The relative importance of the various processes for disposing of the missing volatiles, as well as an improved estimate of their total bulk, must await further analysis. It is reassuring to realize that the Viking landers have the capability for performing some of the most critical experiments needed to answer these questions.

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Viking Lander Location and Spin Axis of Mars: Determination from Radio Tracking Data

Abstract. *Radio tracking data from the Viking lander have been used to determine the lander position and the orientation of the spin axis of Mars. The areocentric coordinates of the lander are 22.27°N, 48.00°W, and 3389.5 kilometers from the center of mass; the spin axis orientation, referred to Earth's mean equator and equinox of 1950.0, is 317.35° right ascension and 52.71° declination.*

Analysis of the first few days of radio tracking data from the Viking 1 lander has provided preliminary determinations of the location of the lander on the surface of Mars, the radius of Mars at the landing side, and the orientation of the spin axis of Mars. Determination of these parameters constitutes part of the overall experimental objectives of the Viking radio science team (*1*). These results illustrate the strength of the precise Viking radio tracking data in the determination of astrodynamic constants; they are also important for the interpretation of data from other Viking experiments and for providing accurate reference points for measurements involving topographic parameters.

The Viking lander data used in this analysis consist of approximately 1 hour of Doppler (range rate) measurements at 1-minute count rate on each of the first 3 days after landing, and approximately 10 minutes of ranging data (three range points) on each of the first 2 days after landing. The estimated precision of the Doppler data is better than 1 mm/sec, and that of the ranging data is better than 15 m.

The spin axis orientation and the two components of the lander position in cylindrical coordinates, the longitude and the distance from the spin axis, are best determined from the Doppler tracking data. The third position component, the distance from the equator along the spin axis, is best determined from the ranging data but is subject to large uncertainties if there are even small relative errors in the ephemerides of Earth and Mars. A previously developed special technique (*2*) that uses nearly simultaneous orbiter and lander tracking data has been used to correct the ephemeris errors.

The present analysis consists of a simultaneous solution for five parameters, three lander coordinates and two spin axis orientation components, with all other parameters fixed at their nominal or best-known values. The results obtained for the lander position components, expressed in areocentric coordinates are: latitude, 22.27° ± 0.02°N; longitude, 48.00° ± 0.07°W; radius from the center of Mars, 3389.5 ± 0.3 km. The corresponding value for the latitude in areographic coordinates, frequently used as the reference latitude on maps, is 22.48°N. These results were obtained with a nominal (*3*) and unadjusted spin rate for Mars; any adjustment in spin rate will affect the longitude.

The results indicate that Viking 1 landed about 28 km from its targeted landing site, well within the expected landing dispersions. The radius to the center of Mars is in good agreement (within 1 km) with earlier estimates of the radius at the indicated surface location (*4*), which included consideration of regional topographic variations.

The values determined for the right ascension α_0 and declination δ_0 of the spin axis, referred to Earth's mean equator and equinox of 1950.0 are:

$$\alpha_0(1950.0) = 317.35° \pm 0.06°$$
$$\delta_0(1950.0) = 52.71° \pm 0.01°$$

When compared with the values of Lorell *et al.* (*5*) and of de Vaucouleurs, Davies, and Sturms (*3*), these values and the corresponding uncertainties represent a statistically significant improvement. The larger uncertainty for the right ascension is due to its high correlation with the lander longitude. Since long arcs of lander tracking data provide an excellent data source for these determinations, additional data will improve these estimates and could provide information on pole motion.

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