Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-116
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TA Facility visited: Iceland

Project Title: Fault Scaling at the Southwest Iceland

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

Fault population studies reveal the lithospheric stress and strength conditions. Geometric fault properties provide insights into mechanical and temporal evolution of fault systems, as well as past and future potential for seismic energy release. Understanding the displacement-length relationship of faults can also help to estimate the current seismicity level. Improved constraints on the current seismicity of Mars based on InSight mission results, are the motivation for a renewed and detailed analysis of martian fault systems. Partly due to the limited number of reliable datasets, data on the relationships between fault displacement and length of extraterrestrial bodies are scarce. Using Digital Elevation Models (DEM) and corresponding orthoimages derived from High Resolution Stereo Camera (HRSC) data, we previously obtained information on the displacement distribution along faults and the maximum displacement (Dmax) at the Memnonia Fossae (MF) fault system on Mars.

The volcanic rifting zone in SW Iceland displays similar characteristics as MF. Specifically, the availability of airborne HRSC data (HRSC-AX) of an area characterized by widespread normal faults in the rift zone at Thingvellir, and well-exposed faults in Reykjanes, are exceptionally well-suited sites as analogues for the MF. Considering the scarcity of terrestrial analogue work complementing the analysis of planetary fault scaling, this field work helps to improve our understanding of fault scaling relationships: Our goal is to combine terrestrial remote sensing data (HRSC-AX) with ground truth to obtain a better basis for evaluating planetary fault scaling (which relies on remote sensing only).

Full Scientific Report on the outcome of your TNA visit

This study involves 2 steps:

- Remote sensing measurements from Iceland (done independently)
- Field measurements from Iceland (supported by Europlanet TA).

The first step was fault scaling and mapping of large-scale faults using remote sensing data, as the HRSC-AX data of Thingvellir and the surrounding area in Iceland are available. However, the details such as opening, shear sense, dip direction and angle of the fault surface, and the extension vector cannot be precisely detected with remote sensing as it is possible with the fieldwork. Therefore, during the fieldwork, measurements were taken from faults larger than a kilometer to support remote sensing work.

Collecting fault measurements in the field not only provides ground truth for the remote sensing data analysis, but also provides data which cannot be provided by remote sensing. As the quality of fault scaling determination increases with the length range of investigated faults, we increased the length range towards shorter faults with ground truth.

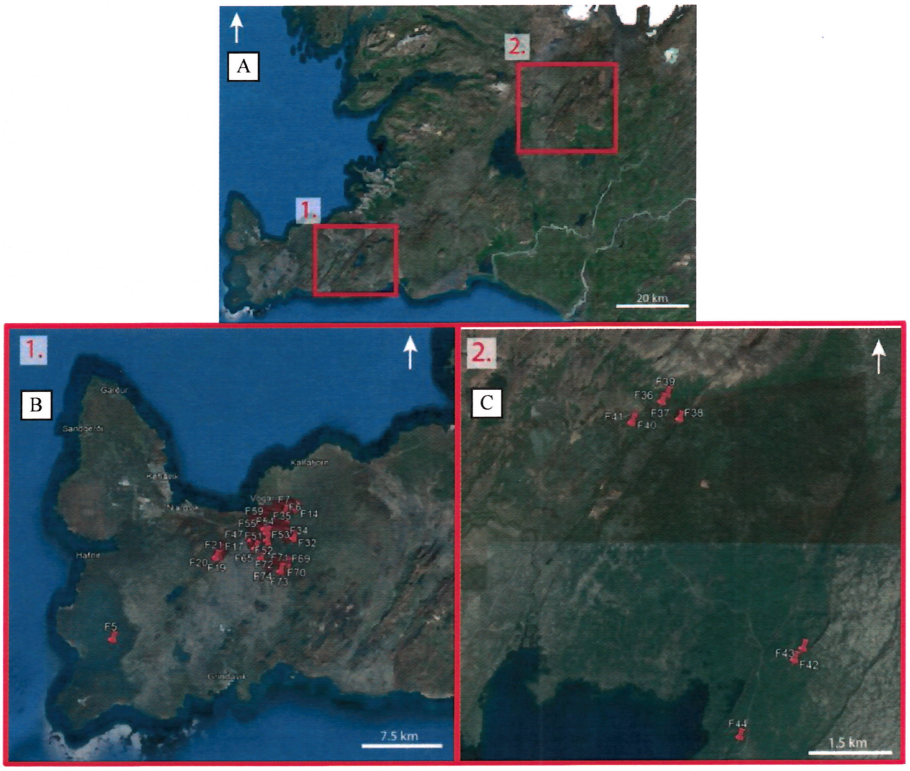


Figure 1: (A) Target study areas (red rectangles). 1st location is at the Reykjanes peninsula (B) and the 2nd location (B) is to the N and NE of Thingvellir. Red pins indicate the faults that have been visited.

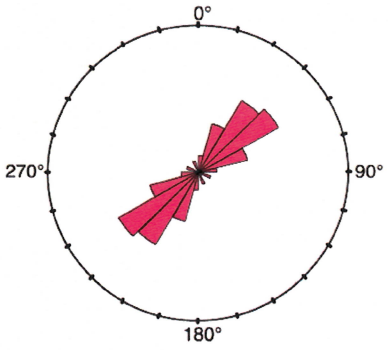


Figure 2: The rose diagram shows the strike distribution of faults and fractures measured during the fieldwork.

For the field measurements, 2 locations have been visited (Figure 1). Location 1 is at the Reykjanes peninsula and the location 2 is N and NE of Thingvellir. In both locations, normal faults and opening mode fractures in basaltic bedrock can be observed, similar to MF, Mars. Therefore, both sites are suitable as analogue sites.

