FORMATION AND EVOLUTION OF THE PENEUS PATERA CALDERA. C.B. Kneuer[1] and N.P. Lang[1], [1]Department of Geology, Mercyhurst College, 501 E. 38th St., Erie, PA 16546; ckneue23@mercyhurst.edu.

Introduction: The term patera (paterae if plural) was originally applied to any large, flat-floored depression with irregular margins identified in Mariner 9 and Viking imagery and included volcanoes as well as impact craters [1]. These craters are characterized by very low slopes of < 1° to ~1.5° that are deeply incised by channel complexes which are radial to a prominent central caldera [1-2]. They are among the oldest central vent volcanoes on Mars [2] and may represent a transition from flood lava eruptions, which dominated the early volcanic history of Mars, to more localized eruptions [2].

Work on highland paterae has focused on Tyrhenna and Hadriaca Paterae – two of five highland paterae on Mars. Work by [1] and [3] on Tyrrhena and Hadriaca Paterae, respectively, suggested that highland paterae were built from a series of explosive eruptions that temporally transitioned into more localized, effusive eruptions. As part of an ongoing campaign to further understand the processes involved in highland patera formation and evolution, we present our initial results on the caldera of Peneus Patera (58.3°S, 52.8° E).

Methodology: Caldera analysis has involved the use of Mars Odyssey (MO) Thermal EMission Imaging System (THEMIS) daytime infrared (IR) and visible (Vis) as well Mars Global Surveyor (MGS) as Mars Orbital Camera (MOC) imagery. Normalized THEMIS daytime IR imagery from JMARS has served as a base layer from which we have superimposed THEMIS Vis and MOC imagery for mapping in the Adobe Illustrator drawing program. Mars Orbiter Laser Altimeter (MOLA), as derived from JMARS, allows for the creation of topographic profiles to help elucidate geologic units and structures within and immediately surrounding the caldera.

Mapping began with the identification of primary and secondary structures [i.e., 4] located within the caldera. Primary structures that we have identified to date include: possible lava flows and a volcanic dome located within the caldera. Secondary structures include concentric graben and tectonic ridges. Identifying primary and secondary structures has allowed for subsequent identification of geologic units (i.e., volcanic units) within and immediately surrounding the caldera as well elucidation of the caldera's geologic history. Explosive deposits are identified based on the descriptions of [2] and [5] and effusive deposits were identified based on the presence of a more rigid (less easily erodible, as compared with possible explosive deposits), but texturally smooth, material that has sharp contacts with surrounding materials.

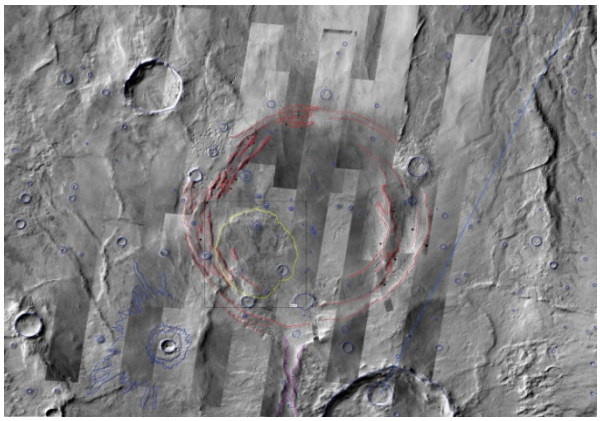

Figure 1: *Map of Peneus patera. THEMIS daytime IR image of Peneus Patera emphasizing the caldera, concentric graben (red lines), and dome (outlined in yellow). THEMIS daytime IR image taken from JMARS. Image is centered at 52.60 E, 57.80N, and the caldera is 125 km in diameter.*

Geologic Overview: Located southwest of the Hellas basin, the Peneus Patera caldera is 125 km in diameter and has flanks that reach an elevation of 1 km above the mean planetary radius. Channels ~5 – 7 km wide radiate from the caldera in all directions; the caldera margins are represented by a suite of concentric graben. (Fig. 1). The caldera floor is texturally smooth and is deformed by northeast trending ridges.

A dome ~45km in diameter is located in the southwest corner of the caldera (Fig. 2). This dome (51.77° E, 58.06°N) decreases by about 400m in elevation from southwest to the northeast (Fig. 3). It locally covers the concentric graben in the caldera's southwest corner and appears to possibly have been erupted from the graben.

