A HOLEY CONUNDRUM: DISTINGUISHING BETWEEN ANCIENT CALDERAS AND DEGRADED IMPACT CRATERS ON MARS. J. R. Michalski[1,2], J. E. Bleacher[3] and S. P. Wright[4], [1]Planetary Science Institute, Tucson, Arizona, 85719, USA; michalski@psi.edu, [2]Dept. of Earth Sciences, Natural History Museum, London, UK, [3]NASA Goddard Spaceflight Center, Greenbelt, Maryland, USA. [4]Dept. of Geology and Geography, Auburn University, Auburn, Alabama.

Introduction: The surface of Mars contains thousands of impact craters exhibiting a range of stages of preservation from youthful craters with well-preserved morphological evidence for impact to ancient craters in which most diagnostic features attributable to impact origin have been removed by erosion [1]. We suggest that some of the most ancient basins Mars, commonly assumed to have formed by impact, are in fact large calderas that formed through explosive volcanism early in Martian history [2].

Approximately 70% of the Martian surface has been resurfaced by volcanism though a significant fraction is from yet unrecognized sources [3]. In fact, while Hesperian and Amazonian volcanic constructs are easily recognized from their classic shield morphologies, relatively little is known about Noachian volcanism – either because those constructs have been strongly modified by erosion [4] or because ancient volcanoes were of a fundamentally different character than more youthful volcanoes [2]. Distinguishing between an impact versus volcanic origin for many ancient Martian basins is complicated, but hugely important for understanding the geologic evolution of the Martian crust.

Observations in Arabia Terra: The Arabia Terra region is one of the most ancient parts of the Martian crust. In northern Arabia Terra, we have identified at least 8 large (20-100 km-diameter) basins that are unlikely to have formed from meteor impact. Many of these features have been dismissed previously as degraded impact craters. Yet, these features generally do not preserve any clear evidence for impact processes; no morphologic evidence for central uplifts, uplifted rims, ejecta, or inverted stratigraphy is observed in remote sensing data. While all of these features could have been removed by erosion, significant resurfacing of ancient impact craters generally results in lower crater depth/diameter ratios than what is observed in these basins [1-2].

The type-example of an ancient caldera, termed here a plains-style caldera complex, is Eden Patera (Figure 1), which is a large, irregularly shaped topographic depression (~55 km by 85 km in diameter, NW-SE and SW-NE respectively) located at 348.9 E, 33.6 N within Noachian-Hesperian ridged plains of likely volcanic origin (Figure 1). Other features in northern Arabia Terra contain evidence for collapse associated with volcanic activity. Siloe Patera (6.6 E, 35.2 N) is a set of nested, deep depressions that reach ~1750 m below the surrounding plains. Euphrates Patera is an irregularly shaped depression that reaches 700 meters depth below the surrounding lava plains and contains several benches in the interior that might be explained by sequential episodes of collapse or lava lake high stands. Semeykin Crater is a large, scalloped depression surrounded by lava plains and friable deposits, which also contains mounds of friable materials in its interior and ridged plains along the exterior. A suite of features, Ismenia Patera, Oxus Patera, and Oxus cavus are located together near 0E, 38.5 N. The two patera exhibit scalloped, breached rims composed of layered materials.

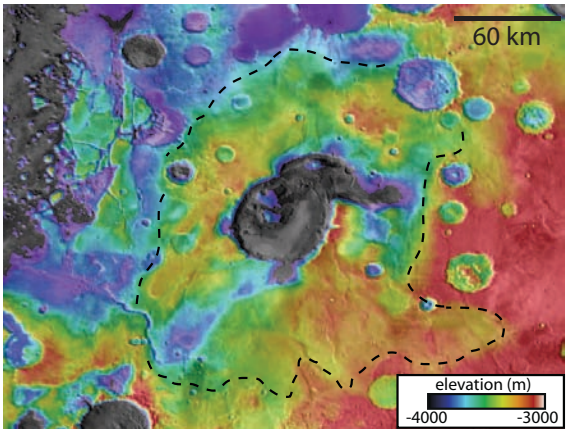

Figure 1: MOLA colorized elevation data are draped over THEMIS daytime infrared data showing Eden Patera, a plains-style caldera complex in Arabia Terra, Mars.

Implications: We suggest that some ancient basins on Mars represent a fundamentally new type of volcanic construct on Mars: plains-style caldera complexes. Ancient, degraded impact craters certainly exist in the Noachian Martian crust, but further work must be done to distinguish between degraded impact craters and ancient calderas. Plains-style caldera complexes might have formed in an early phase of explosive volcanic activity on Mars.

References: [1] Robbins, S. J. and B. M. Hynek, JGR 117, E05004, 2012. [2] Michalski, J.R., J.E. Bleacher, and S.P. Wright, 43rd LPSC, abstract 1263, 2013. [3] Greeley, R. and P. Spudis, Rev. Geophys. 19, 13-41, 1981. Golombek, M. P. et al., JGR 111, 1-14, 2006.