INVESTIGATION OF VENUSIAN PYROCLASTIC VOLCANISM;
M.L. Wenrich and R. Greeley, Department of Geology, Arizona State University, Tempe, Arizona 85287-1404

Magellan results show that the surface of Venus is dominated by volcanic materials [2]. Prior to the Magellan mission, considerations of eruptions in the venusian environment suggested that pyroclastic volcanism may not be common, or if evidence of pyroclastics were found, then it would signal volatile contents of 4% by weight carbon dioxide or 2.5% by weight water [1,3]. In order to assess possible pyroclastic volcanism on Venus, a reconnaissance was conducted using Magellan F-MIDRs (full-resolution mosaics). The following five candidate sites were located in the lowland plains on the F-MIDRs: 50S345, 30N332, 25N333, 20N334, and 60N132. The identifying criterion for pyroclastic airfall deposits is the relationship of radar-dark zones to the background. We infer that in distal depositional thinning of ash away from an inferred vent (and the ability of radar to penetrate loose deposits), some background features may be visible, although subdued, through the deposit. Closer to the vent where the ash is thickest, the underlying features may be completely obscured from view. This mantling relationship in association with other geological considerations is used as the primary criterion for evidence of pyroclastic volcanism when viewing the Magellan radar images. Either a reticulated plain or a plain with any pervasive bright lineations is an appropriate background capable of exhibiting this relationship.

Figure 1. A portion of F-MIDR 50S345 (centered at ~48.5S, 347.5) showing a volcanic construct surrounded by a radar-dark airfall deposit which mantles the underlying plain.
F-MIDR 50S345 (Fig. 1) shows a volcano 5 km in diameter. Concentric about the cone is a radar-dark region of ~25 km in diameter. This radar-dark region is interpreted to be volcanic ash deposited from an eruptive column extending ~25 km above the volcano, based on the relationship between convective column height and distribution distance [1]. This ash mantles the plain, as evidenced by its relationship to the surrounding lineated plain. The bright lineations are truncated by the dark ash deposit and, on this dark, fine ash, ghost lineations are visible. The lineations exhibit the same orientation and character of the bright features, although their radar backscatter is muted, suggesting that radar penetration through the ash allows them to be visible. The deposit is fairly circular in plan view as would be expected from an airfall deposit laid down during no wind [1].

Three contiguous F-MIDRs, 30N332, 25N333, and 20N334 contain possible pyroclastic materials. Many of the volcanic constructs in this area are enclosed within a radar-dark zone surrounded by a reticulated plain. These areas appear darker because the reticulate lineaments visible through the supposed ash are muted. We suggest that the ash has formed a mantle, thinning outward, through which the radar can penetrate, or that the ash was deposited over a plain of NW-SE trending lineaments, and was subsequently overprinted by faint NE-SW lineaments. The radar-dark areas on each of the three F-MIDRs range up to 20 km in diameter.

F-MIDR 60N132 shows an ~100 km² area of radar-dark material surrounded by radar-bright reticulated plains. The dark area subdues and mottles the radar-bright lineaments into discontinuous flecks of white. The edges of the inferred ash are diffuse, grading into the outlying plains. No radar-bright zones are visible within this ash patch, suggesting that no rough pyroclastic flows are present. Such a large deposit could result from a Plinian-type eruption. Although no volcanic vent is clearly visible, the deposit is suggestive of pyroclastic mantling.

We conclude that pyroclastic volcanism has occurred on the venusian lowlands, based on the identification of radar-dark inferred ash deposits that mantle radar-bright plains. This conclusion suggests that some magmas were volatile-rich (≥ 4 wt % CO₂ as a primary magmatic volatile) [1,3] or that at some time in the past Venus’ surface conditions were more accommodating to an explosive mode of eruption (e.g., lower atmospheric pressure or lower temperature) [3].

References: