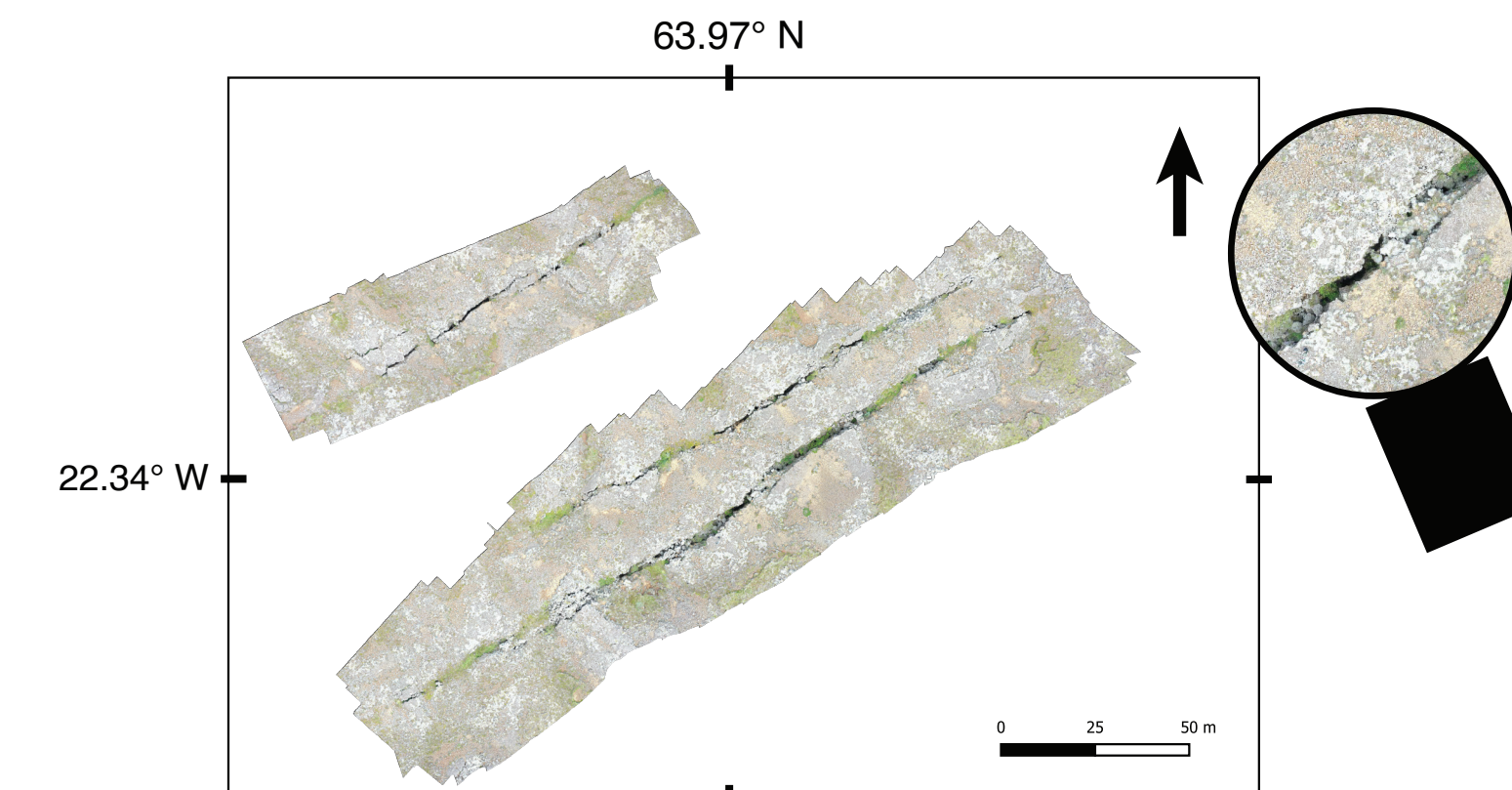


Figure 8: Drone data gathered during the fieldwork

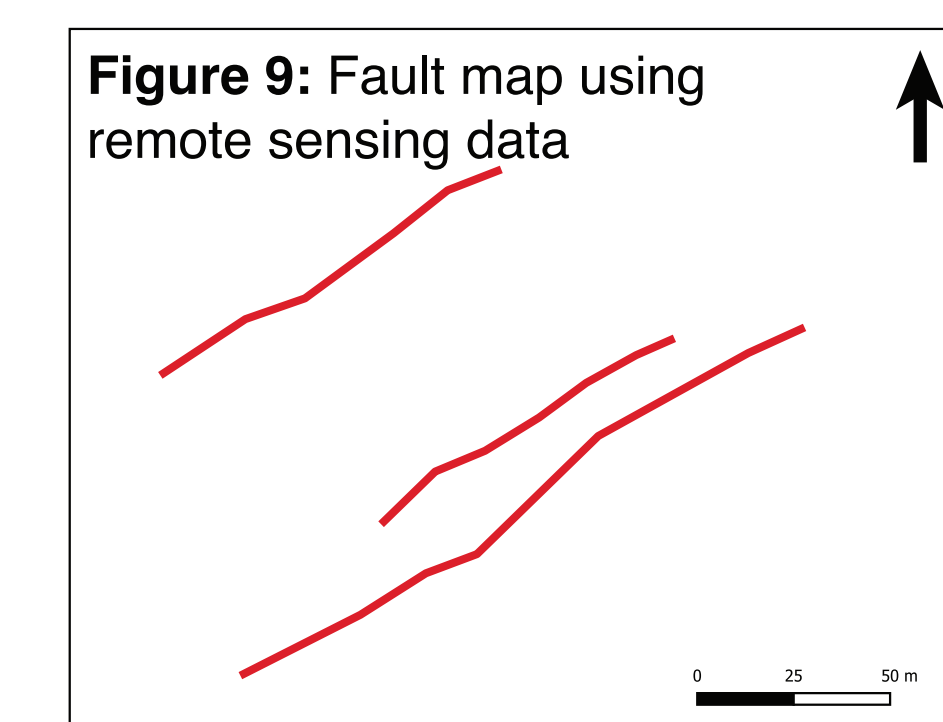


Figure 9: Fault map using remote sensing data

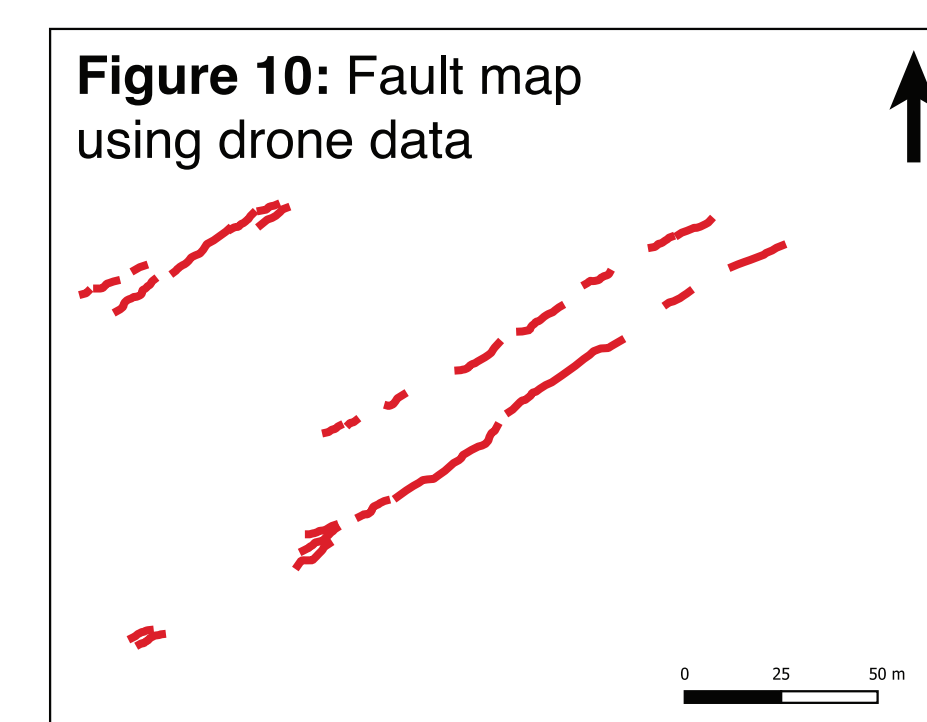


Figure 10: Fault map using drone data

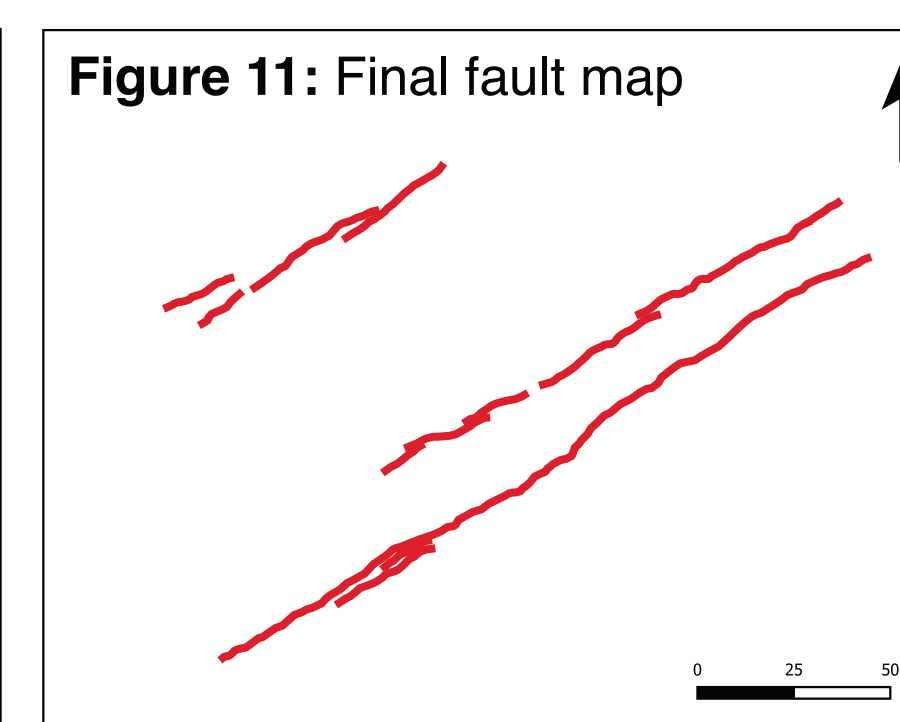


Figure 11: Final fault map

RESULTS & DISCUSSION

- 74 faults were investigated in the field (Fig.12).
- Dmax/L ratios (Fig.13):
 - 0.006 from both the field and remote sensing data for Reykjanes (Fig.6)
 - 0.007 for Memnonia Fossae
- Reykjanes faults extend our knowledge to smaller fault lengths.
 - Smallest recorded fault in Reykjanes is 100 meters, while it is 2 km in Memnonia Fossae.
 - Largest recorded fault in Reykjanes is 4 kilometers, and in Memnonia Fossae it is 43.3 kilometers.
- Faults on Mars share the geometric characteristics of faults on other terrestrial planets including Earth.
- Each dataset has limitations. Combining all datasets extends our understanding across fault scales:
 - Remote sensing data --> limited by resolution
 - Drone data --> complications from local inhomogenities such as basalt joints and vegetation obscures fault traces.
 - Field observation --> limited to smaller faults