Much of Peneus Patera's caldera and flanks are covered by a surficial deposit. This deposit is likely not volcanic in origin, but instead may reflect a volatile rich layer [6]. The deposit obscures volcanic deposits in and around the caldera, impairing the ability to determine the extent and timing of various volcanic units and structures.

Geologic history/Conclusions: Although the surficial deposit covers much of the caldera, and thus impairing determination of a geologic history for this

caldera, the following general sequence of event can be elucidated for the Peneus Patera caldera: 1) A period of explosive volcanism that emplaced the easily erodible deposits on the volcano's flanks. This period of volcanism may have resulted in caldera formation (and therefore formation of the concentric graben); 2) Possible emplacement of volcanic caldera floor materials; 3) Contraction of the Peneus Patera flanks and caldera; 4) Emplacement of the dome in the southwest corner; 5) Occurrence of the surficial, possible volatile-rich, layer.

This general sequence of events – where explosive volcanism transitioned into effusive volcanism (the dome) – is consistent with what is observed with other highland paterae [i.e., 2, 5], suggesting a similar genesis among highland paterae. However, the presence of the dome within Peneus indicates eruption of viscous magma, suggesting that effusive volcanism at Peneus Patera had either a slow effusion rate or is more felsic than effusive deposits at other highland paterae.

References: [1] R. Greeley. P.D. Spudis, (1978), *Geophys. Res. Lett.*, 5, 453-455. [2] R. Greeley. D.A. Crown (1990), *J. Geophys Res.*, 95, 7133-7149. [3] D. H. Scott. M. H. Carr (1978), *Misc. Invest. Ser., Map I-1083, scale 1:25M*. [4] V.L. Hansen (2000), *EPSL*, 176, 527-542. [5] D.A. Crown and R. Greeley (1993), *JGR*, 98, 3431-3451, [6] R. Greeley, et. al. (2007), *LPSC abstract #1373*.

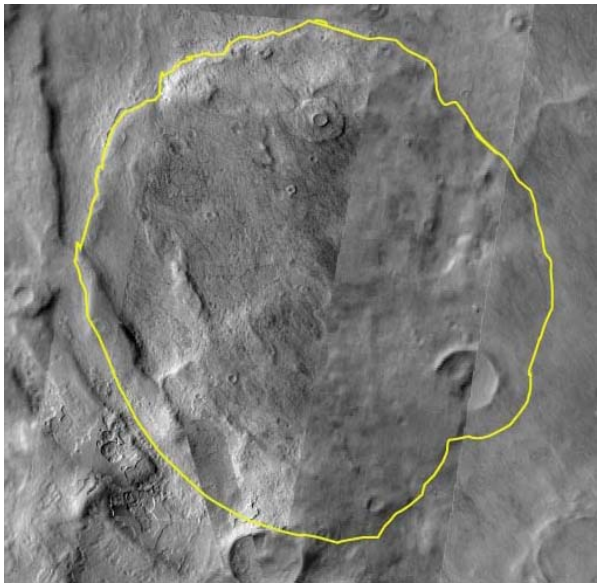

Figure 2: *Normalized THEMIS daytime IR image from JMARS highlighting the volcanic dome (outlined in yellow) in the southwest corner of the Peneus Patera caldera. The dome locally covers concentric graben here suggesting that it may have erupted from one of the graben.*

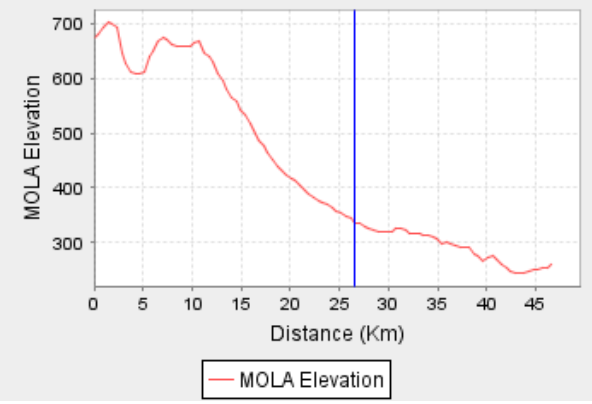

Figure 3: *Topographic profile illustrating the decrease in elevation to the northeast across the dome in the southwest corner of the caldera. profile extends from 51.06E, 57.98N to 52.55E,58.27N.*