AGES OF FAULT STRUCTURES ADJACENT AND RUNNING SUBPARALLEL TO PARALLEL TO VALLES MARINERIS.

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Introduction: There are "graben" like features that are adjacent and run subparallel to parallel to Valles Marineris (VM). Some of the "graben" terminate against Valles Marineris suggesting that the "grabens" pre-date VM. The "grabens" also sometimes merge into collapse features. These observations suggest that the "grabens" and VM may have initiated in the same stress field. The merging of "grabens" into collapse features suggests that the "grabens" are the first stage in the process of forming VM.

Andrews-Hanna [1-3] developed a model for the formation of VM. During the Noachian volcanism resulted in the formation of the Tharsis volcanic bulge. Lithospheric support of the bulge resulted in it being in a super-isostatic state. Formation of Tharsis over the pre-existing crustal dichotomy boundary led to differential flexure due changes in the thickness of the volcanic pile (i. e., load) across the boundary. This resulted in a narrow belt of strong tensile stresses to the south of the buried dichotomy boundary near the present day Valles Marineris. The stresses resulted in near vertical fractures parallel to the present day VM. The fractures filled with magma. Liquids have no strength, so across the near vertical fractures there would have been no flexural support. There were undoubtedly multiple subparallel fractures, which caused blocks of lithosphere to change from being under super-isostatic conditions to more isostatic conditions. Since these blocks were no longer being supported, they subsided initiating the formation of VM. Subsequent sedimentation into this new depression and viscous flow in the lower crust would have resulted in additional subsidence.

This model predicts that the initial fracturing would have taken place over a short time interval. We hypothesize that dating of the "grabens" could date this initial phase of development. In addition, these "grabens" might provide evidence for the presence of the proposed steeply dipping fractures that initiated the formation of VM.

Methods and Results: We collected preliminary estimates of the model ages for the formation of "grabens" by dating features, which are cut by the "grabens" and features that cut the "grabens". We used JMars to count craters and measure their diameters over selected areas and used CraterStats [4] to determine model ages. The features cut by "grabens" are lava flows and impact craters and **Figure 1** is a histogram of model ages. Ages range from 3.5 to 3.9 Ga with the youngest age $3.5^{+0.01}/_{-0.3}$ Ga. Features that cut the "grabens" are ejecta blankets and impact craters and **Figure 2** is a histogram of model ages. Ages range from 0.1 to 3.5 Ga with the oldest age being $3.5^{+0.08}/_{-0.2}$ Ga. **Figure 2** is biased towards younger ages because we dated ejecta blankets. Based on Andrews-Hanna's model the floors of Valles Marineris should post-date VM initiation. **Figure 3** shows that VM canyon floors range in age from 2.6 to 3.5 Ga with the oldest age being $3.5^{+0.04}/_{-0.05}$ Ga.

Figure 1: Ages of Lava Flows and Craters Cut by Graben Faults

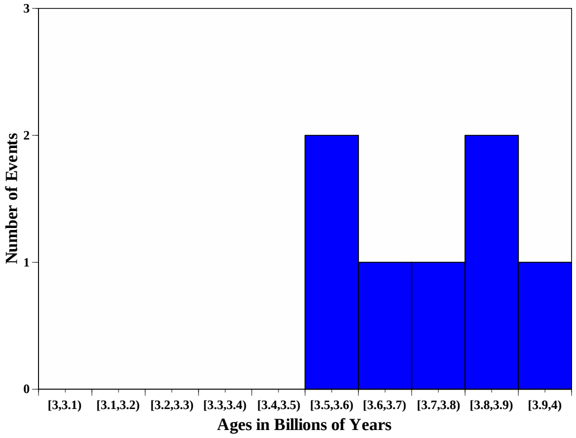


Figure 2: Ages of Graben Faults Cut by Ejecta & Craters

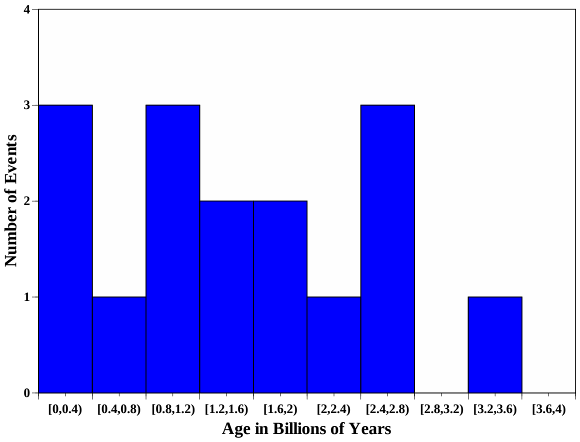
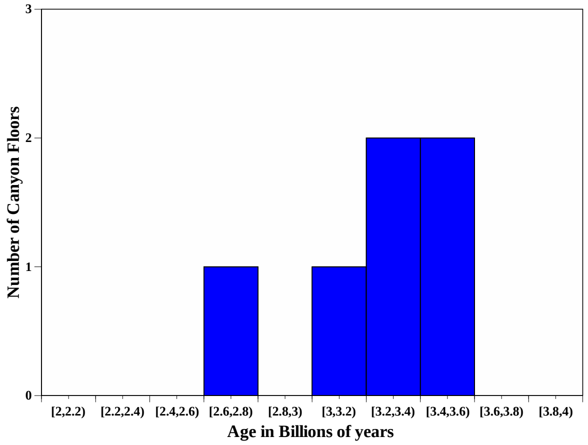


Figure 3: Ages of Canyon Floors Valles Marineris



Conclusions: The canyon floor results are similar to [5], but better defined. These results suggest that vertical fracturing initiated at 3.5 Ga and the subsidence of Valles Marineris may have locally been very rapid. A big assumption is that “grabens” initiated simultaneously. We plan to test this assumption using buffered crater counting of selected regions near VM [6]. In addition, we will look for evidence in the ”grabens” of steep faults, >60°.

References: [1] Andrews-Hanna, (2012a), *J. Geophys. Res., 117*, E03006. [2] Andrews-Hanna, (2012b), *J. Geophys. Res., 117*, E04009. [3] Andrews-Hanna, (2012c), *J. Geophys. Res., 117*, E06002. [4] Michael, G. G. and Neukum, G. (2010) *EPSL, 294*, 223-229. [5] Quantin, C. et al. (2004) *Icarus, 172*, 555–572. [6] Kneissl, T. et al. (2015), *Icarus, 250*, 384–394.