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Insights into the mechanical strength of the Venusian lithosphere from the gravity-driven deformation of large volcanic edifices

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In our Solar System, Venus is the most similar planet to Earth in terms of size, composition, and distance from the Sun, yet these worlds are topographically, tectonically, and geomorphologically very different. The higher average surface temperature on Venus ($\sim$460°C vs. $\sim$4°C on Earth) may be indirectly responsible for many of these contrasting features, since higher temperatures reduce the depth within the lithosphere at which deformation is expected to be predominantly ductile. Experimental data place the Venusian brittle–ductile transition at 2–12km [1], much shallower than on Earth. This implies that the Venusian lithosphere has a lower flexural rigidity and a diminished capacity to support large, heavy landforms such as major shield volcanoes. The relative dearth of tall landforms on Venus compared with Earth may be because most such structures subside into the Venusian lithosphere.

We test this prediction by searching Magellan radar data for evidence of gravity-driven deformation of Venusian volcanoes. Experimental work has demonstrated that volcanoes undergoing such deformation can display a continuum of geomorphological features on their flanks that reflect the rigidity of, and their mechanical relationship with, the underlying basement [2]. Here, we relate these landforms to the deformational history of the volcanoes on which they are found, and explore the implications for the local mechanical properties of the Venusian lithosphere.

References: [1] Mikhail and Heap, under review. [2] Byrne, P.K. et al., (2013) Geology, 41(3), 339-342