Chaotic Caldera collapse: a new interpretation for the origin of Chaotic terrains on Mars

Erica Luzzi¹, Angelo Pio Rossi¹, Matteo Massironi², Riccardo Pozzobon², Daniele Maestrelli³, and Giacomo Corti³

¹Jacobs University, Physics and Earth Sciences, Bremen, Germany (e.luzzi@jacobs-university.de)
²Dipartimento di Geoscienze, Università degli Studi di Padova, Padova, Italy
³CNR-IGG, The National Research Council of Italy, Institute of Geosciences and Earth Resources, Florence, Italy

Chaotic terrains are broad regions on Mars characterized by the occurrence of angular-polygonal blocks separated by deep fractures and grabens, associated with collapse chains and with the overall mineralogy consisting mainly in basalts (Luzzi et al., submitted, 2020). Several mechanisms of formation for Chaotic terrains were proposed in the literature. While it is a shared opinion that the peculiar structures delineating the polygonal blocks of the Chaotic terrains are due to a collapse, the actual process at the origin of such collapse is still debated. Collapses due to the overpressure within a confined aquifer were proposed (Rodriguez et al., 2005; Andrews-Hanna & Phillips, 2007) as well as related to magma-ice/water interactions (Chapman & Tanaka, 2002; Leask et al., 2006; Meresse et al., 2008), or melting of a buried frozen lake (Zegers et al., 2010). We propose a new formation scenario for Chaotic Terrains: a Chaotic (or Piecemeal) Caldera collapse. In such a Caldera collapse the fragmentation of the floor is irregular and characterized by polygonal blocks. We reproduced this process in a series of analogue experiments similar to those performed by Troll et al. (2002): a rubber membrane was used to simulate the magma chamber with multiple cycles of inflation and deflation that generate the characteristic fractures in an overlying K-feldspar sand layer. We performed the experiments in different settings (different geometry of the magma chamber and different depth) and we found that the geometry of the basin is influenced mainly by the shape of the magma chamber. Moreover, after the second cycle of inflation and deflation, the deformation tends to be moderate, consisting only in the formation of minor fractures and not in deep structures, responsible for the polygonal blocks fragmentation, which are instead formed during the first cycles. From a morphological point of view, the reproduced geometry is strikingly similar to that of Chaotic terrains on Mars. Further quantitative analyses on the DEMs are ongoing in order to assess the role played by each variable and refine a plausible collapse history for the specific case of study of Arsinoes Chaos.

REFERENCES


Luzzi et al. (2020). EarthArXiv, DOI: 10.31223/osf.io/td297


