DISCOVERY OF A POSSIBLE LARGE CALDERA IN NORTHWESTERN ARABIA TERRA: IMPLICATIONS FOR RECOGNIZING ANCIENT VOLCANIC SOURCE REGIONS ON MARS.

J. R. Michalski[1-2] , S. P. Wright[3], and J. E. Bleacher[4] [1]Natural History Museum, London, UK [2]Planetary Science Institute, Tucson, AZ, USA. [3]University of New Mexico, Albuquerque, NM, USA, [4]Planetary Geodynamics Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD, USA.

Introduction: The highest profile volcanoes on Mars are large shields such as those in the Tharsis and Elysium regions [1]. These volcanoes may have become active early in Mars history into the Hesperian or perhaps Amazonian [2] – long after erosion and impact rates had decreased dramatically [3]. Therefore, volcanoes that became inactive early in Mars history can be more difficult to recognize due to their subsequent modification by those processes [4]. Understanding the sources of Noachian igneous materials [5,6] remains an important, unresolved problem [7].

Here, we raise the question of whether some ancient craters could in fact be volcanic craters rather than impact craters. Specifically, we have identified one construct in northwestern Arabia Terra (348.9E, 33.6N) that appears to be a large (D = 52 km) caldera (Figure 1), comparable in size to the Nili Patera and Olympus Mons calderas. If this depression is in fact a caldera, it could be a major, previously unrecognized volcanic source region of key importance for understanding the origin of other deposits in the area.

Methods: The putative caldera in NW Arabia Terra was identified using THEMIS and MOLA data. A geologic map of the region was created using THEMIS daytime infrared data and CTX images. Topographic profiles were created from MOLA data for the possible caldera, as well as a number of other well known calderas and impact craters. TES data were used to map dust cover in the region [8], which is pervasive and prohibits compositional analysis.

Results: A geologic map of the putative caldera (Figure 1) shows that the crater is a compound structure composed of two depressions, which are structurally linked to troughs and scarps with a crude NE-SW orientation. The main crater is nearly circular between 0 and 270 degrees, counter clockwise, with steep walls, a flat floor, and interior, layered mound deposits. Despite a high depth/diameter ratio for the depression, which could indicate a lack of younger degradation, there is no evidence for the features that are common to impact craters: no evidence for ejecta, no raised rim, no central peak, and no radial structures or rays.

The crater is surrounded by ridged plains, some of which might represent degraded lava flow margins. The geologic contact between putative volcanic flows emanating from the volcano and the older terrain to the south is not clear at the time of this writing, and may be difficult to distinguish. However, this unit is disrupted by Chaos formation to the west, late-stage modification of the dichotomy boundary to the north, and younger impact craters throughout. Preliminary crater counting results suggest the structure is roughly Late Noachian to Early Hesperian, but more precise counting of smaller craters is underway to better understand the age and modification history of the structure [9].

Layered materials in the floor of the putative caldera are mapped here as Hesperian layered fill analogous to younger, unrelated layered fill deposits observed in other craters in Arabia Terra [10]. However, it is possible that these fill deposits are actually a combination of viscous lava deposits (domes) and pyroclastics that remain within the caldera floor

We propose Pityusa and Malea Patera, of the Circum-Hellas Volcanic Province [7], as being analogous to this feature. Those putative volcanoes developed ~ 3.8 Ga and do not form a well defined volcanic edifice. They also display central depressions that formed within ridged plains, and contain layered deposits.

Implications: It is suggested that some of the protolith of altered, layered rocks in the Mawrth Vallis area could be pyroclastic material [11]. In addition, a regional, dark capping unit found in the Mawrth Vallis region and throughout western Arabia Terra may have a volcanic origin [12]. Altered rocks at Meridiani Planum may also contain a large fraction of basaltic ash and dust that was altered in a closed geochemical system [13,14]. However the source of such materials is an unresolved issue. If the structure in NW Arabia Terra is a caldera, it is a Late Noachian to Early Hesperian source of volcanic deposits for this region. The volume of the depression (>3500 km^3) provides a crude estimate of the amount of magma that may have been evacuated. Such a volume of dense magma could have emplaced a significant amount of fragmented, porous pyroclastics across western Arabia Terra. In a general sense, the recognition of ancient volcanic source regions will help to better understand the origin and distribution of igneous materials across Mars.

