A MASSIVE CENTRAL PEAK AND A LOW PEAK RING IN GALE CRATER – IMPORTANT INFLUENCES ON THE FORMATION OF MT. SHARP.

Carlton C. Allen NASA Johnson Space Center, Houston, TX 77058 carlton.c.allen@nasa.gov

Introduction: The Curiosity rover is exploring 155 km diameter Gale crater and Mt. Sharp, Gale's high central mound (Fig. 1). This study addresses the central peak and proposed peak ring, and their influence on the overall morphology of the mountain.

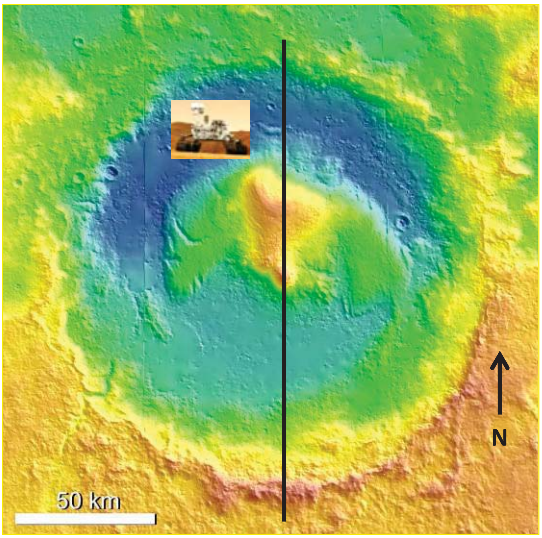

Figure 1. Gale crater and Mt. Sharp, with locations of Curiosity and N-S profile (Fig. 2); MOLA topography.

Central Peak: The highest point on Mt. Sharp, near the crater's center, rises to an altitude near +700 m, which is 5 km higher than the lowest point on the crater floor and over 2.5 km higher than the north rim (Fig. 2). A high-standing N-S plateau, rising to approximately +300 m, extends north 25 km from the peak (Fig. 1). The central peak, exposed on the south and west sides, is massive and shows no evidence of the layering prominent on most of Mt. Sharp (Fig. 3).

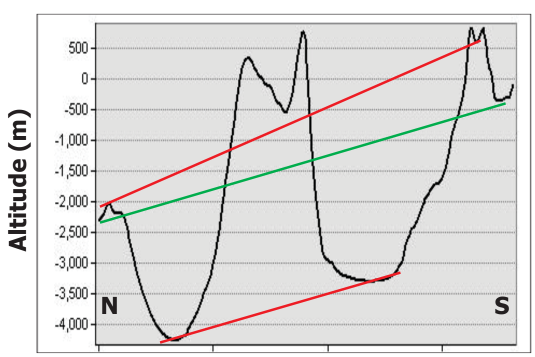

Figure 2. N-S profile thru Gale's central peak; green line – pre-impact slope; red lines – rim-to-rim and floor slopes; MOLA data; 26 x vertical exaggeration.

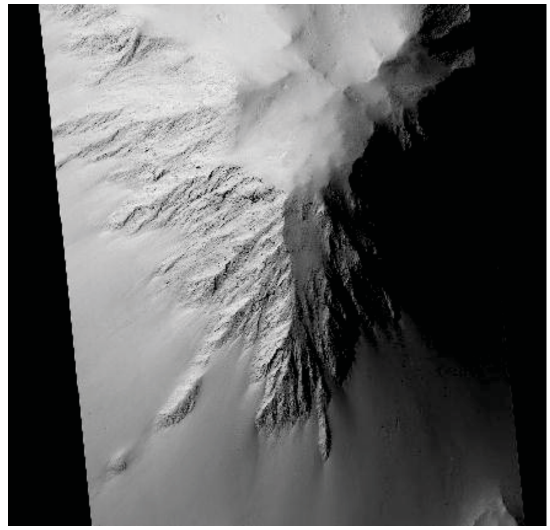

Figure 3. Mt. Sharp's central peak; HiRISE image PSP_010428_1745; frame width 5 km.

The peak's summit and lower slopes are covered with a high-albedo layer tens of meters thick (Fig. 3). This material shows evidence of wind erosion at the summit, and boulder tracks in the lower reaches. It is interpreted as an unlithified aeolian deposit.

Gale's central peak is anomalously large and high, compared to central peaks in Martian craters of similar diameter. A compelling analog is the lunar farside crater Icarus, with a diameter of 96 km and a massive central peak that rises higher than the crater rim. Specific conditions of impact energy and target properties result in a variety of peak dimensions.

Peak Ring: Gale's size makes it transitional between Martian craters with central peaks and craters with peak rings roughly half the craters' diameters [1,2]. The boundaries of Mt. Sharp, as well as an arc of hills to the southeast of the mountain, closely match a circle approximately 80 km in diameter (Fig. 4). This morphology suggests that Gale may contain both a central peak and a partial peak ring, now covered by sediments in the north but exposed in the SE quadrant.

