GALE CRATER MORPHOLOGY COMPARED TO OTHER HIGH CENTRAL PEAK CRATERS ON MARS. F. J. Calef III¹, H. Newsom², J. Williams³, T. J. Parker⁴, M. Lamb⁵, and J. Grotzinger⁶; ¹Jet Propulsion Laboratory-Caltech, fcalef@jpl.nasa.gov, ²University of New Mexico, NM, ³Western Washington University, WA, ⁴California Institute of Technology, CA.

**Introduction:** While Gale Crater’s central mound, especially the lower strata being investigated by the Mars Science Laboratory, are the main focus of many studies e.g. [1,2,3,4,5], the anomalously high central peak and its effect on the volume and stratigraphy of the layered sediments therein have only recently been assessed [6]. Our goal is to reconstruct the antecedent Gale Crater morphology before the central sedimentary mound was constructed by comparing it to similar high central peak craters on Mars. Our first task examines whether the central peak in Gale, which is equal to or higher than most of its crater rim, is unique or a common feature of Martian complex craters of similar size.

**Background:** Martian craters with diameters greater than ~8km fall into the size range of complex craters with central peaks, peak ring, and/or multi-ring interior structures [7]. Gale’s central peak was noted as being distinct from the central mound by [8] and more recently by [9]. Recently, it has also been suggested to have remnants of an inner ring [10]. Other researchers have noted “rare” occasions where complex crater central peaks come close to or exceed average crater rim heights [11]: Guibert and Bedevska craters on Venus [11], Doppelmayer and Gassendi on the Moon [12], Aeneas on Dione [13], and potentially the Marquez Dome on Earth [14]. Hypotheses explaining why these high central peaks occur range from volcanic (antiquated from [12]) to possibly related to unconsolidated, water-saturated sediments [14], though with little explanation. Central peak formation is commonly attributed to rebound of the crater floor and if it reaches too high, it becomes unstable, collapses, and forms a ring structure [15]. This preliminary research doesn’t address the high central peak formation mechanism; however, Gale crater does fall on the martian dichotomous boundary and its influence on the antecedent morphology will be considered.

Central peaks are often compared to their accompanying crater diameter and morphologic characteristics [16], such as central peak height to crater diameter (h̶p) (e.g. [15,17]), central peak diameter, or volume [16] with little discussion of their relation to crater rim height from the crater floor, except to note a few exceptions, as previously mentioned. For Mars, [18] provide data on 441 central peak crater with values for crater depth (d) normalized to central peak height (H̶p) and central peak diameter normalized to peak height to obtain an central peak aspect ratio; their results indicate central peaks are steeper with height and for 208 fresh craters, a few appear to approach H̶p/d ratios close to 1 (Figure 2 adapted from [18]; Gale crater would be at the top of this graph.

**Data:** Gridded MOLA elevation data at ~0.5 km/pixel was searched for large diameter (D >~75 km) complex craters with central peaks >= 80% of their crater rim heights, measured from the crater floor, for direct comparison to Gale crater. MOLA data was imported into a GIS (ArcGIS v10.3) to measure peak and

![Figure 1: High Central Peak Craters on Mars. These craters (white, Gale green) have central peaks ~equal to their rim height. No clear association is made between elevation or terrain type, though none appear in the Tharsis region.](image-url)
rim heights. Since the craters in questions are tens to over a hundred kilometers in diameter, the gridded MOLA DEM resolution supplies hundreds of sampling points, which are a sufficient sampling population for this study. Initial profiles were selected to a) bisect maximize rim and peak heights and b) avoid highly interpolated areas lacking sufficient MOLA tracks, especially near the equator. Profiles were measured using geodesic distances to correct for latitudinal variations among craters. Regional tilts were not removed to assess central peak or rim height, but considered to have minimal affect on our measurements. Profiles bisected the highest point of the central peak and extended a minimum of 5+ km beyond the crater rim.

Results and Discussion: Our searched yielded 27 craters with high central peaks (Figure 1). No clear spatial pattern is noted in latitude, longitude, elevation, or geologic formation other than being devoid in the Tharsis region. Crater profiles were created for each crater with a few examples in Figure 3 that are close to the Gale crater’s diameter. Similar to Gale, these craters are qualitatively similar with high, steep walled, central peak, centrally located within the crater. Unlike Gale, these two craters show little infill allowing a complete profile of the central peak form. Using the 110 km D crater cross-section as guide (red line), a semi-quantitative extrapolation of the central peak is projected below the mound and down below the infill using the crater width and central peak as bounding conditions (Figure 4). If 2D reconstruction is correct, we can estimate the southern crater floor being filled by several hundred meters, up to a kilometer, of sedimentary material. The northern crater floor falls on the other side of the dichotomeric boundary, potentially depressing the original crater planform depth. No definitive impact breccias have been reported by the MSL science team, which means a) the original crater

Future Work: We plan to extend the Gale profile extrapolation into 3D by utilizing a CTX DEM model of Gale crater and HRSC data for the ‘type’ crater in Figure 3 to reconstruct the post-impact/pre-fill crater planform. This will be used to estimate the total volume of the central mound, fill, and impact melt expanding on modeling work in [5,6].