Examination of the similarity between crack patterns due to dry fracture on the ground and heat-shrink polygons on Mars

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Polygons of several tens of meters formed by thermal contraction have been found in the middle and high latitudes of Mars. These polygons may limit the past and present Mars environmental conditions, and research is ongoing. (e.g., Levy et al., J. Geophys. Res. (2009))
Shape, size, and direction of the polygon are determined by various environmental conditions around the polygons. In particular, the shape of polygons found in the crater tends to have anisotropy according to the angle of the slope. It is reported that the shape is close to a rectangle parallel to the slope direction in the steep region, but it becomes random in the gentle slope region at the bottom of the crater bottom(e.g., Ulrich et al., Geomorphology (2011)). A conventional theory suggested that the anisotropy of the shape depends on the slope angle.
On the other hand, it was reported that a similar anisotropic crack pattern appeared in an analog experiment on the ground. When the shear stress induced by vibration exceeds the yield stress of the paste, it can remember the memory of vibration and, when it dries, the direction of crack propagation depends on the memory of such motion(memory effect of paste; Nakahara and Matsuo, PRE (2006)). The dry crack pattern usually takes a random shape. Since the paste is easily broken in the flowing direction, when the paste is flowed along the slope, a dry crack pattern close to a rectangle parallel to the slope is formed. This phenomenon is attributable to that a cluster structure of particles extending parallel to the flowing direction is formed microscopically, and this structure is maintained because of its plasticity. The point is that not only the external force but also the rheology (plasticity, etc.) of the fluid affects the shape of the dry crack pattern. This phenomenon is close to the thermal contraction polygon on Mars, and anisotropic shapes may be formed due to factors other than the slope angle. In that case, it is expected that not only the slope angle but also the properties of the soil in the past are factors that determine the anisotropy of the polygon shape. By testing this hypothesis, it may be possible to constrain the properties of the soil in the past (such as plasticity, rheology and then water content).
In this study, we used the image data of HiRISE, a high resolution camera mounted on MRO(NASA). We quantify the anisotropy by measuring the angle of the polygon shape and find the threshold of the slope angle where the anisotropy appears. We further check a range of the threshold values in different types of polygons and evaluate the validity of slope angle as a controlling factor of the polygon anisotropy.

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