Paper Number: 2389

What are wrinkle ridges telling us about the sub-surface of Mars?

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Wrinkle ridges are probably one of the most commonly observed tectonic structures on terrestrial planets, including Moon, Mercury, Venus and Mars. Whatever the planet, wrinkle ridges can be described by two principal elements (Figure 1) from imagery: 1) a broad ridge up to tens of kilometres wide and meters to kilometres high with a lobate contour and 2) sinuous, discontinuous or echelon crenulations (wrinkles) located on the ridge. Based on their morphology, they are interpreted as the result of compressive stress [e.g. 1, 2, 3].

On Mars, many authors studied their morphology in order to determine compressive model(s) forming these compressive tectonic structures, including buckle fold [2], simple thrust fault [4], conjugate thrust fault [5, 6], fault-bend fold [7, 8] and fault-propagation fold [9].

All models assumed explicitly or not that wrinkle ridges formed in layered material. Then, all concludes that thrusts root along a brittle-to-ductile transition level, often showing a flat horizon like a decollement zone [6 to 8].

Based on HRSC visible imagery (Mars Express mission) and altimetry acquired by MOLA, we revisit wrinkle ridges in different regional contexts on Mars, including Noachian ($t>3.7$ Ga) and Hesperian ($3.7<t<3.0$ Ga) terrains. In each region, the model of fault-bend fold would be the best to explain the formation of wrinkle ridges, implying that thrust faults would be superficial rooting along a flat decollement zone in layered material.

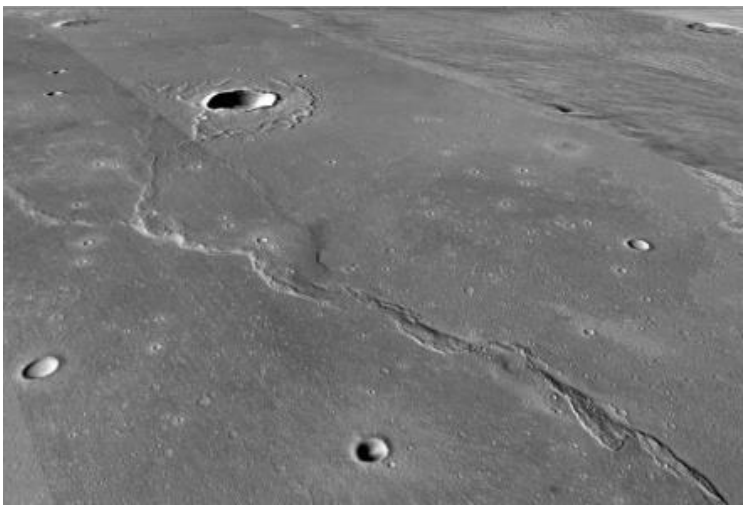

Figure 1: Wrinkle ridges in Elysium Planum, Mars (impact crater with ejecta is 3 km wide)

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