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Hints at diapirism in Arabia Terra craters, Mars

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Arabia Terra is a region of Mars located at the boundary between the southern highlands and the northern lowlands and classically dominated by heavily cratered terrain. Unlike the rest of the topographic dichotomy on the planet, in Arabia Terra the elevation transition is very gentle, falling of 4 km over a distance of 2500 km (average slope = 0.0016°). Most of the impact craters within the region display a central bulge, bearing a well preserved stratification and a wide range of smaller morphologies like pitted cones, mounds and knobs (Franchi et al. 2013). Images acquired by HiRISE and CTX cameras on board MRO provided a comprehensive dataset in which also these small features can be easily recognized. These are tens of meters of diameter and tens of meters high, and many of them show an apical orifice. They are interpreted to have worked as pathways for subsurface fluid flow (e.g. Pondrelli et al., 2011; Rossi et al., 2008). Indeed an active underground fluid flow activity in Arabia Terra It has been recently hypothesized (e.g. Andrews-Hanna et al, 2011) , being crater central bulges a place of sulfate precipitation, due to local water table emergence (e.g. Franchi et al., 2013).
To date, there is no clear explanation for occurrence of central bulges surrounded by prominent depressions in Arabia craters. In addition, in Firsoff and Crommelin craters it is possible to recognize folds and outward dipping strata on the central bulges and their surroundings. Interestingly, a few craters with a prominent bulged floor elsewhere in Arabia Terra do not display stratification and are not explainable as impact related structures as their expected pristine central peak derived by hydrocode modelling is ∼2km lower and one third the diameter than the actual topography (Pozzobon et al., 2013). All these evidences are not consistent with a typical lacustrine stratigraphic environment, whether interested by sulfate precipitation or not, and suggest active deformation after or during bulge sequences deposition.
One or – more likely - multiple layers of sulfates below the shallower levels of Arabia Terra surface need, in our opinion, to be hypothesized in order to explain all these contrasting observations. Indeed impact cratering on such an evaporate bearing layered target might have provided the ideal conditions of faulting, interconnectivity of evaporatic beds and lithostatic load release to allow diapirs ascent, In turn diapirism could have been responsible for central bulging as testified by outward dipping strata on stratified bulges, broad un-stratified bulges and folding (see Jackson and Vendeville, 1994 for typical salt tectonics). The depth of the fluid source calculated with a fractal method (Pozzobon et al., 2013) using the position of the small widespread mounds within Firsoff and Crommelin craters can give a hint of the average depth of the evaportic horizons (∼4 km).
As further developments we plan to test and quantify our model to take into account geological evidences, possible kinematics, rheology and stratigraphic constrains.

References: Andrews-Hanna, J.C., and Lewis, K.W., 2011, Early Mars hydrology: 2. Hydrological evolution in the Noachian and Hesperian epochs: Journal of Geophysical Research, v. 116, p. E02007, doi: 10.1029/2010JE003709. Franchi, F., Rossi, A. P., Pondrelli, M., Cavalazzi, B. (2014) Geometry, stratigraphy and evidences for fluid expulsion within Crommelin crater deposits, Arabia Terra, Mars. Planet Space Sci., in press. DOI: 10.1016/j.pss.2013.12.013, Jackson M.P.A. & Vendeville B.C. (1994) - Regional extension as a geologic trigger for diapirism, GSA Bulletin, 106: 57-73, Pondrelli, M., Rossi, A. P., Ori, G.G., van Gasselt, S., Praeg, D., and Ceramicola, S., 2011, Mud volcanoes in the geologic record of Mars: The case of Firsoff crater: Earth and Planetary Science Letters, v. 304, p. 511–519, doi: 10.1016/j.epsl.2011.02.027., Pozzobon R. et al. (2013), AGU Fall Meeting, Abstract #1797270.