

MARS: VOLCANIC PLAINS IN THE CRATERED UPLANDS AND POSSIBLE TECTONIC ASSOCIATIONS: E.F. Albin and R. Greeley, Department of Geology, Arizona State University, Tempe, AZ 85287

Low lying regions such as intercrater areas and the interiors of impact basins in the ancient cratered plateau of Mars are often filled with smooth plains material interpreted to be of volcanic origin. These plains are widespread, as discussed in previous studies (1,2,3), and are an important key to understanding the volcanic and tectonic history of the planet. The objective of this investigation is to examine these volcanic plains and to assess the possible relationships with tectonic features. The recent advances using Viking orbiter data (e.g., global geologic maps at 1:15M (4,5,6) and assembly of 1:2M photomosaics) have made this study possible.

Two kinds of volcanic plains, composed of simple and complex flows, are recognized on the basis of surface morphology and can be dated using impact crater frequencies. Simple flows (7) display few flow features such as channels, but they typically have numerous mare-type ridges (3). They have a combined aerial distribution in the cratered uplands of about 6.634×10^6 km². Impact crater frequencies indicate a lower-Hesperian age. These plains are inferred to be analogous to flood or plateau basalts. In contrast, complex flows generally lack wrinkle ridges and may exhibit flow structures such as flow fronts and lava channels (3,7). Approximately 3.042×10^6 km² of the cratered plateau is covered by this type of plains unit. Relative age dating gives a mid- to upper-Hesperian age. These plains appear to be composed of overlapping flows that suggest sporadic eruptions of the Hawaiian style.

The major recognizable tectonic features on Mars are attributed to: (a) impact basins; (b) stresses produced by the Tharsis bulge; (c) Valles Marineris; and (d) the boundary between the northern lowlands and the southern uplands. Both (a) and (b) create extensional fractures in the lithosphere that could allow magma to migrate to the surface. Table 1 shows the percentage of volcanic plains of all types and ages in the cratered uplands and their possible association with tectonic features. Impact basins generally display concentric ring-fractures that may serve as loci for volcanism (8). Thirty impact basins larger than 200 km in diameter are distributed within the cratered uplands (9,10). Of these, nineteen have volcanic plains that occur within the largest ring-fracture. Most plains are of the older, "simple flow" variety. They have a total aerial extent of about 2.535×10^6 km² and account for 27 percent of all the volcanic plains observed.

Both simple and complex flows are common in the cratered plateau adjacent to the Tharsis region. Intense deformation occurred in the Tharsis area during the Noachian and Hesperian times, resulting in fracture systems that are mostly radial to a sequence of volcanic centers that shifted from Thaumasia to Pavonis Mons (11,12). The fractures are penecontemporaneous with the emplacement of volcanic plains and cut across extensive areas of the cratered plateau. Several fissure vents in the plateau have an orientation similar to that of the fractures (13). Approximately 1.607×10^6 km² of volcanic plains occur within the area cut by Tharsis-related fractures. Taken together, this evidence suggests that Tharsis-related tectonism may be linked to the eruption and emplacement of 16 percent of those plains identified in the cratered uplands.

About 57 percent of the volcanic plains (having an aerial distribution of $5.534 \times 10^6 \text{ km}^2$) have no apparent relationship to obvious tectonic features. Most of these plains are simple flows that occur in intercrater areas of the eastern and south polar region of Mars. Perhaps these plains are derived from tectonic features that are now obliterated. Further investigations of martian tectonics, on a global scale, may help to decipher the timing and mode of emplacement of these plains.

Table 1 The relative abundance of volcanic plains as related to tectonic features.

Tectonic Event	Type of Volcanic Plains	Aerial Distribution	Percentage
impact basins	simple flows	$1.594 \times 10^6 \text{ km}^2$	17%
	complex flows	$9.409 \times 10^5 \text{ km}^2$	10%
Tharsis bulge	simple flows	$6.967 \times 10^5 \text{ km}^2$	7%
	complex flows	$9.104 \times 10^5 \text{ km}^2$	9%
unknown	simple flows	$4.343 \times 10^6 \text{ km}^2$	45%
	complex flows	$1.191 \times 10^6 \text{ km}^2$	12%

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