- **Days 1, 2, 3, 4, 6, and 7:** Location 1 field measurements
- **Day 5:** Location 2 field measurements

The field measurements were done using these tools: GPS, a compass, measuring-tape, and a drone (DJI Mavic 2nd gen.)

Since the second location, Thingvellir, is a national park and highly vegetated area, the first location Reykjanes peninsula was better suited to generate larger data sets. Therefore, more days were spent at the first location.

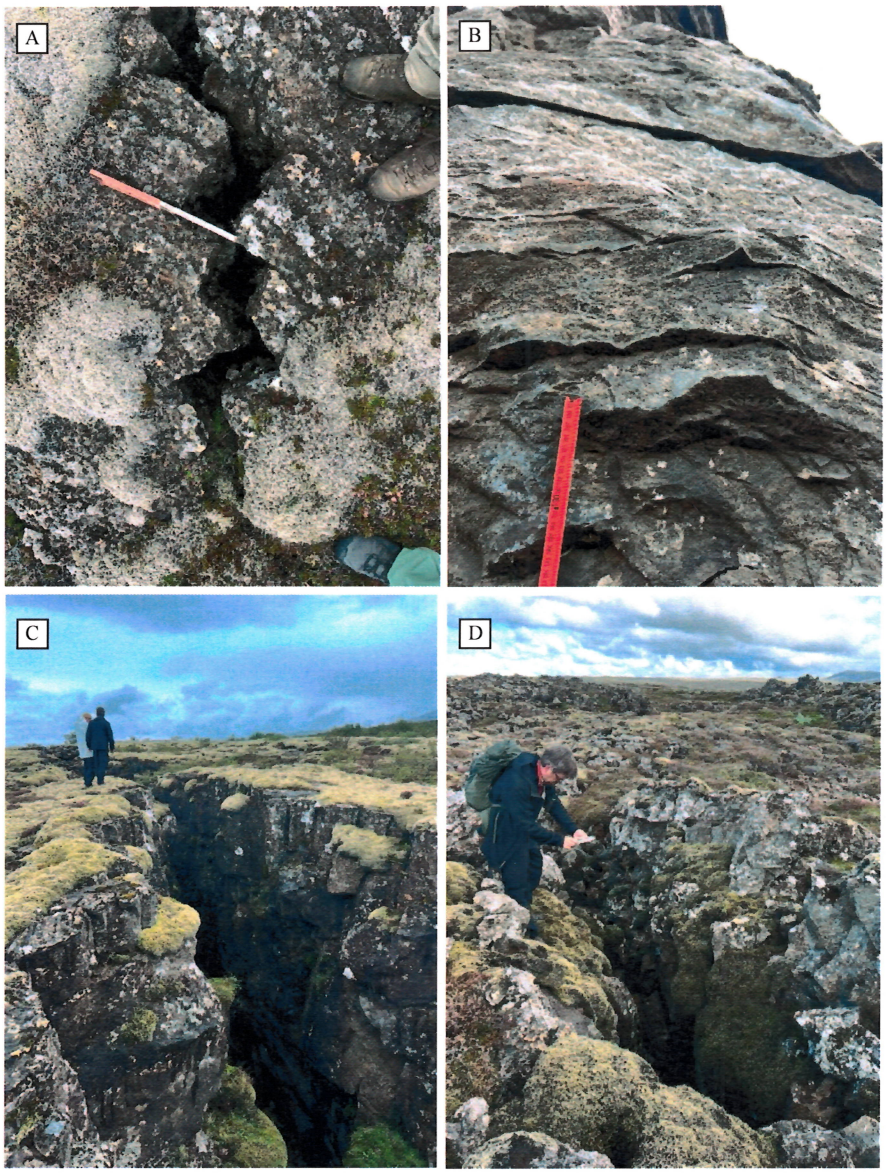


Figure 3: Examples of structures from the field: (**A**) Small opening mode fracture with visible extension vector. (**B**) Layering of the bedrock shows the shear sense of the structure. (**C**) Large fault cuts the older lava deposits, columnar basalts. (**D**) Large fault cuts the younger AA lava deposits.

A total number of 178 waypoints were recorded and inspected. 74 faults and fractures of various sizes were investigated. At the different waypoints gathered from the 74 structures, their strike (Figure 2), dip direction, dip angle, perpendicular opening, extension vector direction and length, shear component direction and length, vertical displacement length and direction were measured. These faults are located in different ages of lava flows (Figure 3: C and D). Their spatial and temporal relationship as well as the structural geological evolution are also investigated. Data gathered in the field have a substantial effect together with the remote sensing data, since investigating at different scales provide more perspective and information. This fieldwork encompasses not only an investigation into Icelandic geological phenomena but also serves as a holistic exploration of fault scaling dynamics, with potential implications for advancing remote sensing-based fault scaling research on diverse celestial bodies.

- Give details of any publications arising/planned (include conference abstracts etc)

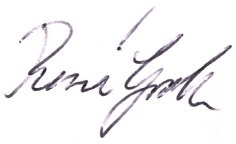
One or two journal papers, conference abstracts for the upcoming conferences such as LPSC and EGU are planned publications.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 01.08.2023 Arrived: 01.08.2023	02.08.2023	1	7	1	10.08.2023	Departed: 10.08.2023 Arrived: 10.08.2023

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	René Groben, Matís ohf., Iceland
Host Signature	
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- Project Leader confirmation

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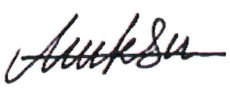
Project Leader Signature	
Date	05.09.2023