9. M. T. Chahine, *J. Atmos. Sci.* **27**, 960 (1970).
10. R. T. Menzies, *Appl. Opt.* **15**, 2597 (1976).
11. R. A. McClatchey, W. S. Benedict, S. A. Clough, D. E. Burch, R. F. Calfee, K. Fox, L. S. Rothman, J. S. Garing, *Atmospheric Absorption Line Parameters Compilation* (publication AFCRL-TR-73-0096, Air Force Cambridge Research Laboratories, Bedford, Mass., January 1973).
12. R. D. Grass, personal communication.
13. R. A. McClatchey, R. W. Fenn, J. E. A. Selby, F. E. Volz, J. S. Garing, *Optical Properties of the Atmosphere (Revised)* (publication AFCRL-TR-71-0279, Air Force Cambridge Research Laboratories, Bedford, Mass., 1971).
14. We thank M. Shumate for helpful suggestions. A portion of this work was supported under NASA contract NAS-7-100.
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The Prime Meridian of Mars and the Longitudes of the Viking Landers

Abstract. *A new planetwide control net of Mars has been computed by a single large-block analytical triangulation derived from 17,224 measurements of 3,037 control points on 928 Mariner 9 pictures. The computation incorporated the new Viking-determined direction of the spin axis and rotation rate of Mars. The angle* V, *measured from the vernal equinox to the prime meridian (areocentric right ascension) of Mars, was determined to be* $V = 148.368° + 350.891986° (JD - 2433282.5)$, *where JD refers to the Julian date. The prime meridian of Mars passes through the center of the small crater Airy-O. The longitudes of the Viking landers are* $\lambda_1 = 47.82° \pm 0.1°$ *and* $\lambda_2 = 225.59° \pm 0.1°$.

A new coordinate system for Mars was defined after the Mariner 9 mission (*1*). This coordinate system included a new direction for the spin axis, a new rotation rate, a new reference spheroid for cartographic purposes, and a new prime meridian defined as the meridian passing through the center of a small crater called Airy-O. The system was adopted by the International Astronomical Union at its General Assembly in Sydney in 1973 (*2*) and is used on all modern maps of Mars (*3*).

Analysis of the radio tracking data from the Viking 1 and Viking 2 landers has resulted in improved values for the direction of the spin axis and the rotation rate of Mars (*4*). The location of the lander sites was also determined very accurately relative to the vernal equinox of Mars and in terms of latitude and areocentric radii. The best method of determining the longitudes of the landers is by means of a photogrammetric tie to Airy-O. However, because it has not been possible to identify the lander locations on orbiter pictures, this approach has not been feasible. This inability to find the lander locations relative to the local topography is a shortcoming of the Viking mission, and care should be taken in the future to be sure that landers and rovers can be located with reference to the local terrain. A less direct method of determining the longitudes of the landers is to measure the angle between the prime meridian and vernal equinox by treating this angle as an unknown in the least-squares computation of the planetwide control net (*5*). This method has always been used in the past as there was no hope of obtaining independently determined accurate coordinates of such points as landers.

A new planetwide control net of Mars has been computed by a single large-block analytical triangulation derived from 17,224 measurements of 3,037 control points on 928 Mariner 9 pictures. The computation incorporated the new Viking-determined direction of the spin axis and rotation rate of Mars (*4*). The photogrammetric method has been described elsewhere (*5*). The least-squares computation resulted in improved values of latitude and longitude of the control points and orientation angles of the pictures. The spacecraft coordinates when the pictures were taken were obtained from the Jet Propulsion Laboratory Science Data Team and were assumed correct in the computation. The areocentric radii at the control points were derived from three sources: 2,163 were interpolated from occultation measurements and used in past control net computations (*5*), 22 were computed photogrammetrically (*6*), and 852 were derived from elevations on the available U.S. Geological Survey 1:5,000,000 topographic series of Mars maps (MC-4, MC-10, MC-11, MC-17, MC-18, MC-19, and MC-23). The elevation contours on these maps were derived from analysis of many sources of data (*7*). The analytical triangulation required the solution of 8,858 normal equations. The standard error of the measurements was 0.0167 mm or slightly more than one pixel (0.0144 mm).

This control net computation determined the angle from the Mars vernal equinox to the prime meridian to be

$$V = 148.368° + 350.891986° (JD - 2433282.5)$$

where JD is the Julian date and 2433282.5 is the Julian date of the reference epoch 1950 January 1.0 Ephemeris Time. On the basis of the value of V, the longitudes of the Viking landers are (*4*) $\lambda_1 = 47.82° \pm 0.1°$ and $\lambda_2 = 225.59° \pm 0.1°$.

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References and Notes

1. G. de Vaucouleurs, M. E. Davies, F. M. Sturms, Jr., *J. Geophys. Res.* **78**, 4395 (1973).
2. "Physical study of planets and satellites," in *Proceedings, 15th General Assembly, 1973: International Astronomical Union Transactions* (International Astronomical Union, Thessaloniki, Greece, 1974), vol. 14B, p. 107.
3. R. M. Batson, *J. Geophys. Res.* **78**, 4424 (1973).
4. W. H. Michael, Jr., *et al.*, *Science* **194**, 1337 (1976); A. P. Mayo, W. T. Blackshear, R. H. Tolson, W. H. Michael, Jr., G. M. Kelly, J. P. Brenkle, T. Komarek, *J. Geophys. Res.*, in press.
5. M. E. Davies and D. W. G. Arthur, *J. Geophys. Res.* **78**, 4355 (1973); M. E. Davies, *Photogramm. Eng.* **39**, 1297 (1973); *Mariner 9 Control Net of Mars: May 1974* (Report R-1525-NASA, Rand Corporation, Santa Monica, Calif., May 1974).
6. M. E. Davies, *Icarus* **21**, 230 (1974).
7. S. S. C. Wu, *Topographic Mapping of Mars* (Interagency Report: Astrogeology 63, U.S. Geological Survey, Washington, D.C., 1975).
8. This research was supported by contract NASW-3017, Planetary Geology Office, National Aeronautics and Space Administration.

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Cholera Toxin Crystals Suitable for X-ray Diffraction

Abstract. *Large crystals of the cholera toxin were grown; their dimensions, symmetry* ($P2_1$), *order, and resistance to radiation make them ideally suited for a high-resolution x-ray structure determination. There is one molecule (approximately 84,000 daltons) per asymmetric unit, and therefore the lattice reveals no molecular symmetry. Two distinct bioassays indicate that the protein from dissolved crystals retains full biological activity.*

We report here the preparation of cholera toxin (CT) crystals which are quite suitable for a high-resolution x-ray crystallographic structure determination. Cholera toxin is a protein exotoxin which, when released by the *Vibrio cholerae* in the small bowel, produces a noninflammatory secretory diarrhea (*1*). The massive secretion of salt and water is triggered by the binding of the toxin to