STRATIGRAPHY AND TOPOGRAPHY OF MCMURDO CRATER AREA, PLANUM AUSTRALE MARS: IMPLICATIONS FOR RESURFACING HISTORY AND POROUS CHARACTER OF THE SOUTH POLAR LAYERED DEPOSITS.

K. L. Tanaka[1], P. H. Schultz[2], and K. E. Herkenhoff[1], [1]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, ktanaka@usgs.gov, [2]Department of Geological Sciences, Brown University, Providence, RI, Peter_Schultz@Brown.edu.

Introduction: McMurdo Crater (84.5°S, 0°W) is the largest extant impact (~23 km diameter) that has scarred the south polar layered deposits (SPLD) of Planum Australe, Mars. It occurs along the margin of the SLPD and formed a broad field of secondary craters across the planum. These secondaries as well as other associated features serve as both (1) key stratigraphic markers that provide a basis for resolving stages in the resurfacing history of the SPLD, and (2) important indicators of the SPLD substrate character.

McMurdo Crater: Table 1 shows crater morphology parameters measured from Viking images (421B77-80) and 18 MOLA profiles currently available across the crater . The crater gouged the margin of Planum Australe, which is bounded by a scarp ~1.5 km high. The crater is only partly enclosed and opens out to the surrounding, lower-lying plains (Figs. 1 and 2). McMurdo includes a partly enclosed inner ring that is offset to the north of the center of the crater. This offset along with the lack of a northern rim may indicate that slumping associated with the impact event destroyed the northern rim and may be the cause of the apparent inner ring feature. No associated crater flows or ramparts have been detected. South of McMurdo, Planum Australe rises relatively rapidly; this rise may be due to uplift caused by the impact.

McMurdo's secondary craters are generally rimless (Figs. 3-4), except perhaps locally south of the crater. Because of imprecise locating of the MOLA tracks vs. the Viking images, we could not discriminate whether the dips seen in the profiles were secondary craters vs. other similar-scale topography (e.g., Fig. 4). In addition, the MOC image (Fig. 4) resolved lumps associated with the secondaries that may be piles of ejecta.

Table 1: Dimensions of McMurdo Crater and associated features.

Diameter	~23 km
Depth	1780 m
Maximum wall slope	18.4°
Rim height	0 to 51 m
Rim elevation	3031 to 3645 m
Inner ring diameter	~11 km
Inner ring depth	~600 m
Secondary size range	0 to 3 km
Depths of secondaries	< 25? m
Extent of secondaries	0 to 85 km
Lump widths	<400 m at 50 km range

Stratigraphy and Resurfacing: McMurdo's secondaries are unevenly distributed, apparently due to local burial and perhaps erosion [1,2]. On Planum Australe, a smooth mantle of variable albedo (unit Apm in Fig. 3) appears to bury the secondaries. This unit; mapped as SPLD (unit Apl) in previous mapping [3], might form the uppermost SPLD below the residual ice cap (unit Api) as well as deposits on broad, flat terraces southeast of McMurdo.

Peripheral to Planum Australe, the stratigraphy is less clear because of apparent eolian mantling. Hilly terrain may be made up of degraded ancient highland material (unit HNu), whereas as undulating, locally high-standing material may be an outlier of SPLD (unit Apl?). The smooth material filling in the low areas may also be younger SPLD material. McMurdo secondaries were obliterated by erosion at the perimeter of Planum Australe, which may account for the narrow trough in front of the planum east of McMurdo (Fig. 2), and (or) by deposition of unit Apm.

Post-McMurdo erosion of most of the SPLD on Planum Australe apparently has been relatively minor, perhaps on the order of meters to a few tens of meters at most to account for the preservation of secondary craters. Locally, ridges in the SPLD have crisp morphology and lack secondaries, and thus appear to have undergone greater erosion (Fig. 4). Deposition of the post-McMurdo SPLD-like mantle material (unit Apm) has been localized. These relations indicate that at least the flatter surfaces of Planum Australe have not changed significantly for what may have been a considerable period of time, consistent with surface age modeling based on crater statistics [4].

SPLD Character: McMurdo crater apparently formed in relatively unconsolidated layers on the basis of the following observations. First, the secondary craters are unusually large for the size of the crater. Laboratory experiments reveal that impacts into uncompacted, porous substrate produce large clumps of ejecta. This suppresses the role of the atmosphere [5], thereby minimizing the atmospheric effect on ejecta emplacement. Equally important it creates anomalously large and rimless secondary craters, which are largely the result of compression. Clumps and clouds of ejecta into porous materials have been observed experimentally to produce shallow, low-rimmed craters [6]. Moreover, anomalously large secondary craters around relatively small craters also have been found in the circum polar sedimentary plains and in craters on the Medusa Fossae Formation [5]. Second, the MOC-resolved lumps would be consistent as soft-captured primary ejecta debris analogous to large glass bombs captured in the Argentine loess on Earth [7]. Third, the low rim height of McMurdo suggests that it has undergone extensive collapse (as indicated by the floor debris and slumps). Such collapse would be expected in an unconsolidated substrate due to the enhanced depth of the transient crater.

