

SMALL VOLCANOES IN TEMPE TERRA, MARS: THEIR DETAILED MORPHOMETRY AND INFERRED GEOLOGIC SIGNIFICANCE: P.A. Davis and K.L. Tanaka, U.S. Geological Survey, Flagstaff, AZ 86001

The Tempe Terra province contains a variety of volcanic landforms that range in size from small vents (less than 10 km in diameter) to moderately sized volcanoes (150 km in diameter) [1-6]. The volcanoes are aligned along the dominant northerly and northeasterly trends of the faults in this region, and many of the volcanoes occur on grabens [2,4,5]. Some workers have speculated on the nature of some of the volcanoes on the basis of their general morphology, shadow-measurement height, lateral dimensions, and geologic setting [1-4]. As part of a larger study, we have obtained detailed photoclinometric profiles across five of the more conspicuous small volcanoes in the Tempe Terra region (Fig. 1). From these data, we extracted for each volcano its flank width and edifice height and the width and depth of its summit crater. We statistically compared these dimensions for each volcano with a set of average dimensions for each type of terrestrial volcanic feature listed in [6]. These comparisons indicate that the morphometries of the Martian volcanoes 1, 2, and 3 most closely match Earth's cratered basaltic lava shields, and the morphometries of volcanoes 4 and 5 are similar to those of terrestrial basaltic tuff rings.

All five of the studied volcanoes are on or near grabens or fractures. All five have two morphologic characteristics in common: summit pits and a diffuse basal contact with the surrounding plains (except where the local topographic gradient causes ponding of associated lava flows). The volcanoes' summit pits differ: volcano 1 has a small circular pit, volcano 2 has an elongate pit whose trend parallels the local faults and whose length is approximately equal to the volcano's flank width, volcanoes 3 and 5 have two similar-sized circular pits aligned parallel to a local fault trend, and volcano 4 has a large rectangular pit aligned parallel to a local fault trend. The flank slopes of volcanoes 1 and 2 are about 7.8° ; those of volcanoes 3 and 5 are 5.3° and 5.5° , respectively; and that of volcano 4, the lowest, is 2.6° .

Our quantitative morphometric comparisons of the five Martian volcanoes with various types of terrestrial volcanoes [6] suggest that volcanoes 1, 2, and 3 are most similar to terrestrial cratered basaltic lava shields that have little tephra; volcano 1 is most similar to a low lava shield (e.g., Mauna Iki), whereas volcanoes 2 and 3 are most similar to Icelandic lava shields. Our comparisons further suggest that the morphometric characteristics of volcanoes 4 and 5 are similar and most closely match those of basaltic tuff rings.

On Earth, tuff rings form as a result of volcanic eruption through a zone of either ground water or ground ice [7-8]. The occurrence of tuff rings on Mars, which is indicated by the morphometries of volcanoes 4 and 5, suggests that water existed in the shallow Martian crust during the time of formation of these volcanoes.

Our quantitative analysis of volcanoes 1, 2, 3, and 5 indicates that their flank width, edifice height, and summit-crater dimensions are statistically close to those of cratered table mountains. Such an affinity has been suggested for similar small volcanic domes in the Olympus Mons region [9]. We do not, however, believe that the four Tempe Terra volcanoes are table mountains, because their profiles (Fig. 1) do not have the flat tops and steep flanks characteristic of table mountains [6]. Thus, our next analysis will be more rigorous and will include additional morphometric parameters (such as flank slope) so that we can more precisely constrain the morphometric classification.

References: [1] Hodges (1979) *NASA TM 80339*, 247; [2] Hodges (1980) *NASA TM 81776*, 181; [3] Moore and Hodges (1980) *NASA TM 82385*, 266; [4] Plescia (1981) *Icarus*, 45, 586; [5] Scott (1982) *J. Geophys. Res.*, 87, 9839; [6] Pike and Clow (1981) *U.S. Geol. Surv. Open-File Rep. 81-1038*, 40 p.; [7] Wohletz and Sheridan (1983) *Amer. Jour. Sci.*, 283, 385; [8] Lorenz (1986) *Bull. Volcanol.*, 48, 265; [9] Hodges and Moore (1979) *J. Geophys. Res.*, 84, 8061.

