

## TOPOGRAPHIC AND 3-D ANALYSES OF SILOE PATERA, ARABIA TERRA SUGGEST A VOLCANIC ORIGIN

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**Introduction/Background:** Early interpretations of cratered highlands on Mars may instead be a volcanic region [1]. “Supervolcanoes within an ancient volcanic province in Arabia Terra, Mars” [1] provides evidence for seven supervolcanoes, one of which is Siloe Patera. These volcanoes are characterized by lower than normal topographic relief, collapse features, layered deposits, as well as effusive volcanism and explosive eruptions [1]. Siloe Patera postdates the Noachian age (4.5-3.5 Ga) of Arabia Terra [2] and presents a variety of features that can be interpreted to be volcanic in nature. Although, an alternative hypothesis for Siloe Patera’s origin is nested impact craters, evidence points more towards multiple caldera collapses or a combination of impact and caldera collapse events.

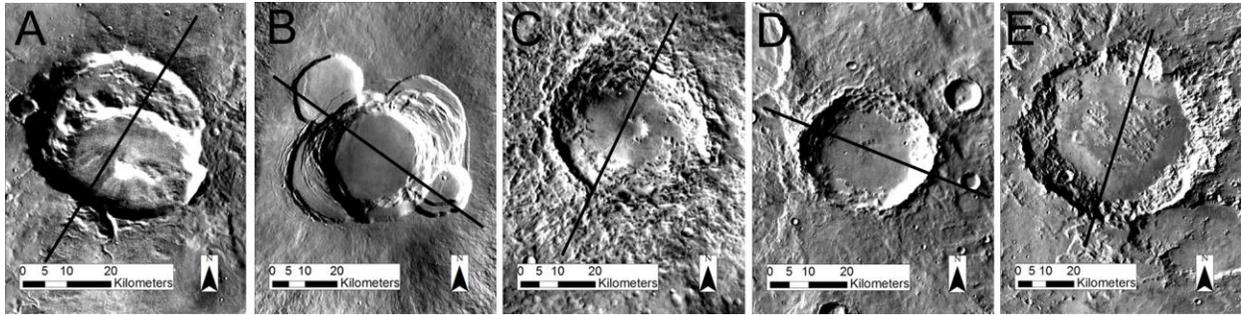
Siloe Patera is located in the Arabia Terra at 35.23N, 6.5E and is approximately 40 km (north-south) by 30 km (west-east) in diameter. Its age has not been determined but is suspected to be Early Hesperian or older and has likely been modified by a complex history of erosion and deposition of Arabia Terra [2, 3]. Siloe Patera’s main features are characterized by two collapse structures, possible sagging due to removal of a pluton at depth (south-southeast of Siloe) [1], and a possible lava flow (southwest). Siloe Patera shows no signs of ejecta, an impact-induced central peak, raised or overturned rim, or other common characteristics of impact craters [4].

**Materials and Methods:** Many features of Siloe Patera are difficult to interpret when looking at 2-D images, so a 3-D model of Siloe Patera was rendered using ArcGIS and ArcScene. Mars Orbiter Laser Altimeter (MOLA) data points were collected from MOLA PEDR Query – Orbital Data Explorer website and imported into ArcGIS through Excel. Raw MOLA points were displayed and interpolated using the Inverse Distance Weighted function to produce an elevation layer of Siloe Patera and the surrounding area. A contour layer with an interval of 5 meters was rendered and used to create a Triangular Irregular Network layer that digitally represents the surface of Siloe Patera. This was later used in ArcScene to produce a 3-D model of Siloe Patera (Figure 3). Using the Interpolate Line tool in ArcGIS 3-D Analyst, topographic profiles were rendered and exported to Excel to create topographic profiles that can easily be compared (Figures 1 and 2). Siloe Patera was compared to Ascræus Mons and three impact craters similar in size to Siloe Patera. Due to varying elevations of each feature, elevation data for each of

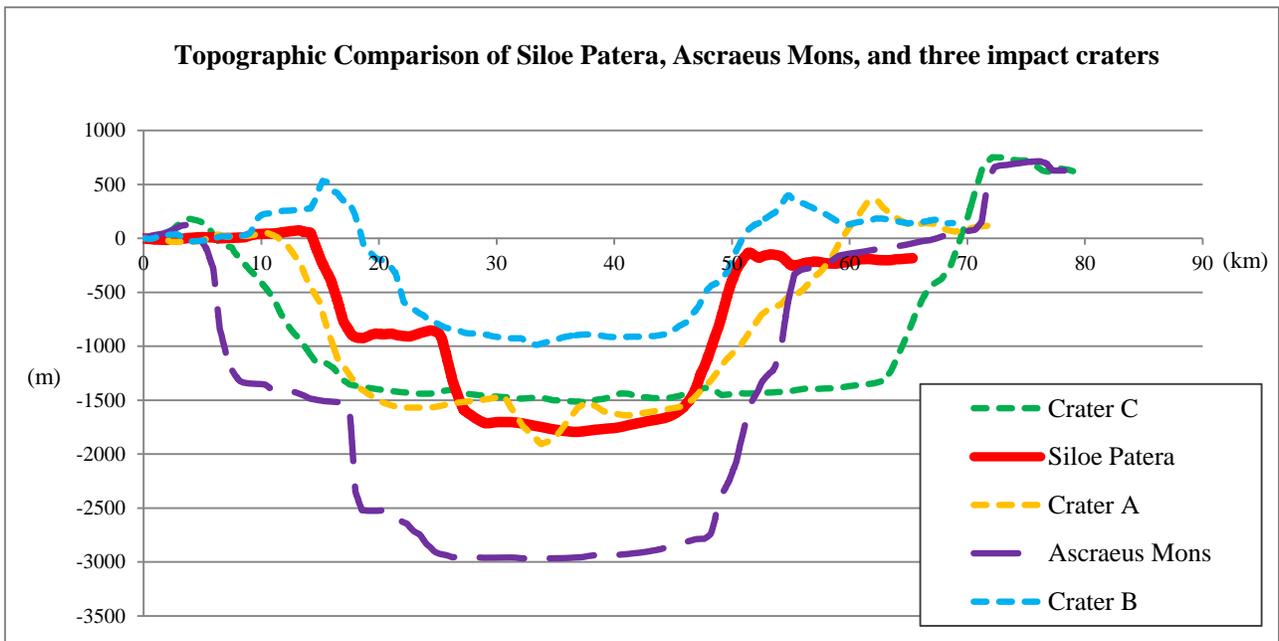
these regions was normalized to zero to facilitate comparison.

