VOLCANISM ASSOCIATED WITH THE HELLAS BASIN OF MARS

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The locations of five major volcanic centers may have been partly controlled by ring structures of the Hellas Basin. Hellas is a multi-ringed basin thought to have been formed by a great impact near the end of the main accretionary period of Mars. The number of Hellas Basin rings and their exact locations remain in doubt due to the age and asymmetry of the basin. Estimates range from three rings with locations determined principally from features on the Martian surface (Peterson, 1974) to five rings with locations derived mainly from theoretical considerations (Potter, 1976). The following discussion considers the former group and ignores the theoretical one. The inner ring lies near the margin of the dust-mantled floor of the basin and is poorly defined by surface features. The second ring is best defined on the west side of the basin by a set of normal faults, scarps and ridges located at the top of the main slope into the basin. The third ring is defined by several sets of widely separated features including a rift valley and numerous subparallel ridges and scarps arranged concentrically about the center of Hellas. From the center of the basin at about 40°S,292°W, the second and third rings as defined above have radii of approximately 1235 and 2130 km respectively.

The second ring passes beneath two major volcanic centers, the Hadriaca Patera shield on the northeast rim of the basin and the multiple calderas of the Amphitrites Patera shield complex on the southwest rim. The Hadriaca Patera shield has a single central caldera about 70 km across and is fairly circular in plan except for a lobe extending southwesterly (downslope) into the Hellas Basin. The Amphitrites Patera shield complex is a group of coalesced shields with five calderas (six if the crater Barnard is considered to be a caldera) ranging from 70 to 120 km across, and is oval in plan, elongate in an east-west trend. Its basal margins are generally indistinct, particularly on the west, but the complex may be as much as 1400 km across at its broadest.

The third ring passes beneath Tyrrhena Patera and near two unnamed volcanic centers at about 32°S,250°W and 68°S,323°W. Tyrrhena Patera appears to be an old shield with a complex summit caldera, and is partly buried by plains material on its eastern flank. Potter (1976) mapped two relatively fresh calderas near 32°S,250°W in an area of ridged plains material interpreted to be a field of flood lavas. The volcanic center near 68°S,323°W is a complex of mountains and dark low patches (Peterson, 1974; West, 1974). The mountains have several elongated depressions on them which may be of volcanic origin. The dark patches are thought to be young unmantled lava flows (Peterson, 1974). This complex is also located in an area of ridged plains material interpreted to be flood lavas. Dozens of ridges and scarps in this area are radial or concentric about the complex at 68°S,323°W.

Potter (1976) suggested that a major northeast-trending fracture system may have controlled the locations of Amphitrites Patera, Hadriaca Patera, and Tyrrhena Patera, as well as other features in the Hellas Quadrangle. This postulated linear fracture system intersects only one of the theoretical

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basin rings of Potter (1976), under the Amphitrites Patera shield complex. Figure 1 shows the relationships between five major volcanic centers and the second and third rings of the Hellas Basin as derived from structural features on the Martian surface. A broad northeast-trending fracture system could account for these relationships with all five volcanic centers occurring at or near the intersections of the linear system with basin rings.

