RADAR MAPPING OF MERCURY; J. K. Harmon, National Astronomy and Ionosphere Center, Arecibo, PR 00613 and M. A. Slade, Jet Propulsion Laboratory, Pasadena, CA 91109.

Introduction. Arecibo S-band radar observations have been used to make full-disk radar maps of Mercury. The observations were made in two groups: a first set of observations in March-April 1991, when the subradar track was at 5°S latitude, followed by a second set of observations in July-August 1991, when the track approached 12°N. The transmitted signal was modulated by a random (non-repeating) binary phase code with a long (100 μs) baud. This transmission scheme allowed us to make delay-Doppler reflectivity maps which, though subject to the usual north-south ambiguity, were free of confusion from overspreading. This same technique was used at Arecibo in 1990 to make radar maps of Mars [1]. These are the first full-disk radar maps of Mercury made using delay-Doppler methods.

Full-planet Maps and Features. Examples of full-disk reflectivity maps are shown in Figures 1 and 2. These are maps of the depolarized echo, with dark areas corresponding to radar-bright regions. High depolarized brightness normally indicates high λ-scale roughness and/or high dielectric constant, although unusual surfaces might give enhanced backscatter (“opposition effect”). The map in Figure 1 has a subradar point (map center) at 27°W, 9.8°N; the map in Figure 2 is centered at 325°W, 5.3°S. The brightest feature in Figure 1 is the “north polar anomaly” (see below). A bright spot has also been identified at the south pole. Next to the polar anomalies, the most distinctive features are a pair of radar bright spots at 345°W longitude— one in the northern hemisphere (55°N) and another in the southern hemisphere (30°S). The southern feature is particularly prominent in Figure 2. These features, which are located in the hemisphere left unimagined by Mariner 10, are apparently associated with one of the CW spectral features identified 20 years ago by Goldstein [2]. Also visible on the eastern (right) side of Figure 2, near the equator, is an oblong radar-dark feature with a bright rim; this reflectivity feature coincides with a 2.5-km-high plateau found in Arecibo radar altimetry [3]. Two features have been found in the imaged hemisphere of Mercury. One of them, located at 35°W (see Figure 1), is probably the same feature seen at X-band [4] near the bright rayed crater Kuiper. The other feature, seen at mid-latitudes further to the west (∼85°W; map not shown here), may be associated with the bright rayed crater Copley.

North Polar Anomaly. The north polar anomaly was first discovered in a Goldstone/VLA map from 8 August 1991 [5] and subsequently identified in all of the Arecibo data obtained between 31 July and 29 August 1991 [6]. An example of a delay-Doppler image showing the polar feature is shown in Figure 3. The Arecibo maps, which follow the planet through half of a rotation in August, show that the feature is oblong and slightly offset from the north rotational pole (the elongation and offset is toward the 300° longitude meridian); this can be seen from the sequence of maps shown in Figure 4, which shows (top to bottom) the north pole at subradar longitudes of 210°, 304°, 353°, and 27°. The depolarized albedo of this feature is very high— equivalent to a full-disk albedo of 0.5 for an assumed Lambert scattering law. The north polar anomaly has also been identified in the polarized mode, and the ratio μc of depolarized to polarized cross section is ∼1.0.

South Polar Anomaly. A weak polar feature was identified in the delay-Doppler images from 30 March, 4 April, and 7 April 1991 (see the 7 April image in Figure 5). This feature can readily be seen in Figure 6, which shows echo power vs. delay summed over the central 5 Doppler bins in the delay-Doppler image. The position of this feature is inconsistent with it being from the north polar anomaly, which was just hidden over the north limb at the time of the observations. This feature must be coming from the south pole. This south polar anomaly is about 2° in diameter and is slightly offset toward the far side (the 180°-longitude side) of the pole.

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