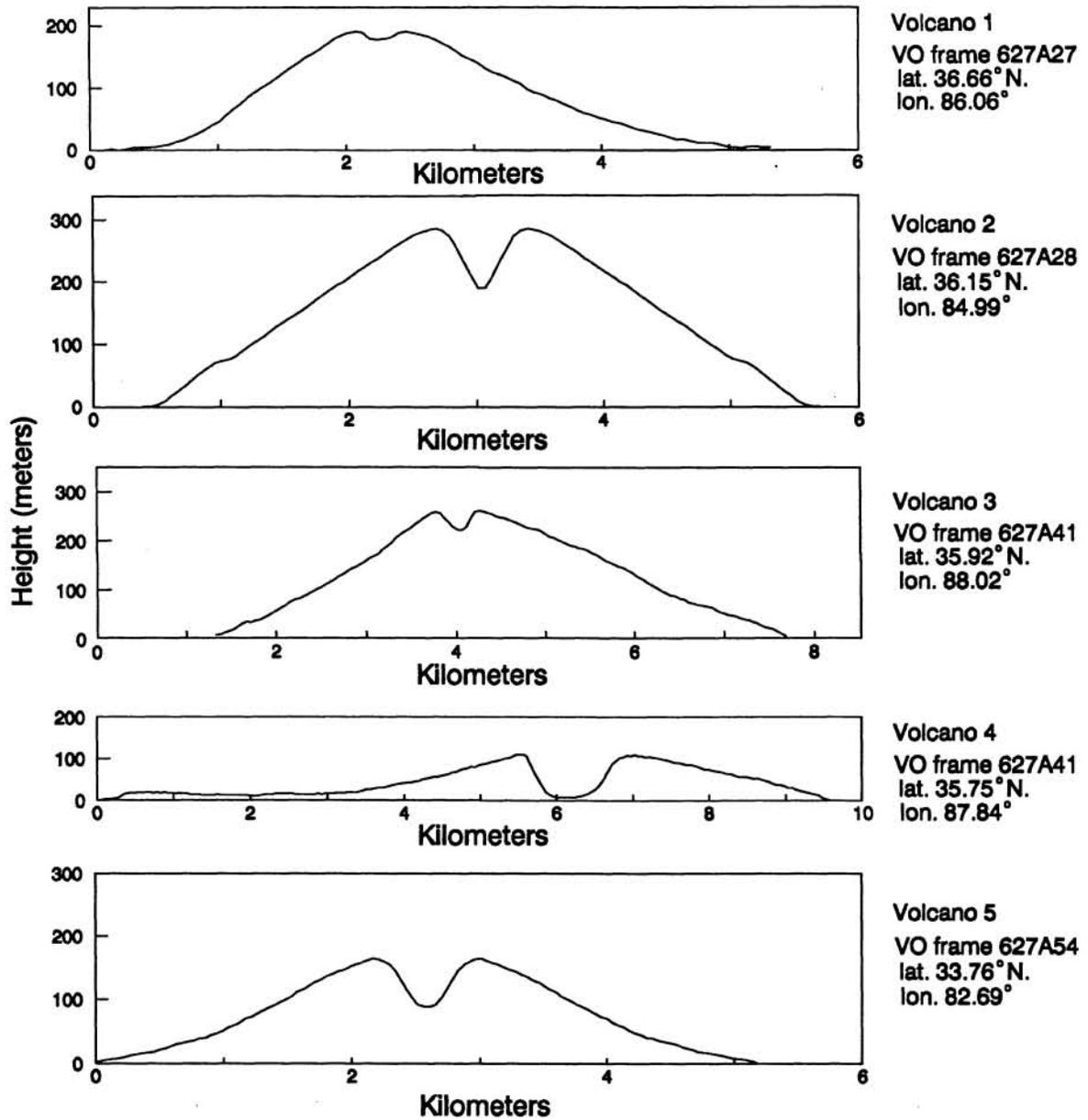


Figure 1. East-west photoclinometric profiles of five small volcanoes in Tempe Terra. Vertical exaggeration X5. Viking Orbiter (VO) frame used to derive each profile and the latitude and longitude of the summit of each volcano are listed next to the respective profile.