A TECTONIC ORIGIN FOR NON-MASCON RELATED LUNAR GRABEN.
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Introduction: Tectonic features and their spatial distributions can be used to probe the evolution of the stress state of the Moon. Furthermore, the morphology of individual tectonic structures can be diagnostic of the source of stressed that induced their formation.


Figure 1: A graben outside Oceanus Procellarum.

Some of the youngest landforms across the lunar surface include lobate scarps that reveal evidence of near-surface contraction [1, 2]. An earlier period of basin localized deformation produced tectonic structures that exist radial and concentric to the nearside mare basins [3]. These older features within and proximal to the mare basins include graben (Fig. 1) and wrinkle ridges produced by tectonic stresses related to loading by mare basalts [4, 5, 6]. An alternative hypothesis for forming basin concentric graben is volcanic dike intrusions [7, 8]. The distribution and characteristics of nearside graben is a key component of the mare-localized tectonics.

An established relationship between the topographic profile of basin concentric graben to determine whether their morphology is more consistent with dike intrusion or passive tectonics [9]. If a graben is formed due to dilation by a subsurface dike, it will have prominent flanking uplifts that decay rapidly away from the central trough whilst passive graben formation will exhibit flanks that decay much more gradually [9] (Fig. 3). This approach has also been used to identify dike related graben within Schrodinger basin and the rim of the South Pole Aitken Basin [8].

We propose a systematic approach to exploring graben around mascon basins and non-mascon mare and make observations of the graben topography assessing their flank uplift morphology for both mascon and non-mascon basins. We initially select Oceanus Procellarum as a non-mascon mare, and sample graben around its northwestern edge.

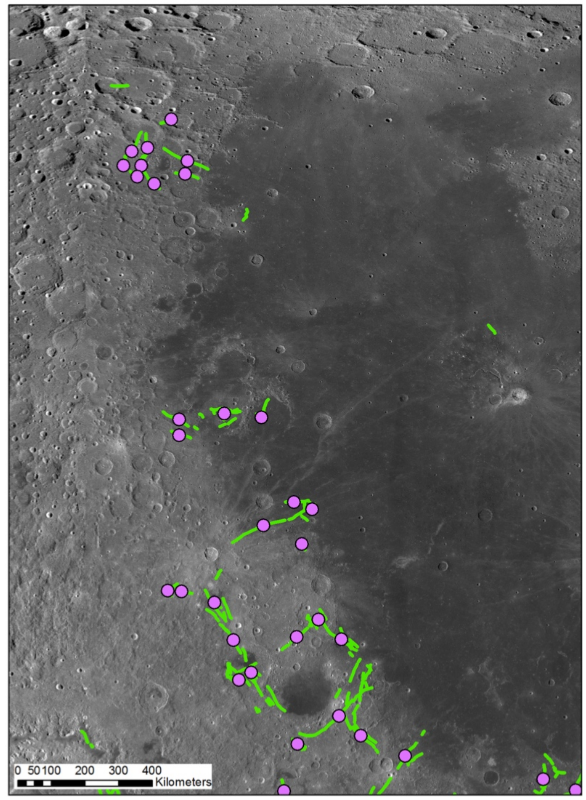

Figure 2: Lunar graben (green) mapped around Oceanus Procellarum and locations on individual graben identified for this topographic analysis are shown in purple.

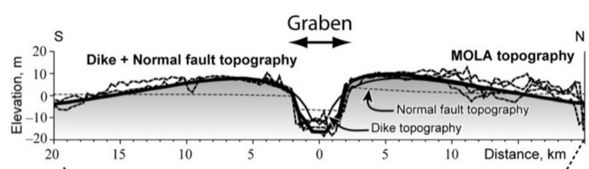

Figure 3: Figure 10.14b of [9] highlighting the characteristic topographic signature of a graben formed by dilation of a subsurface dike (bold black line) and a passive dike (thin dotted line).

Methods: We utilize a global graben map [10] to select target graben that are most likely to be influenced by stresses local to the basin. These graben did not include fractures within floor fracture craters or graben in close proximity to other known local mascons.