**Discussion/Results:** The 3-D image of Siloe Patera (Figure 3) reveals two features that are difficult to explain for impact sites. A ~10 km long, ~2 km wide, ~200 m high ridge of material with a high thermal inertia (in nighttime THEMIS TIR images) runs along the lowest southern floor. This may be a dike or cinder cone that represents the last activity as seen on many caldera floors. Further, channels in impact crater ejecta typically run downhill from the impact crater rim and/or proximal ejecta outwards to the distal ejecta and surrounding plain [5]. While Siloe has one large notch in its southern rim, Siloe has several smaller channels nearly-parallel to its rim to the southwest, east/southeast, and east/northeast. A comparison of topographic profiles of Siloe Patera, Ascræus Mons, and impact craters A, B, and C (Figure 2) suggest that Siloe Patera is a caldera. Impact craters generally have a uniform profile due to their symmetric structure [4,6] (Figure 2) whereas large calderas do not [7]. Impact craters commonly have a raised rim due to structural uplift and the deposition of ejecta, a broad U-shape with flat bottoms due to post-impact crater fill, and shallow gradient slopes. Ascræus Mons, like other volcanoes, is wedge-shaped in profile with steep slopes and local bench-like structures. Siloe Patera more closely resembles Ascræus Mons than the three impact crater profiles due to its steep slopes, wedge shape, bench, and lack of raised a rim. The 3-D model (Figure 3) shows that an upper bench is not flat but instead dips toward the north with steep, arcuate scarps at the head of the bench. The bench also has several peaks along its southern extent that we interpret to be post-caldera vents similar to those found at Valles Caldera in New Mexico [6]. Depth (d) verses diameter (D) analyses, or d/D ratio, of Martian impact craters largely falls in the 0.03-0.17 range, as measured here: Crater A = 0.034, Crater B = 0.038, Crater C = 0.032 [6]. Siloe Patera (d/D = 0.049) is similar to Ascræus Mons (0.048), and thus is more likely a large caldera rather than an impact crater [1].

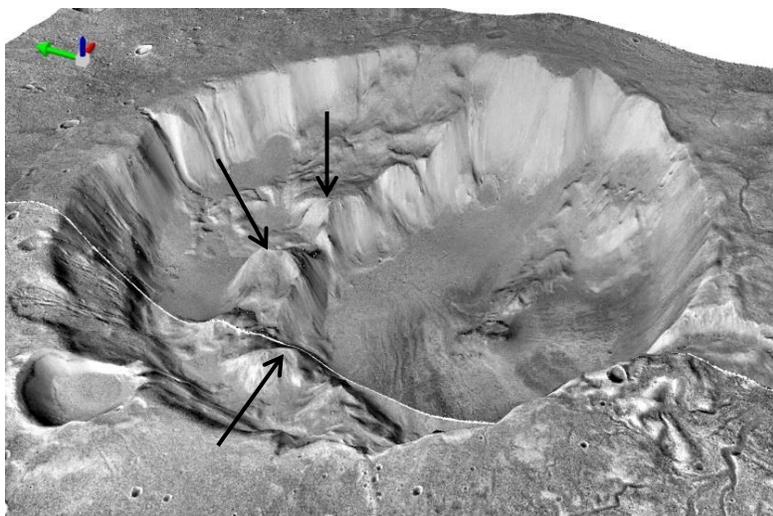
**References:** [1] Michalski & Bleacher (2013) *Nature* 502, 47-52 [2] McGill (2000) *JGR* 105, 6945-6959. [3] Fergason & Christensen (2008) *JGR-Planets* 113, doi:10.1029/2007JE002973 [4] Barlow & Bradley (1990), *Icarus*, 87, 156-179 [5] Grant & Schultz (1993) *JGR-Planets* 98, 11025-11043 [6] Garvin & Frawley (1998) *GRL* 25, 4405-4408 [7] Wohletz & Heiken (1992), *Volcanology and Geothermal Energy*, 141-177.



**Figure 1.** Context of topographic profiles shown in Figure 2. A.) Siloe Patera; B.) Ascraeus Mons; C.) impact crater A; D.) impact crater B; E.) impact crater C.



**Figure 2.** Comparison of topographic profiles from structures shown in Figure 1. X-axis is measured in kilometers and y-axis is measured in meters. Vertical exaggeration = ~25.



**Figure 3.** 3-D model and CTX mosaic view of Siloe Patera rendered in ArcScene and ArcGIS. Green arrow shows north. Black arrows point to possible vents near southern margin of bench.

