GEOLOGY OF THE TEMPE-MAREOTIS REGION, MARS; H.J. Moore, U.S. Geological Survey, Menlo Park, CA 94025.

The Tempe-Mareotis region is of interest because (1) the rock units and landforms are the results of a variety of geologic processes that began billions of years ago and continue to the present day, (2) the volcanism contrasts with volcanism elsewhere on Mars, and (3) the volcanism is related to volcanism in Tharsis in space [1] and time. Processes include: (1) fluvial resurfacing of Noachian rocks in the Hesperian (or possibly Late Noachian), (2) northeast-trending graben with zigzag segments produced by extensional stresses after the fluvial erosion, (3) plains volcanism that began in the Late Hesperian and continued into Amazonian time, and (4) deposition of dusts and ongoing surface changes due to winds. The basaltic plains volcanism in Tempe-Mareotis is quite different than volcanic styles of the flood basalts of the plana and shields of the montes. Intense fracturing of the rocks in Tempe Fossae preceded the plains volcanism; this zone of fracturing lies along the northeastward extension of the Tharsis bulge and a great circle defined by the volcanoes atop the bulge (Arsia, Pavonis, and Ascraeus Montes and Uranius Patera). Volcanism in Tempe-Mareotis occurred in the Late Hesperian and Early Amazonian when many of the Tharsis volcanoes were forming, but eruptions from most of the great Tharsis shield volcanoes continued into more recent times.

Among the oldest rocks are those interpreted to be eroded layered deposits of Noachian age [eg. 2]; they probably include some combination of impact crater and basin ejecta, volcanics, and fluvial and eolian sediments. The oldest in-place crustal materials in the region may be present at the lowest elevations in Tanais Fossae where the relief of the layered deposits is near 1.6 km, but ejecta near the rims of large craters such as Reykholt must have come from depths near ten km.

Subsequent to the deposition of the layered deposits, the valleys of Tanais Fossae began to form -- possibly because of magmatic heating of ice-rich deposits within the layered deposits. Perhaps, water released during this heating resulted in a fluvial resurfacing event in the Hesperian (or possibly Late Noachian) Period. The flow of water etched terraces in the layered deposits, eroded impact craters, and left residual deposits in incised channels. The regional extent of this fluvial resurfacing event is unclear, but it could have been extensive. Enipeus Vallis, in the western part of the region and some 480 km long, may have formed during this fluvial resurfacing event.

Extensional stresses at right angles to the projected axis of the Tharsis bulge resulted in the formation of northeast-trending graben [3,4] with zigzag segments after the fluvial erosion event. Graben formation almost ceased and was followed by basaltic plains volcanism [3] in the Late Hesperian [2]. This volcanism produced low shields and lava fields. The magmas reached the surface along vents and fissures with a wide range of azimuths, but they were oriented chiefly in northeasterly directions; modal azimuths were near N. 47° E. and N. 62° E. Lavas continued to issue from local vents and fissures aligned in northeasterly directions from the Late Hesperian into the Early Amazonian.

Eolian processes, represented by windstreaks, bright-red surface materials with high albedos and low thermal inertias, and dune forms in graben, produced the most recent deposits and landforms. Eolian processes have been observed by spacecraft and are active today.

The volcanic landforms of the region are similar to landforms produced by basaltic plains volcanism [3] on Earth. Exemplified by the Snake River Plain in Idaho, basaltic plains volcanism is intermediate between flood or plateau basalt and Hawaiian volcanism [5]. Like plains and flood basalt volcanism on Earth, low shields and lava fields with flow fronts distinguish Tempe-Mareotis volcanism from Lunae Planum and Hesperia Planum volcanism on Mars. Like plains and Hawaiian volcanism on Earth, small shields distinguish Tempe-Mareotis volcanism from the great shields produced by Tharsis volcanism on Mars. Volcanic styles in Ceraunius Fossae and at high elevations in Syria Planum resemble the style of volcanism in Tempe-Mareotis [6].

In general, the appearances and dimensions of the shields in Tempe-Mareotis are similar to those of the Snake River Plain and suggest basaltic volcanism. The shields are typically near 5 km across, but one is near 60 km across. There are four types of volcanic edifices in Tempe-Mareotis: (1) low shields with summit depressions and smooth flanks, (2) low shields with summit depressions and radially textured or hummocky flanks, (3) low shields with summit knobs and hummocky flanks, and (4) domes. Reasons for the differences between the different kinds of shields are unclear, but radially textured flanks are probably the result of lava tube ridges, flows, and channels. Tumuli may give rise to hummocky flanks. Smooth flanks may result from pyroclastic eruptions, but lavas cannot be excluded. Height and flank-width ratios, which range from 0.011 to 0.097, are like those of low shields on Earth, which range from 0.010 to 0.067 [7,8]. Summit crater-diameter and flank-width ratios, which range from 0.211 to 0.931, are relatively large compared with those of low shields on Earth, which range from 0.032 to 0.54. Average yield strengths of lava flows in Tempe-Mareotis are near 1 -2 kPa and consistent with basaltic lavas.

Volcanism in Tempe-Mareotis is chiefly Late Hesperian, about the same age as the paterae and tholi in Tharsis, but volcanism continued into the early Amazonian. Eruptions from the Tharsis montes continued well-beyond those in Tempe-Mareotis. Although the summit elevations of the large shields tend to increase with decreasing age, eruptions producing edifices with small relief at low elevations persisted in Ceraunius Fossae [6], Cerberus [9], and at the base of Olympus Mons [10] over the same interval of time as the large shields.

[1] Carr, M.H., 1974, JGR, 79, 3,943. [2] Scott, D.H. and Tanaka, K.L., 1986, U.S.G.S. Misc. Inv. Map I-1802-A. [3] Plescia, J.B, 1981, Icarus, 45, 586. [4] Scott, D.H. and Dohm, J.M., 1990, Proc. 20th LPSC, 503. [5] Greeley, R., 1982, JGR, 87, 2705. [6] Hodges, C.A. and Moore, H.J. , 1994, USGS Prof. Paper 1534, 194p. [7] Pike, R.J., 1978, Proc. 9th LPSC, 3239. [8] Pike, R.J. and Clow, G.D., 1981, USGS Open-file Rept. 81-1039, 40p. [9] Plescia, J.B, 1990, Icarus, 88, 456. [10] Morris, E.C., et al., 1982, U.S.G.S. Misc. Inv. Map I-2001.