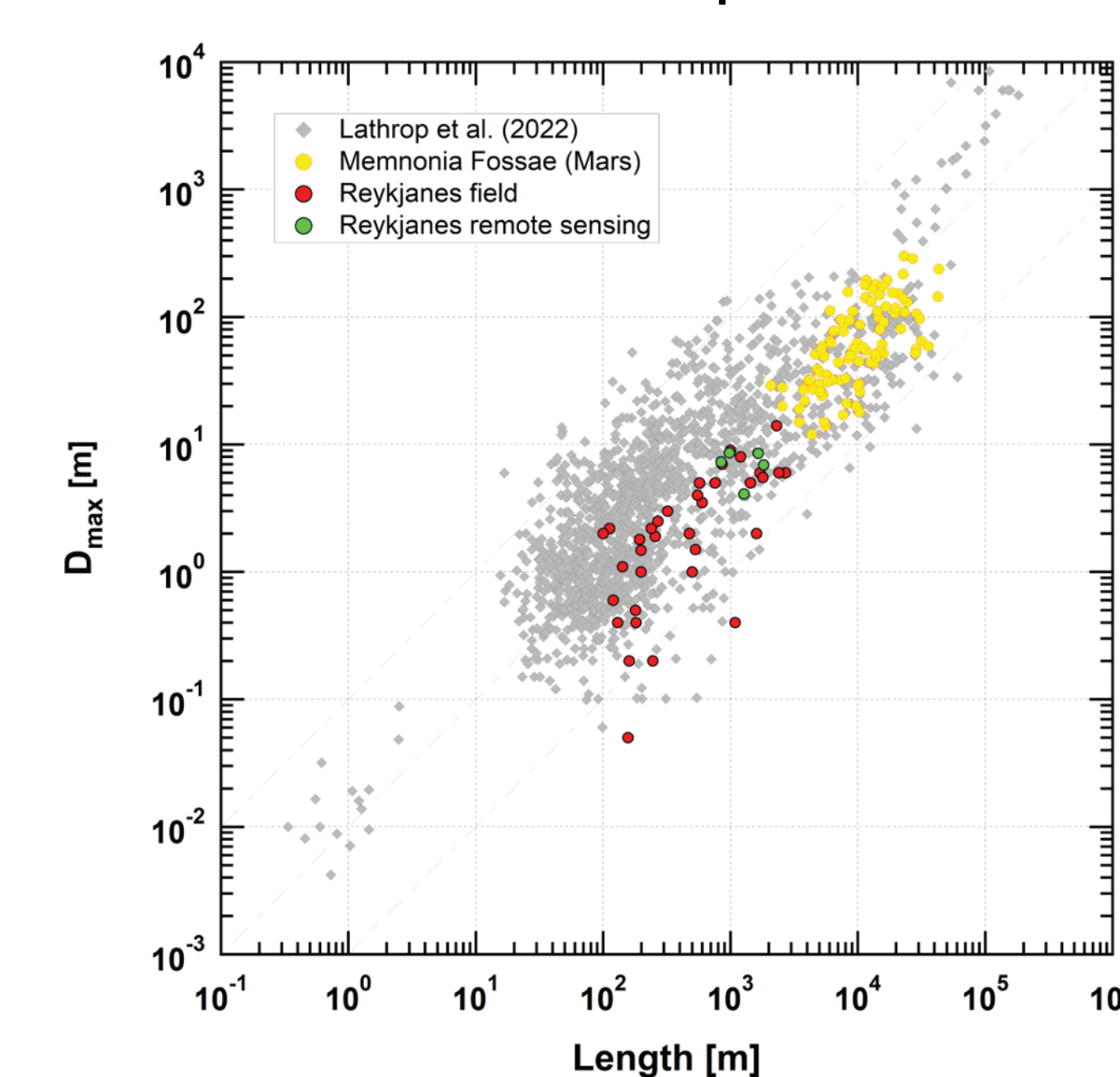
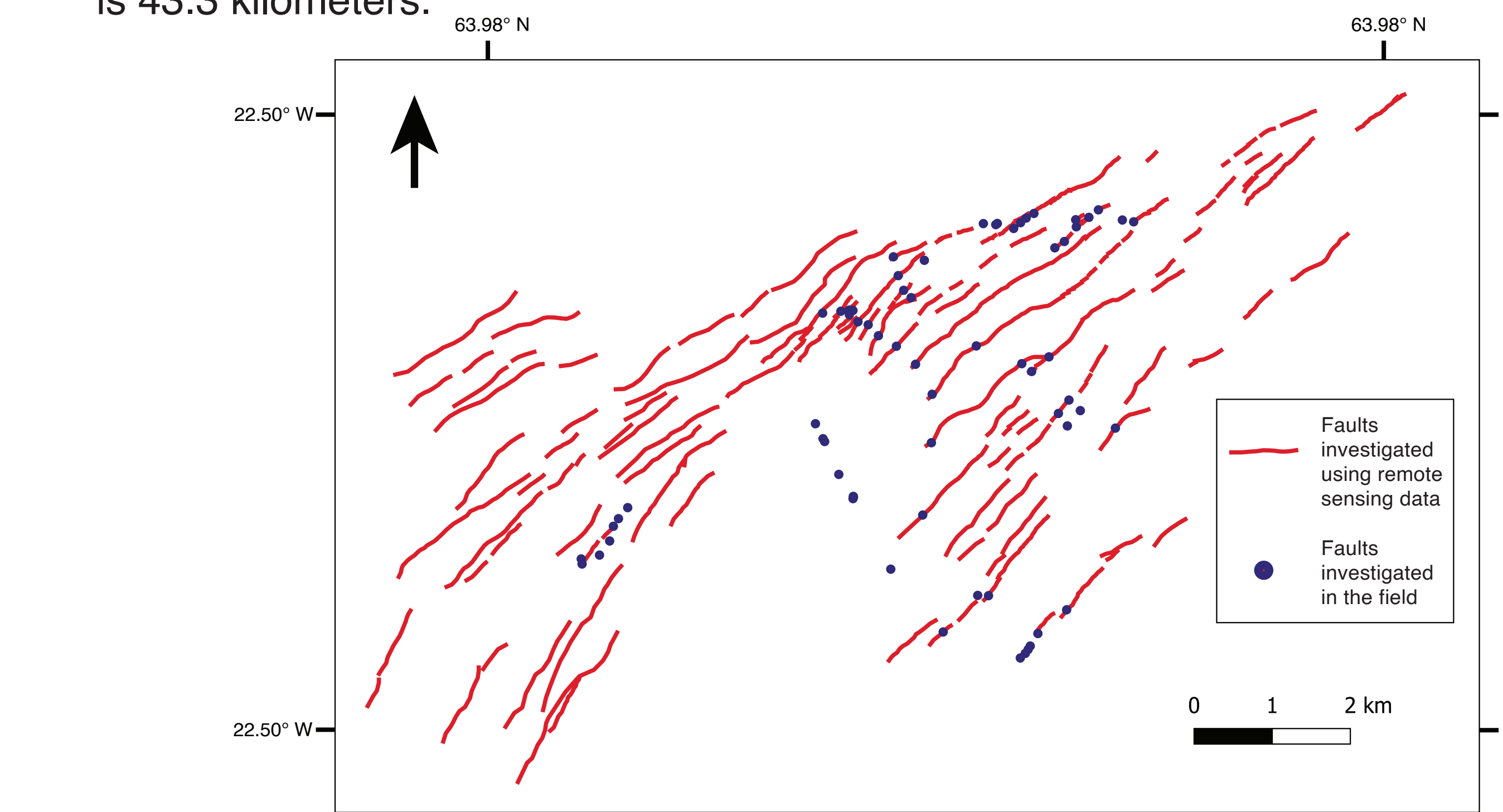


Figure 13: Comparison of Dmax/L values of volcanic rocks on Earth [7], Iceland (Fig.6), and Memnonia Fossae.

CONCLUSION

Reykjanes and Memnonia Fossae show similar fault scaling characteristics despite different ages and tectonic settings.

Multi-source Earth analogues and, in the future, rover observations are key to resolving smaller-scale faults where orbital data fall short.

Analogue studies bridge gaps where Mars geological and geophysical data are limited.

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I know how it feels. But the way we read mine will help reveal yours.



My old crust hides too many scars, I need higher resolution to trace them.

