INCIDENCE ANGLE AND RESOLUTION: POTENTIAL EFFECTS ON INTERPRETING VENUSIAN IMPACT CRATERS IN MAGELLAN RADAR IMAGES.

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The Magellan orbiter, scheduled for launch in 1989, includes an imaging radar that will cover from 70-90 percent of the venusian surface at a spatial resolution about 120-300 m [1]. Because of characteristic radial symmetry in plan view, impact craters are ideal landforms for evaluating the effects that incidence angle and spatial resolution may play in the interpretation of Magellan images. Observations of small terrestrial craters by Seasat synthetic-aperture radar (SAR) at high resolution (~25 m) and of comparatively large venusian craters by Venera 15 and 16 images at low resolution (1000-2000 m) and shorter wavelength show similarities in the radar responses to crater morphology. At low incidence angles (< ~ 15°), the responses are dominated by large-scale slope effects on the order of meters; consequently it is difficult to locate the precise position of crater rims on the images. With the viewing geometries of both the Seasat SAR and the Venera systems, abrupt contrasts in radar response to changing slope (hence incidence angle) across a crater produce sharp tonal boundaries normal to the illumination. Crater morphology that is radially symmetrical appears on images to have bilateral symmetry parallel to the illumination vector. Craters are compressed in the distal sector and drawn out in the proximal sector. At higher incidence angles (> ~ 35°) obtained with the viewing geometry of SIR-A, crater morphology appears less compressed on the images.

At any radar incidence angle, the distortion of a crater outline is minimal across the medial sector, in a direction normal to the illumination. Only the medial sector may yield an accurate measure of the diameter, provided there is sufficient contrast to locate the crater rim. It is important in radar images to distinguish between departures from crater circularity that are real and image distortion that relates to the scene illumination. Naturally occurring irregularities in morphology commonly appear to be asymmetrical relative to the crater outline, and not obviously related to the illumination vector.

Radar-bright halos surround some craters imaged by SIR-A and by Venera 15 and 16. The brightness probably denotes the radar response to small-scale surface roughness of the surrounding ejecta blankets [2, 3, 4]. In some cases the halos appear to be bilaterally symmetrical about an axis that parallels the illumination vector, with reduced brightness from the foreslopes to the backslopes. Such responses probably denote contrasted incidence angle effects.

Because of orbital considerations, the nominal incidence angle of Magellan radar at the center of the imaging swath will vary from about 45° at 10° N latitude to about 16° at the north pole and at 70° S latitude [5]. Figure 1 shows that at latitudes from 20° N to 10° S the viewing geometry will approach the SIR-A configuration. North of 60° N and south of 40° S the viewing geometry will be analogous to Seasat SAR. At the latitudinal extremities of imaging in both hemispheres the viewing geometry will approach the Venera 15 and 16 configuration. With this variable viewing geometry, radially symmetrical landforms can be expected to show outlines that vary with latitude. Radially symmetrical impact craters on Magellan images will show bilateral symmetry parallel to the illumination vector toward the higher latitudes, where they will appear increasingly compressed.

The spatial resolution of Magellan radar is coarser than Seasat SAR and SIR-A, but finer than Venera by about an order of magnitude [5]. This will provide the morphological detail necessary to verify the origin of large and degraded craters comparable to those observed on Venera images. It should also enable the discrimination of craters with diameters below the limits of reliable Venera resolution (~ 8 km). Similarities in the radar responses of small terrestrial impact craters and maar craters of comparable dimensions...
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(~ 2 km diameter, observed by Seasat SAR and SIR-A) emphasize the difficulties in discriminating an impact origin from a volcanic origin in the images [6]. Similar difficulties will probably apply in discriminating the origin of small venusian craters, if they exist.

REFERENCES


Figure 1. Variation of Magellan nominal incidence angle with Venus latitude, showing corresponding nominal values at beam centers for Seasat SAR, SIR-A, and Venera 15 and 16. Short dashed lines indicate latitudinal range of Venera coverage. Negative latitudes denote southern hemisphere.

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