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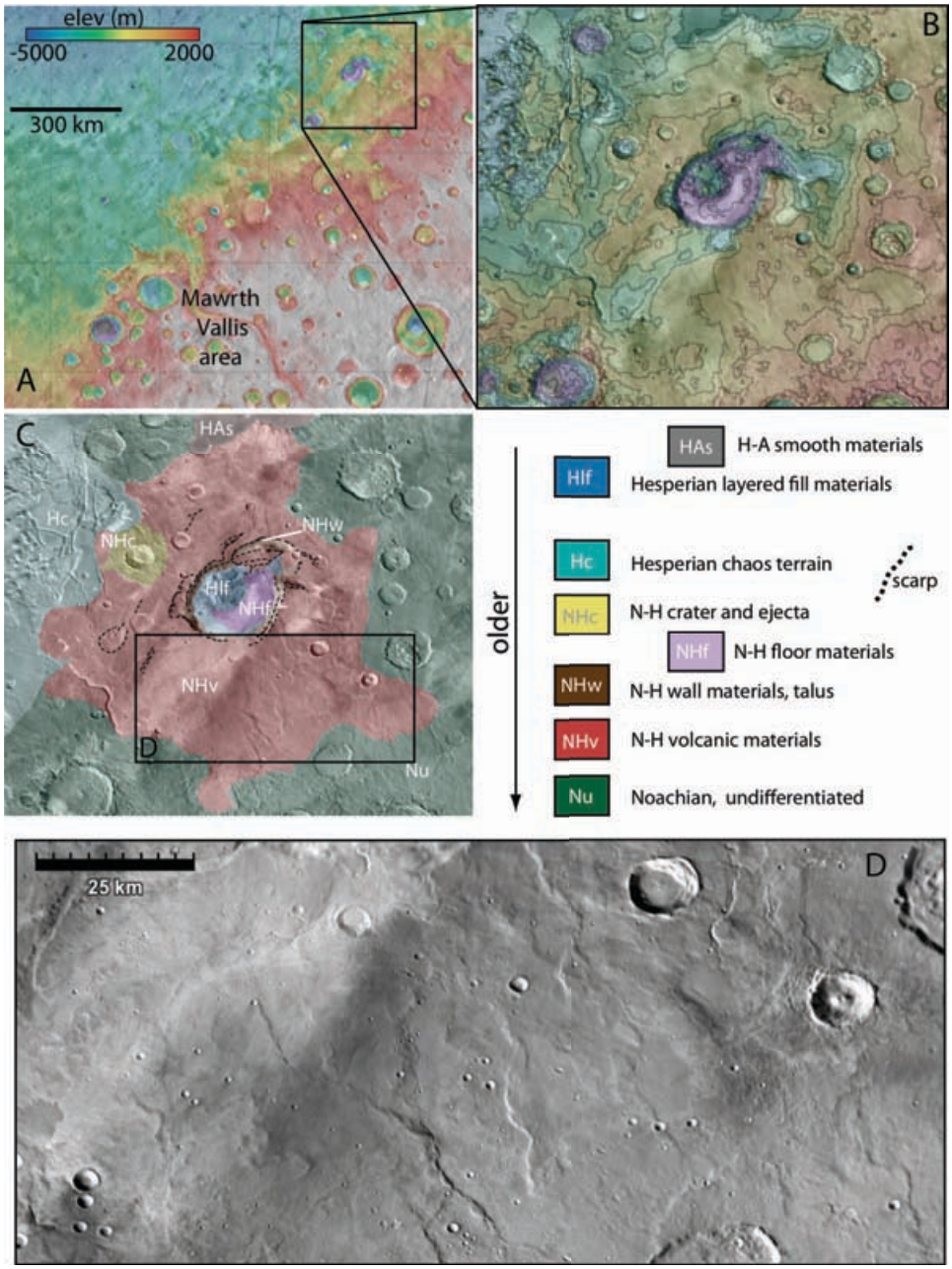

Figure 1: (A) MOLA topography draped over THEMIS daytime infrared show the northwestern Arabia Terra region and the regional context of a putative caldera, which is shown in greater detail in "B." The surface geology mapped in this work is shown in "C." And inset in the geologic map is presented in panel "D," showing evidence for lava flows emanating from the caldera.