STRUCTURE OF THE MARTIAN POLAR DEPOSITS. M. T. Zuber, Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139-4307; (617) 253-6397; zuber@mit.edu.

Introduction: The polar regions of Mars represent primary reservoirs of present-day volatiles on Mars [1] and preserve the records of water [2], carbon dioxide [3] and dust [4] over timescales that range from seasonal to geological [5, 6]. Major progress in understanding of the polar regions has been made since the initial telescopic detection of polar seasonal frost over two centuries ago [7], to moderate resolution imaging from the Mariner 9 [8] and Viking 1 and 2 orbiters [9] to systematic high resolution mapping by the current Mars Global Surveyor spacecraft [10]. Detailed *in situ* sampling of the south polar layered terrains by the Mars '98 Polar Lander, due to land in December, 1999, will forge a link between local geology and global volatile cycles.

Northern Cap. The northern (Planum Boreum) and southern (Planum Australe) polar caps and circumpolar deposits show considerably different geological characteristics [11]. The northern polar cap (Fig. 1) is dominated by residual ice deposits and layered deposits extending to about 78° N latitude, which are arranged generally symmetrically relative to each other but are slightly asymmetrical relative to the present rotational pole. Residual ice dominates the surface near the pole, and layered deposits become more abundant toward lower latitudes, first within the troughs that form the distinctive swirl patterns, and then as a continuous annulus at the edge of the cap. The continuous layered deposits give way to circumpolar deposits at about 78° N. MOLA data have shown that Olympia Planitia, a dune-covered area adjacent to the polar cap at 180 longitude, slopes distinctly up toward the cap [10, 12]. This, together with residual ice remnants in this area, provides evidence of older ice deposits whose presence would make the polar region symmetrical around the present rotational pole.

Southern Cap. In contrast, the southern ice cap is much smaller in extent than the northern, although the southern polar layered deposits extend much farther from the ice cap and exhibit a more asymmetric distribution than their northern counterparts. Residual ice is much more limited in extent (an area with about one-third the diameter of the north polar cap) and is offset from the present rotational pole toward 35° - 40° E such that the pole does not fall within the residual ice deposit. The topography is highest in the south polar region within the residual ice deposits (87° S, ~10° E), where a broad dome is present with over 3 km of relief at one end of the cap (Fig. 2). The relief of the southern polar cap is comparable to that of the northern cap [13, 14].

For the southern cap, the area of probable ice-rich material greatly exceeds the region of residual ice that is apparent from images. This conclusion is based first on the existence of distinctive plateau regions that correlate with layered terrain units [13], as would be expected if the layers were deposited on cratered terrain. In addition, impact craters within the plateaus share unusual geometric properties with counterparts in the north polar region [15] that are observed to have formed in an ice-rich substrate. This similarity suggests that significant portions of the south polar ice cap may be buried beneath mantling dust deposits. Third, profiles across the northern and southern caps [13] show a striking correspondence in shape that argues for a similarity in composition and suggests that the southern cap may have a significant water ice component. The surface exposure of the residual south polar cap has been observed to display a CO_2 composition [16], which led to the idea that CO_2 is the dominant volatile in the southern cap. However, recent experiments on the rheology of solid CO_2 [17] combined with relative elevation measurements from stereo imaging [14] also suggest that H_2O is the more likely dominant volatile constituent of the southern cap [18], although the dust content in the deposits remains uncertain.

Acknowledgements: Thanks to the following individuals for discussion, figures, and permission to discuss data in advance of publication: O. Aharonson, S. Clifford, K. Fishbaugh, J. Garvin, C. Johnson, M. Malin, G. Neumann, D. Paige, R. Phillips, D. Smith, S. Solomon, L. Tyler, R. Zurek and J. Zwally.

References: [1.] Thomas P. et al. (1992) in *Mars* ed. H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Univ. Ariz. Press, Tucson, pp. 767-795. [2.] Jakosky B.M. and Haberle R.M. in *Mars* H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Eds., Univ. Ariz. Press, Tucson,, pp. 969-1016. [3.] James P.B. et al. (1992) in *Mars* H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Eds., Univ. Ariz. Press, Tucson, pp. 934-968. [4.] Kahn R.A. et al. (1992) in *Mars* H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Eds., Univ. Ariz. Press, Tucson, pp. 1017-1053. [5.] Fanale, F.P. et al. (1992) in *Mars* H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Eds., Univ. Ariz. Press, Tucson, pp. 1135-1179. [6.] H. H. Kieffer, H.H. and Zent, A.P. (1992) in *Mars* H. H. Kieffer, B. M. Jakosky, C. W. Snyder, M. S. Matthews, Eds., Univ. Ariz. Press, Tucson, pp. 1180-1218. [7.] Herschel W. (1784) *Phil. Trans., 24*, 233-273. [8.] Muaary B.C. et al. (1972) *Icarus, 17*, 328-345. [9.] Blasius K.R. et al. (1982) *Icarus, 50*, 140-160. [10.] Zuber M. T. et al. (1998)

