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Icelandic analogues for faulting in the volcanic regions of Mars: the impact of data resolution and magmatic resurfacing events on understanding fault growth behaviour

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Despite differences in the tectonic settings on Mars and Earth, comparative studies of normal faulting behaviour on these two planets could be one of the routes to understanding parameters, such as surface gravity and lithospheric strength, which control variations in crustal processes across planetary bodies. Comparisons can be made between the distribution of Terran maximum displacement/length (Dmax/L) relationship of faults and those measured on Mars. However, usefully extracting values controlling differences in fault growth behaviour relies not only on being able to constrain the effects of differences in data resolution but also in understanding variations in tectonic settings on Earth. In this study we have compared Dmax/L measurements made at a range of resolutions on Earth at the actively rifting, Krafla volcanic zone, NE Iceland, and on Mars in the region of fault systems to the north of Alba Patera. For the Krafla faults, we created a 0.5 m resolution digital elevation model (DEM) of the area from airborne LiDAR, additionally downsampling to create 10 m and 30 m DEMs. From these we measured three major fault systems, as single faults at 30 m resolution, and all component faults at 10 m and 0.5 m resolution. For the Martian faults we measured fault systems as single faults using ∼463 m resolution Mars Orbiter Laser Altimeter (MOLA) data and as component faults using ∼6 m resolution Context Camera (CTX) from the Mars Reconnaisance Orbiter (MRO).

Additionally, to allow comparative measures between the magmatically resurfaced regions of Alba Patera and similar regions on Earth, we used the 0.5 m resolution to measure the displacement/length profiles of 775 faults in a magmatically resurfaced area of Krafla to develop a model of fault growth through resurfaced layers, with lengths ranging from 10s to 1000s of metres. We suggest that, from the Krafla data, the variation in resolution can account for a substantial amount of the spread observed in the published dataset and that it is possible to establish whether a measured fault is likely to be a single fault, without segmentation, regardless of the resolution it has been measured at, based on its location within the distribution of the published Dmax/L dataset. Additionally, the data show that, in a magmatically resurfaced region, continued fault growth may result in a lower Dmax across the fault system (measured as a single fault in low resolution data) as the fault re-establishes through a segmented system of faults at the surface. By comparing the Martian and Terran data we show that both the resolution of the data and influences such as resurfacing should be taken into consideration when using comparative studies.