ALBA PATERA, MARS: ASSESSMENT OF ITS EVOLUTION WITH MOLA AND MOC DATA: M. A. Ivanov[1] and J. W. Head[2]. [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow, Russia, mishaivn@mtu-net.ru; [2]Brown University, Providence RI, USA, james_head_iii@brown.edu.

Introduction: Alba Patera is one of the largest shield volcanoes on Mars [1] and is characterized by relatively low relief and large base diameter compared with Olympus Mons and the Tharsis volcanoes [2]. Alba Patera has been studied in many aspects [2 and reference therein]. Here we report on preliminary results of our analysis of the new MOLA topographic map (1 by 2 km spatial resolution) and MOC images for the region of Alba (20-60°N, 90-130°W). These data show details of the previously known structures, reveal new ones, and greatly facilitate analysis and interpretation of features on the surface of Mars.

Description of Alba Patera volcano: To describe the features of Alba Patera volcano and the geological relationships among them, we used both the Viking and MOC images and the high-resolution topography produced from MOLA data. Topographically, the volcano of Alba Patera consists of two major parts: 1) a distal, almost horizontal, apron of lava flows and 2) the topographic edifice of the volcano itself.

1) Apron of lava flows. The main portion of the apron coincides with the unit Hal (lower member of Alba Patera Formation) [3] and consists of numerous lava flows radiating away from the volcano. The flows make up a radial pattern, which is most prominent to the NW of the volcano. Some flows are extremely long, about 900 km, and could be traced back almost to the ring-like zone of graben encircling the summit of Alba. Along its northern boundary, the distal apron of Alba Patera is in contact with unit Aa_1 (member 1 of Arcadia Formation, [3]). Commonly, along this contact the lava flows abruptly terminate and disappear, suggesting that the flows mostly predate the Arcadia Formation [3].

To the NE and E of the volcano, the systems of graben of Alba and Tantalus Fossae greatly reduce the topographic and morphologic signatures of the lava flows. At the eastern slope of Alba (at ~100°W, 45°N), however, fragments of lava flows oriented in the ENE direction and disrupted by Tantalus Fossae are still visible. Although many graben of Alba and Tantalus Fossae die out within the apron, some of the most prominent tectonic structures cut across the boundary of the units Hal and Aa_1 and deform the surface of the latter unit. To the SE and S of Alba Patera lava flows which are apparently related to clusters of small (several km across) volcano-like features are observed. These flows make up the majority of unit AHcf, the Ceraunius Fossae Formation [3], which is superposed on the unit Hal and has been mapped as Hesperian /Amazonian in age. To the south of Alba Patera, flows of the unit AHcf are superposed on the system of graben of Ceraunius Fossae.

2) The main dome of Alba Patera. This portion of Alba is defined by a distinct break in regional slope and makes up the main body of the volcano, which is ~1350 by 1130 km across with the long axis oriented in an E-W direction. The MOLA data show that the main topographic anomaly of the volcano could be further subdivided into several smaller parts.

A) Flanking zones of Alba. The elongation of Alba Patera is because two flanking zones (shoulder-like features) are located to the W and E of the central main dome of Alba, which has dimensions ~900 by 800 km. Both shoulder-like features are characterized by a fan-shaped distribution of lava flows. Although Hodges and Moore [2] pointed out that the west flank of Alba Patera resembles the SW rift zone of Mauna Loa, the general shape of the western flanking zone was unknown before MOLA topography. The western shoulder is larger and extends from the ring system of the summit graben to the west for about 525 km. The shoulder has a fan-like shape opened toward the W and is about 730 km in a N-S direction. The eastern shoulder is significantly smaller and has dimensions about 250 km and about 200 km in W-E and N-S directions, respectively. In the MOLA topographic map the western and eastern shoulders of Alba Patera are analogous in both the general shape and the distribution of lava flows to the structures at the flanks of the Tharsis Montes, especially Arsia Mons.

B) Summit area of Alba. The summit area of Alba consists of two main parts, the system of concentric and radial graben and the central dome topped with a complex of nested calderas. ***The system of ring graben,*** Alba Fossae to the west and Tantalus Fossae to the east, mostly coincide with the crest and outer slopes of the topographic rim crowning the summit area of Alba Patera. The rim has dimensions about 450 km (E-W direction) by 550 km (N-S direction) and corresponds to the boundary between the middle (unit Aam) and upper (unit Aau) members of Alba Patera Formation [3]. Many individual structures of the graben systems cut lava flows on the outer slopes of Alba. ***The central dome*** of the volcano corresponds to the unit Aau and is about 430 by 350 km across. This feature is visible only in MOLA topography. The gentle slopes of the dome are covered with numerous sinuous lava flows radiating away from the top of the dome. The flows which are closer to the summit of the dome are apparently superposed on the graben of Alba and Tantalus Fossae while near the base of the dome the graben cut the flows. Such relationships suggest that the emplacement of the flows and formation of the graben systems were approximately synchronous.