*Science, 282,*2053-2060. [11.] Tanaka K.L. and Scott D.H. (1987) *USGS Misc. Inv. Series Map I-1802-C*. [12.] Fishbaugh, K. and Head J. (1999) *LPSC XXX*, 1401-1402. [13] Smith D.E. et al. (1999) *Science, 284,* in press. [14.] Schenk P. and Moore J. (1999) submitted to *J. Geophys. Res*. [15.] Garvin J.B. et al. (1999) submitted to *Icarus.* [16.] Paige, D.A. and Keegan K.D. (1994) *J. Geophys. Res., 99, 25,993-26,013.* [17.] Durham W.B. et al. (1999) *LPSC, XXX,* 2017-2018. [18.] Nye J.F. et al. (1999) submitted to *Icarus.*

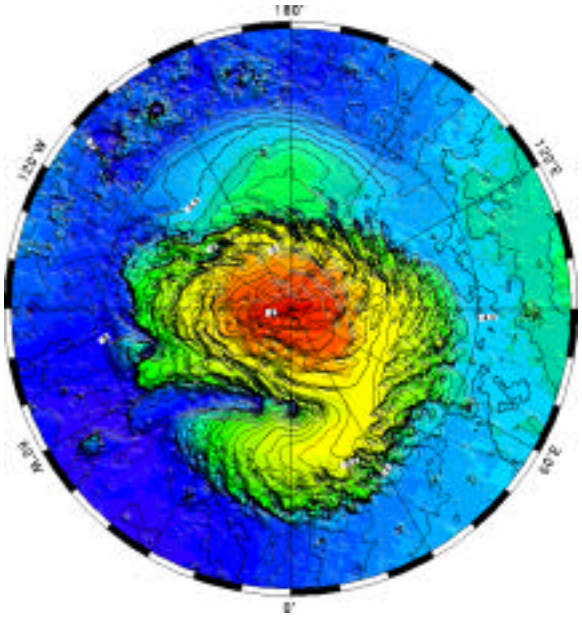

Figure 1. topographic map of the north polar region or Mars [10].

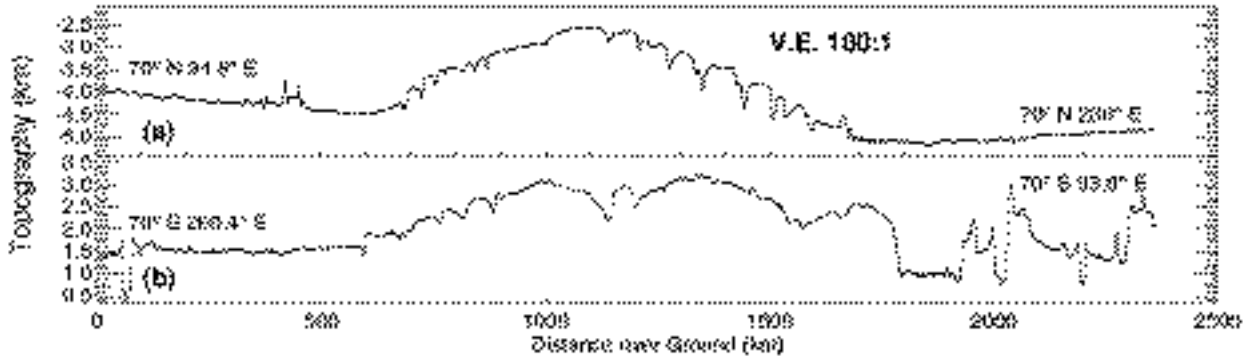

Figure 1. Profiles across the (a) north [10] and (b) south polar deposits [13] from Mars from the Mars Orbiter Laser Altimeter [1]. The profiles were extracted from MOLA Precision Experiment Data Record ap01576c during the MOC calibration period in March, 1999.