The LROC WAC DTM (GLD100) was used to accumulate topographic profiles across individual graben to assess their morphology. Figure 2 shows a region of Oceanus Procellarum where mapped graben have been selected as targets for this work, and locations along these graben ideal for topographic analysis are identified. These locations include sections of uninterrupted graben that were not heavily modified by crater impacts, mass wasting, or other degradation. Profiles can be examined for evidence of characteristic morphologies attributed to graben formed by dilation from subsurface dikes (illustrated in Figure 3).

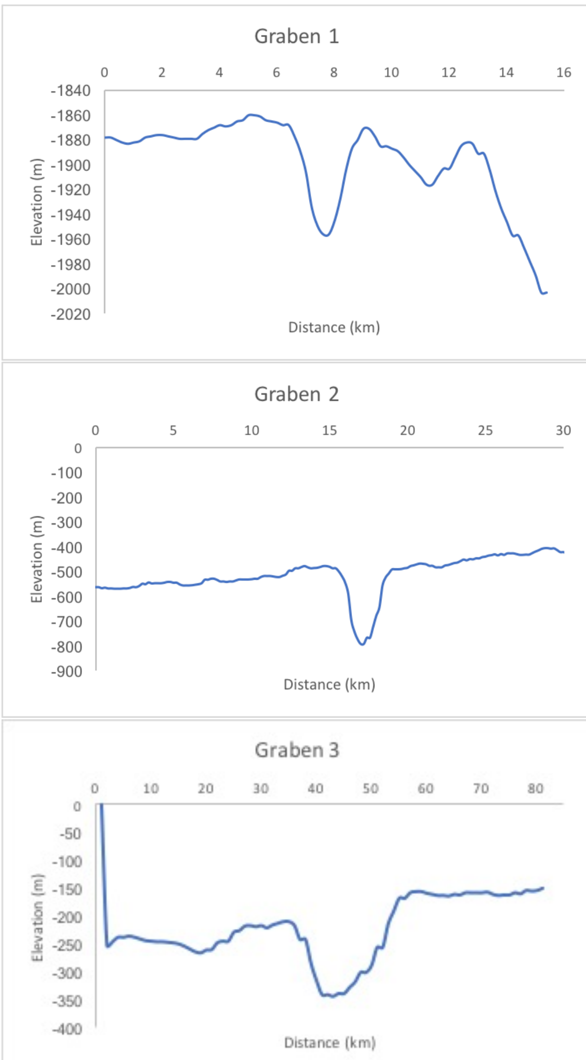

Figure 4: Topographic profiles from the LRO WAC global stereo of targeted graben identified around Oceanus Procellarum. None of these graben appear to have uplifted flanks that decrease slowly with increasing distance from the central trough.

Results: Figure 4 highlights graben around Oceanus Procellarum identified for this study. The three graben highlighted here show little evidence of uplifted flanks within close proximity to the central graben. If dike intrusion were forming any of these graben, the uplifted flanks would show a more gradual tapering off (thin dotted line in Fig. 3). The profiles (Fig. 4) have not been detrended or averaged and additional graben will be selected to verify that the pattern of graben morphology around Oceanus Procellarum is consistent with preliminary results (Fig. 4).

Discussion: The mascon tectonic model proposes that contractional and extensional structures in mascon basins are the result of the accumulation of mare basalts on an impact-thinned and weakened lithosphere that results in load induced flexure and subsidence causing contraction in the interior of the basin and extension near the margins [4, 5, 6]. GRAIL gravity data clearly shows that Procellarum is not a typical lunar mascon [11, 12]. Our preliminary results suggest that non-mascon related graben are tectonic in origin. This suggests an alternative mechanism must be sought to account for graben generated by passive normal faulting unrelated to mascons.

Future Work: We will present additional profiles around basins associated with mascons, and those not associated with mascons to compare whether any patterns in graben morphology exists to support a passive or volcanic dike intrusion model for basin related graben formation

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