The central dome of Alba Patera is topped with a ***complex of calderas***. The complex consists of two distinct calderas visible in Viking images [4-7]. The detailed MOLA topography reveals, however, that these calderas are nested inside a larger depression (~140 by 120 km) that has no discernible signature in the Viking images. The western and southern edges of the depression coincide with the scarps outlining the two obvious calderas and a topographic ridge represents its NE rim. The two visible calderas occupy the western and southern portions of the larger depression and have dimensions 95 by 65 km and 65 by 55 km, respectively. Between these two calderas there is a dome about 55 by 45 km across which is visible in the MOLA topographic map only. The dome is topped with a small (about 10 km across) circular depression. The surface of the dome, especially near the summit depression, is relatively smooth and featureless but further down the slopes of the dome lava flows become visible. The base of the dome appears to be cut by the calderas.

The high-resolution MOC image, M08-02859 (69 km long and 3 km wide, resolution 4.61 m/px), crosses the southern caldera and covers the SSE flanks of the dome. Analysis of this image provides the possibility of characterizing these structures in detail. The scarp of the southern wall of the caldera is characterized by fine-scale lineations oriented along the strike of the scarp. On the caldera floor numerous broad and narrow lava flows appear to be mantled by material with hummocky texture. Many impact craters, relatively fresh and degraded, are visible on the caldera floor. The northern wall of the caldera is lower than the southern one and there is little evidence for the layering there. Beyond the northern wall of the caldera the SSE slope of the summit dome begins. The surface there is characterized by homogeneous hummocky texture consisting of numerous small (tens of meters) knobs and hillocks and elongated ridges oriented toward the summit of the dome. Lava flows are generally absent in the area near the summit and those which are still visible appear to be mantled. There is distinct paucity of impact craters on the slopes of the dome and a few recognizable craters appear as heavily eroded and filled structures.

Apparent sequence of events and possible evolution of volcanic styles: Cross-cutting and embayment relationships among lava flows and tectonic structures (as seen in both the high-resolution topography of MOLA and MOC images) within the area of Alba Patera establish the following sequence of events during the evolution of the volcano. The distal lava flow apron appears to be the oldest feature of Alba. More concentrated eruptions (probably at lower eruption rates) in the central area of the volcano led to the growth of the main dome of Alba Patera. Lava flows on the main dome run from its flanks and are superposed on the surface of the distal apron. The radial and concentric graben of Alba and Tantalus Fossae cut the surface of both the lava apron and the main dome of Alba and thus are younger. The unit Aa_1 covers up the majority of the graben, yet a few graben disrupt the surface of the unit. This suggests that the formation of the Alba and Tantalus Fossae graben systems could occur as multiple episodes at different times. Lava flows on the surface of the western shoulder of Alba cover many graben of Alba Fossae and thus should be younger than these tectonic structures. In contrast, the eastern shoulder of Alba is heavily deformed by graben of Tantalus Fossae. Such relationships suggest that either volcanic activity at the western shoulder (rift-zone) lasted longer than that at the eastern shoulder, or that the formation of Alba and Tantalus Fossae was non-synchronous and Tantalus Fossae are younger than their counterparts, or both. The central dome of Alba appears to be partly synchronous with the ring graben system and probably it continued to evolve longer than the development of the graben because many lava flows from the dome embay graben of either Alba or Tantalus Fossae. The latest episodes of evolution of Alba Patera are concentrated at the summit of the central dome where the complex of calderas and small summit dome topped with a shallow depression were formed.

Effusive volcanism in the form of numerous lava flows was predominant during almost the entire evolution of Alba Patera (from the stages of formation of the distal apron to the dome at the summit of the volcano). The presence of a dendritic system of valleys [8] suggests, however, that the valleys have been cut into material which is more erodable than lava [7]. Mouginis-Mark et al. [7] interpreted the valley networks on the slopes of Alba as evidence for plinian pyroclastic activity through the vent within the caldera complex, specifically, through the depression on top of the small summit dome. These authors suggested that Alba Patera started to form by explosive eruptions in the central, summit, area of the volcano and continued by effusive eruptions. The mantled appearance of features both around the depression on top of the small summit dome and its slopes strongly supports the possibility of explosive eruptions at the summit of Alba as in the case of Hecates Tholus [9]. The lack of fresh impact craters on the flanks of the dome imply, however, that an episode of resurfacing probably related to plinian activity may have occurred geologically relatively recently in the evolution of Alba Patera.

References: [1] Carr, M. H., The surface of Mars, Yale Univ. Press, 232 p., 1981, [2] Hodges, C. A. and H. J Moore, Atlas of volcanic landforms on Mars, *USGS prof. pap. 1534*, 1994, [3] Scott, D. H. and K. L. Tanaka, *USGS, MapI-1802-A*, 1986, [4] Cattermole, P., *JGR*, 91, E159-E165, 1986, [5] Cattermole, P., *JGR*, 92, E553-E560, 1987, [6] Cattermole, P., *Icarus*, 83, 453-493, 1990, [7] Mouginis-Mark, P. J., et al., *Bull. Volc*., 50, 361-379, 1988, [8] Gulick, V. C. and V. R. Baker, *JGR*, 95, 14325-14344, 1990, [9] Mouginis-Mark, P. J., et al., *JGR*, 87, 9890-9904, 1982.