MORPHOMETRIES AND POSSIBLE TERRESTRIAL ANALOGS OF SMALL MARTIAN VOLCANOES; Philip A. Davis and Kenneth L. Tanaka, U.S. Geological Survey, Flagstaff, Arizona 86001.

Summary. Using Viking Orbiter images, we obtained photoclinometric profiles for over 1000 small (basal diameters less than about 5 km) Martian hills with summit craters; the hills are interpreted to be volcanoes. This morphometric database was compared with similar data compiled for various types of terrestrial volcanoes to determine the closest terrestrial analogs for the small Martian volcanoes. Our analysis indicates that the small volcanoes in many of the volcanic fields have morphometries that are closest to terrestrial cinder cones. However, some Martian volcanic fields are dominated by volcanoes whose morphometries are most similar to low-sloping and steep-sided terrestrial shield volcanoes, Icelandic lava shields, and tuff rings.

Introduction. We visually examined the entire inventory of Viking Orbiter images and selected all of the several hundred images containing small landforms that appear to be volcanic constructs on the basis of morphology (i.e., hills with summit craters) and geologic setting. Most of these landforms have been previously interpreted as volcanic constructs [1-7]. Most occur between 0 and 60 degrees north latitude; the individual volcanic fields cover a wide longitudinal range in the northern hemisphere [1-7]. In the southern hemisphere are relatively few small volcanoes; occurrences are isolated, scattered, and mostly in the west. We made a photoclinometric profile of each volcano in the selected Viking Orbiter images, using the methods described by [8], to obtain detailed topographic data for over 1000 small volcanoes. From each profile, we extracted summit-crater diameter and depth and flank width, height, and slope (Table 1). (Data for the 36 small volcanoes that occur in the southern hemisphere were examined in our analysis but are not shown.) We performed a preliminary statistical analysis of these data, comparing the morphometric characteristics of the small volcanoes to those compiled for terrestrial volcanoes by [9] in order to determine the most likely terrestrial analog for each of the small Martian volcanoes.

Morphometric Comparisons. Our preliminary morphometric comparisons of the small Martian volcanoes and possible terrestrial analogs show that (1) the volcanic fields located in Cydonia Mensae and southwest of Utopia Planitia have volcano morphometries most closely similar to terrestrial cinder cones, as suggested in a similar comparison by [3]; (2) two small volcanic fields (within Cydonia Mensae and within Chryse Planitia) have volcano morphometries most similar to steep-sided terrestrial shield volcanoes, as suggested by [10]; (3) a small volcanic field north of Olympus Mons and west of Alba Patera has volcano morphometries most similar to low-slope terrestrial shield volcanoes; and (4) small volcanoes on a plateau remnant between Tempe Fossae and Mareotis Fossae have morphometries most similar to low-sloping terrestrial shield volcanoes (as suggested by [6]), Icelandic lava shields, and terrestrial tuff rings.

Cinder Cone Relations. Terrestrial and lunar cinder cones generally have a crater-diameter/cone-basal-diameter ratio of 0.4 [3,11]. Our data for four different Martian cinder cone fields show a range in this ratio from 0.29 to 0.39 and an average for all cinder cones of 0.33; the two cinder cone fields southwest of Utopia Mensae have both the highest and the lowest average crater-diameter/cone-basal-diameter ratio. Wood [3] found that lunar cinder cones have a cone-height/cone-diameter ratio of 0.04, whereas terrestrial cinder cones have

an average ratio of 0.18 [11]. The cone-height/cone-diameter ratio obtained from a single Martian cinder cone by [3] is 0.06. Our data (from 969 measurements) show that the ratio for Martian cinder cones (0.033) is slightly lower than that of lunar cinder cones, despite the difference in lunar and Martian gravity. This result indicates that Martian cinder cones are constructed either at low rates, as proposed for lunar cones [3], or of different materials (e.g., mud volcanoes).

References. [1] Hodges, C.A. (1979) ***NASA TM 80339***, 247; [2] Hodges, C.A., and Moore, H.J. (1979) ***JGR 84***, 8061; [3] Wood, C.A. (1979) ***PLPSC 10th***, 2815; [4] Hodges, C.A. (1980) ***NASA TM 81776***, 181; [5] Moore, H.J., and Hodges, C.A. (1980) ***NASA TM 82385***, 266; [6] Plescia, J.B. (1981) ***Icarus 45***, 586; [7] Frey, H. and Jarosewich, M. (1982) ***JGR 87***, 9867; [8] Davis, P.A., and Soderblom, L.A. (1984) ***JGR 89***, 9449; [9] Pike, R.J. and Clow, G.D. (1981) ***U.S. Geol. Survey Open-File Rpt. 81-1038***, 40p; [10] Greeley, R. ***et al.*** (1977) ***JGR 82***, 4093; [11] Porter (1978) ***Bull. Geol. Soc. Amer. 83***, 3607; [12] Scott, D.H. and Tanaka, K.L. (1986) ***U.S. Geol. Survey Misc. Invest. Ser. Map I-1802-A***; [13] Greeley, R. and Guest, J.E. (1987) ***U.S. Geol. Survey Misc. Invest. Ser. Map I-1802-B***.

Table 1. Averages and standard deviations of morphometric characteristics of small Martian volcanoes obtained by photoclinometric analysis of Viking Orbiter digital images for the northern hemisphere of Mars.

Geologic Unit[1]	General Location	Number Profiled	Crater Diameter [D_{cr}] (m±σ)	Crater Depth [d] (m±σ)	Cone Diameter [D_{co}] (m±σ)	Cone Height [h] (m±σ)	D_{cr}/D_{co} (m±σ)	h/D_{co} (m±σ)	Terrestrial Analog
Aal	Cydonia Mensae	414	306 ±76	6 ±4	866 ±236	26 ±15	0.361 ±0.079	0.030 ±0.011	Cinder Cone
Hvg	Cydonia Mensae	31	394 ±139	7 ±10	1164 ±259	37 ±25	0.338 ±0.086	0.031 ±0.019	Cinder Cone
Hvr	SW of Utopia Planitia	315	208 ±57	7 ±7	725 ±135	44 ±24	0.290 ±0.070	0.060 ±0.027	Cinder Cone
Apk	SW of Utopia Planitia	209	321 ±80	7 ±4	840 ±194	22 ±23	0.391 ±0.087	0.026 ±0.011	Cinder Cone
Aal	N of Olympus Mons	7	984 ±486	5 ±7	5035 ±1915	43 ±27	0.191 ±0.032	0.008 ±0.002	Low-sloping Shield
Hshp-Hch	Chryse Planitia	40	300 ±140	7 ±8	1345 ±397	72 ±54	0.229 ±0.109	0.039 ±0.021	Steep-sided Shield
Hvk	Cydonia Mensae	7	445 ±147	14	1926 ±242	59 ±20	0.225 ±0.048	0.034 ±0.011	Steep-sided Shield
Htu	Tempe-Mareotis Fossae	5	836 ±351	65 ±34	5393 ±803	203 ±59	0.150 ±0.042	0.039 ±0.014	Shields and Tuff Rings

[1]Symbols for geologic units from [12, 13].