N89-18363



EARTH-BASED RADAR CONTRIBUTION TO MARS SAMPLE RETURN; T. W. Thompson and L. Roth, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

Earth-based radar has often observed planets decades before space missions and provided valuable information leading to the success of those missions. As we contemplate how a Mars Sample Return Mission will be performed, we should review possible measurements by earth-based radars.

The most direct radar measurement is ranging where echo time provides topography. This is a good experiment for Mars as the rapid rotation provides surface coverage of several tens of degrees of longitude in a few hours of observation. A second radar measurement is total echo power which, in turn provides estimates of the bulk dielectric constant of the surface. Mars shows a large variation in this quantity. A third radar measurement is the echo shape which can be related to rms slope of the surface. A fourth radar measurement involves diffuse scattering which is controlled by the populations of wavelength-sized rocks.

Another important factor in earth-based radar observations of Mars is the interplay between the orbits of Mars and earth and the fact that radar echo strength is proportional to the inverse fourth power of the Earth-Mars distance. Observations of Mars are done near opposition when the Earth-Mars distance is less than 1.0 AU. Furthermore, the oppositions near perihelion have ten time stronger echoes than oppositions near aphelion. The 1986, 1988, 1990 oppositions are near perihelion and are the best times to observe Mars since 1971-1973 and until 2001-2003-2003.

Earth-based radar coverages in 1986, 1988, 1990 complement the 1971-1973 observations and cover Mars latitudes from the equator to $-25^{o}$ (about 20% of the martian surface). Radar observations for the remainder of the 1990's will be north of the equator covering latitudes from the equator to $25^{o}$. Futhermore, the proposed radar upgrades at the Arecibo radar facility will overcome some of the deficit in echo power mentioned above. A summary of earth-based radar echo strength and martian latitude coverage is shown in figure 1.

The ability of earth-based radars to measure topography is illustrated in Figure 2, which shows an elevation profile of crater Bakhuysen ($344.0^{o}$ $-23.0^{o}$, 140km) in Sinus Sabaeus. The radar profile shows a raised rim and flat floor.

The ability of radars to measure dielectric constant is illustrated in Figure 3, which shows measurement from twenty six 12.5 cm tracks of the Goldstone Radar in 1986, when the latitude coverage was $-3^{o}$ to $-10^{o}$ (a new area for earth based radar). The bulk dielectric constant for longitudes of $180^{o}$ to $90^{o}$ is 3.0-4.0, while longitudes of $75^{o}$ to $0^{o}$ (Valles Marineris) have dielectric constants near 5.0. These dielectric constants are reasonable values for regoliths with the regoliths. Analysis of the 1971-1973 Goldstone 12.5 cm data suggests that Mars radar may be reflectivity related to martian seasons, as shown in Figure 4.

In summary, earth-based redars provide measurements of topography, bulk dielectric constants, rms slopes, and surface rock populations. All these measurements will be valuable to a Mars Sample Return Mission. The 1988 and 1990 oppositions provide excellent opportunities to extend southern earth-based coverage of Mars to $-25^{o}$, while oppositions for the rest of the 1990's will provide coverage of northern latitudes to $25^{o}$.