The combination of a central peak and a peak ring occurs in other large Martian craters. One prominent example is Lyot (215 km diameter), with a 1.5 km high peak and a peak ring nearly 3 km high. Liu Hsin (135 km diameter) contains a central peak and a low peak ring. Irwin and Grant [3] mapped both a central peak and a peak ring in Holden crater (154 km diameter), which has been nearly filled with sedimentary layers.

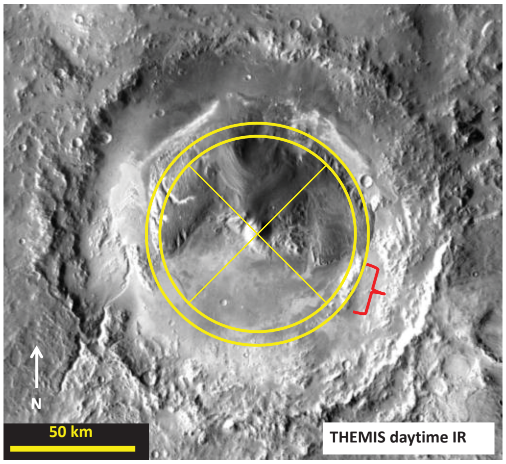

Figure 4. Locations of Gale's central peak and modeled peak ring (circles), with a possible peak ring exposure (bracket).

The arc of hills southeast of Gale's central peak (Fig. 4) is the only extensive exposure of that crater's possible peak ring. The altitude of these hills is around -2,100 m, approximately the altitude of the plateaus that form both the eastern and western lobes of Mt. Sharp's lower section (Fig. 1). The hills, as much as 200 m in height, show no evidence of layering. They are deeply eroded and covered with boulders in some areas, an erosion style similar to the peak ring material in the 203 km diameter crater Lowell [4]

Influence of a Central Peak and Peak Ring: Gale's central peak and peak ring were emplaced immediately after the impact, and influenced the subsequent history of deposition and erosion that formed Mt. Sharp. Central peak and peak ring material is derived from deep below the crater's surface, and is fundamentally different from the layered sediments that constitute the bulk of the mountain.

The highest point of the central peak is located near the geometric center of the crater, but the topography of Mt. Sharp shows a high, broad ridge extending ~ 25 km to the north (Fig. 1). This feature, now covered by layered sediments, may be built on a central peak complex considerably more massive than the peak currently exposed. Such a massive complex would have strongly influenced the lacustrine deposition and erosion evident in orbital images and now confirmed by the Curiosity rover. Sediments derived from the north rim, in particular, may have been diverted around the peak to form the twin lobes of Mt. Sharp's lower segment.

The model of Kite *et al* [5] demonstrates that winds flowing down crater walls could both deposit sediments to form a mountain, and subsequently erode those sediments. The presence of a high central peak complex must have strongly influenced this process, leading to the thousands of wind-eroded layers that form the upper portion of the mountain [6].

Spray *et al* [1] suggested that a peak ring in Gale crater could have influenced the location Mt. Sharp's lower segment by localizing the deposition of sediments. This effect could account for the fact that the northern, eastern, and western boundaries of Mt. Sharp correspond to a ~ 80 km diameter circle (Fig. 4). Other Martian craters, including Holden and Lyot, show evidence of sedimentary deposits fully or partially filling the areas within their peak rings. Lowell contains a layered deposit over 300 m thick within the bounds of its peak ring (Fig. 5).

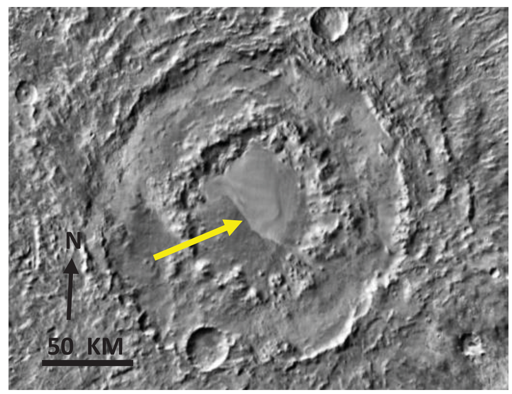

Figure 5. Layered deposit (arrow) within the peak ring of Lowell crater; THEMIS daytime IR mosaic.

Conclusions: Mt. Sharp contains a massive central peak ~ 5 km high. Portions of the peak complex may extend north as much as 25 km from the crater center. Gale may also contain a low peak ring, currently only exposed in the southeast quadrant. The central peak and peak ring would have strongly influenced the deposition and erosion of sediments forming the upper and upper and lower segments of Mt. Sharp.

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References: [1] Spray J. et al (2013) *LPS XLIV,* Abs. #2959. [2] Schwenzer S. et al (2012) *Planet. Space Sci., 70,* 84-95. [3] Irwin R.P. III and Grant J.A. (2013) Geologic Map of the MTM—15027, --20027, --25027, and –25032 Quadrangles, Margaritifer Terra Regions of Mars, USGS. [4] Pascuzzo, A. and Allen, C. (2015) *LPS, XLVI.* [5] Kite E. et al (2013) *Geology,* doi: 10.1130/G33909.1. [6] Dapremont A. et al. (2014) *LPS, XLV,* Abs. #1288.