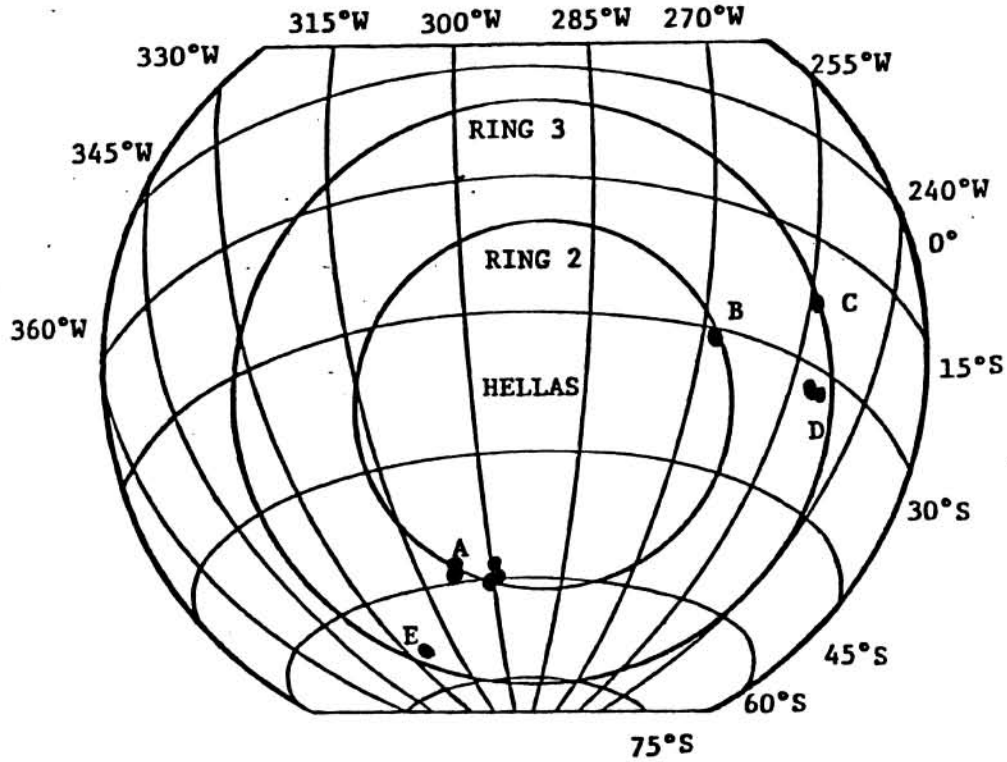

Figure 1: Hellas Basin rings and major volcanic centers.
A=Amphitrites Patera shield complex (5 calderas)
B=Hadriaca Patera shield
C=Tyrrhena Patera shield
D=Unnamed pair of calderas
E=Unnamed volcanic complex

Direct evidence for the existence of this northeast-trending fracture system, such as linear scarps, ridges or faults, is lacking due to burial by the extensive volcanic materials and eolian sediments found in the region.

The Hadriaca Patera shield covers an area of about 7.3 X 10^3 km^2, and the much larger Amphitrites Patera complex covers roughly $10^6 km^2$. In comparison, Olympus Mons covers about 2.4 X $10^5 km^2$. The actual area of Amphitrites Patera can only be estimated because its marginal contacts can only be approximately located with available imagery. Also, the Amphitrites Patera complex appears to be partially buried by ridged plains material associated with the volcanic center at 68°S,323°W. The topographic relief of the volcanic features in the Hellas region is small compared with that of

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the Tharsis shields and Olympus Mons. The Amphitrites Patera complex apparently stands less than 5 km above the floor of the Hellas Basin and much less over the cratered plains to the west (Barth, et al., 1974). Consequently, despite its much greater areal extent, Amphitrites Patera has a much smaller volume (probably less than one third) than Olympus Mons, whose volume is about $3 \times 10^6 km^3$. The great differences in height between the features in the Hellas region and those in the Tharsis region may be due in part to isostatic compensation, since the southern shields have had more time to approach equilibrium. However, in the cases of the Amphitrites Patera complex and the extensive ridged plains units, multiple vents and coalesced flows are probably the main cause of the large areas and low relief. The great sizes and gentle slopes of these features are suggestive of low viscosity basaltic lavas.

The five major volcanic centers in the Hellas region are varied in age, but all appear to be substantially older than Olympus Mons except for the dark low patches near 68°S,323°W which look very fresh. Impact crater densities on the volcanic units support these conclusions.

The apparent association of volcanic centers with Hellas Basin rings and possibly with a linear fracture system that may have intersected the rings suggests that volcanic activity could have been initiated on a large scale soon after the basin formed. This would mean that volcanism has been an important process in forming major constructional features on the surface of Mars throughout most of the history of the planet. The region also contains many features that appear to be relatively young, which is indicative that active volcanism has been an enduring and/or recurring process over a great span of time.

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