# EARTH-BASED RADAR CONTRIBUTIONS TO MARS SAMPLE RETURN

T. W. Thompson and L. Roth

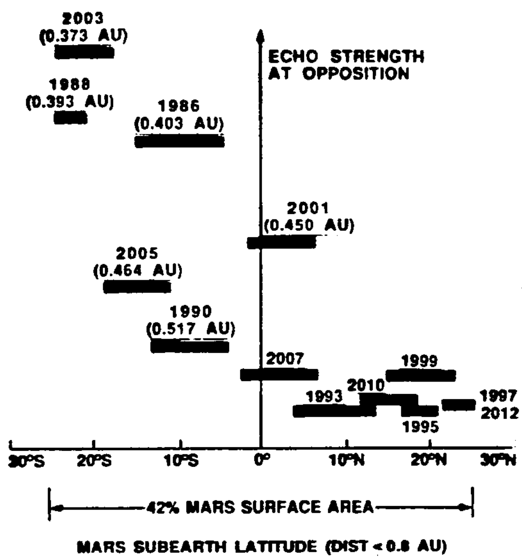


Fig. 1. Mars Echo Strength vs. Coverage

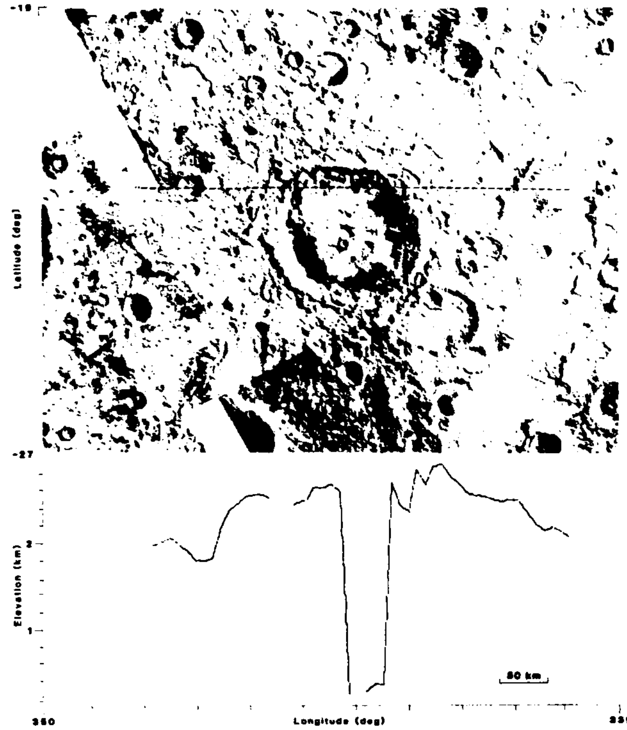


Fig. 2. Mars Radar Elevations

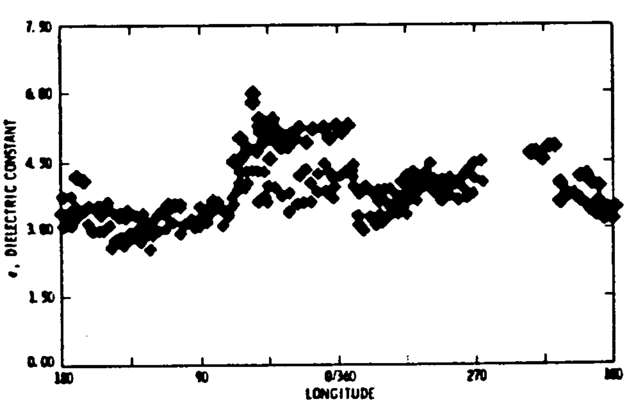


Fig. 3. Mars Dielectric Constants

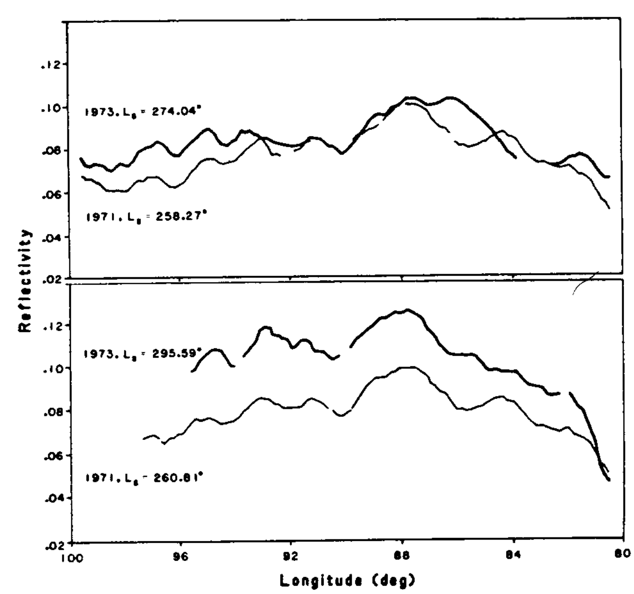


Fig. 4. Mars Reflectivity vs Season