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Major Subsurface discontinuity revealed by central uplifts of impact craters in the vicinity of Valles Marineris

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Despite recent efforts from space exploration to sound the Martian subsurface with RADARs, the structure of the Martian underground is still unknown. Major geological contacts or discontinuities inside the Martian crust have not been revealed. Another way to sound the subsurface is to analyze the central peaks of impact craters that have been exhumed from depth at the time of impact. The last Martian mission, MRO (Mars Reconnaissance Orbiter), did a real effort in targeting the central peaks of impact craters with both its high resolution instruments: CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) and HiRiSE (High Resolution Science Experiment). We analyzed the composition and the nature of the rocks exhumed from depth on 30 impacts craters in the vicinity of Valles Marineris. The stratigraphic uplift forming the central peak depends on the size of the impact and would represent around 1/10 of the final diameter. The studied impacts emplaced on a large range of elevation from +6000 m to -2000 m of MOLA absolute elevation and the sizes of the impact cover a large from 10 km to 150 km of diameter. These large ranges of values allow a remarkable sampling of the subsurface that allowed us to reconstruct the subsurface structure of the region. Our analyses of both mineralogy from 35 CRISM hyperspectral data and geology from 50 Hirise pictures allowed us to distinguish two kind of material exhumed in the central peak. Intact layers form the first group. The layers are intensely deformed, folded and fractured. The layers have the same thickness from a crater to another, of around one meter. The dominant composition of these layers is a mixture of olivine and high calcium pyroxene, what is a typical basaltic composition. A significant part of these basaltic-type layers are hydrated adding a sharp 1.9 μm feature to the basaltic type spectrum. We also detected smectites and hydrated glass in less abundant amount. Exhumed light toned massive rocks are the second group. These massive rocks, depleted in any recognizable structures are highly fractured. The common composition of these central peaks is Low Calcium Pyroxenes with olivine in some cases. Associated hydrated phases have also been detected: smectites, serpentines and hydrated glass. The spatial distribution as well as the in-depth distribution between the two group of rocks exhumed is not random and reveal a major geological discontinuity below the Tharsis lava plateau.