

EGU21-79

<https://doi.org/10.5194/egusphere-egu21-79>

EGU General Assembly 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



The large-scale troughs on Asteroid 4 Vesta are opening-mode fractures

Hiu Ching Jupiter Cheng and Christian Klimczak

Structural Geology and Geomechanics Group, Department of Geology, University of Georgia, Athens, GA 30602, USA
(jupiterchc@uga.edu)

The Dawn mission at Asteroid 4 Vesta revealed two sets of enormous linear structures. Both sets are troughs—linear, negative-relief landforms—with one spanning around at least two-thirds of the equator and the other set incompletely preserved in the northern hemisphere. A previous study evaluated the cross-sectional geometries of the troughs and interpreted them as analogous to grabens, which are landforms caused by normal faults. However, for the troughs to be large-scale opening-mode fractures, i.e., joints, was heretofore not considered. To distinguish between normal faulting and jointing, we investigated the map patterns, cross-sectional geometries, and variations of relief and width along the length of these troughs. Relief and width are meaningful measurands that causally relate to the vertical displacement of faults or aperture of joints, respectively. Their distributions along the trough length should thus reveal differences in fracturing behavior. In addition, we derived strength-depth profiles to characterize the rheologic structure of Vesta's lithosphere and determine the predicted fracturing behavior in its brittle regime.

We mapped all large-scale troughs on Vesta, including four equatorial and two northern troughs, and no map patterns diagnostic for faulting were identified. The troughs are bounded by scalloped rims and mainly show V- and bowl shapes in cross-section. The variation of reliefs of the two-opposing trough-bounding scarps reveals that the relief maxima for each of the investigated troughs are located off-center, and at different locations along the trough they bound. In contrast, we found that both the individual and cumulative variations in trough width have their maxima near the center of the trough. These map patterns and geomorphologic characteristics are largely inconsistent with the mechanics of graben formation but instead point to an origin by opening-mode fracturing. Moreover, our calculations of lithospheric strength evolution that enable assessments of fracturing behavior reveal that Vesta's lithosphere has been dominated by a thick brittle portion throughout its history. Solutions to the Coulomb criterion considering a range of strengths properties of intact to fractured basaltic materials are in support of jointing as the major fracturing mode in at least the upper ~14 km of Vesta's lithosphere.