References: [1] Howard, A. D., *et al*. (1982) *Icarus 50*, 161-215. [2] Herkenhoff, K. E. (2000*) USGS Map I-2686* (in press). [3] Tanaka, K. L. and Scott, D. H. (1987) *USGS Map I-1802-C.* [4] Herkenhoff, K. E. and Plaut J. J. (2000) *Icarus* (in press). [5] Schultz, P. H. (1992) *JGR 97,* 11,623-11,662. [6] Schultz, P. H. and Gault, D. E. (1985), *JGR 90,* 3701-3732. [7] Schultz, P. H. et al. (1999) *LPSC XXX,* #1898.

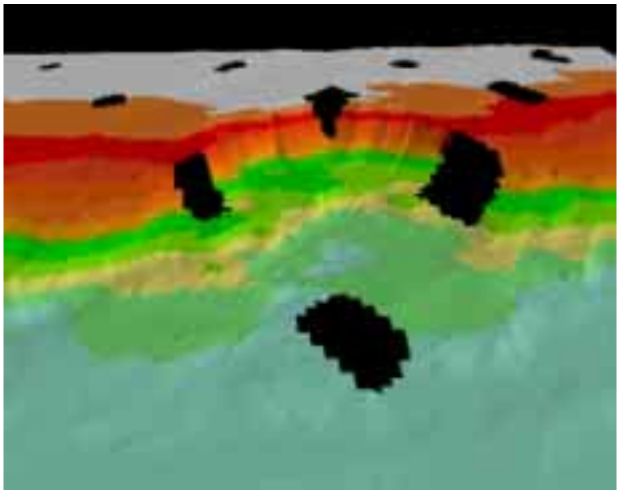

Fig. 1. Digital terrain model looking southward into McMurdo Crater. [Vertical exaggeration 4X]

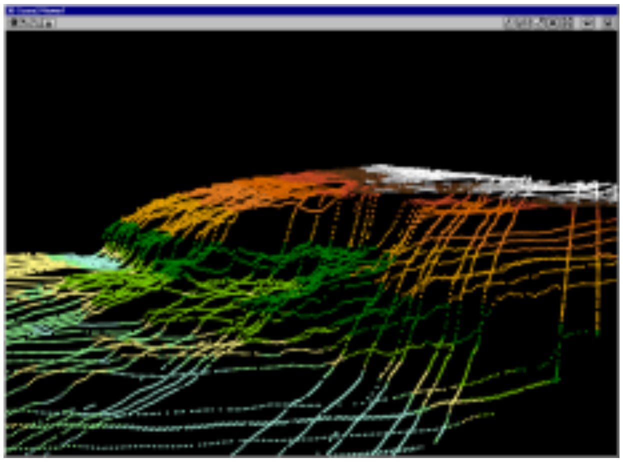

Fig. 2. MOLA tracks in 3D of McMurdo Crater looking southeastward across Planum Australe. Note shallow trough at base of Planum Australe (center left) and inner crater ring (dark green). [Vertical exaggeration 6X]

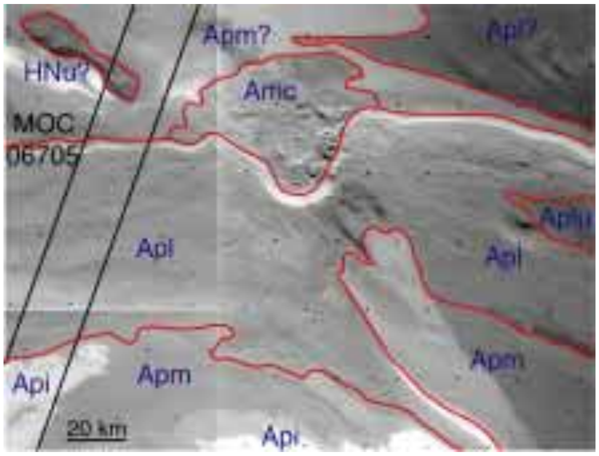

Fig. 3. Viking mosaic of McMurdo Crater. Api, residual ice cap; Apm, polar mantle material; Apl, SPLD; Amc, McMurdo crater materials; HNu, undivided highland material.

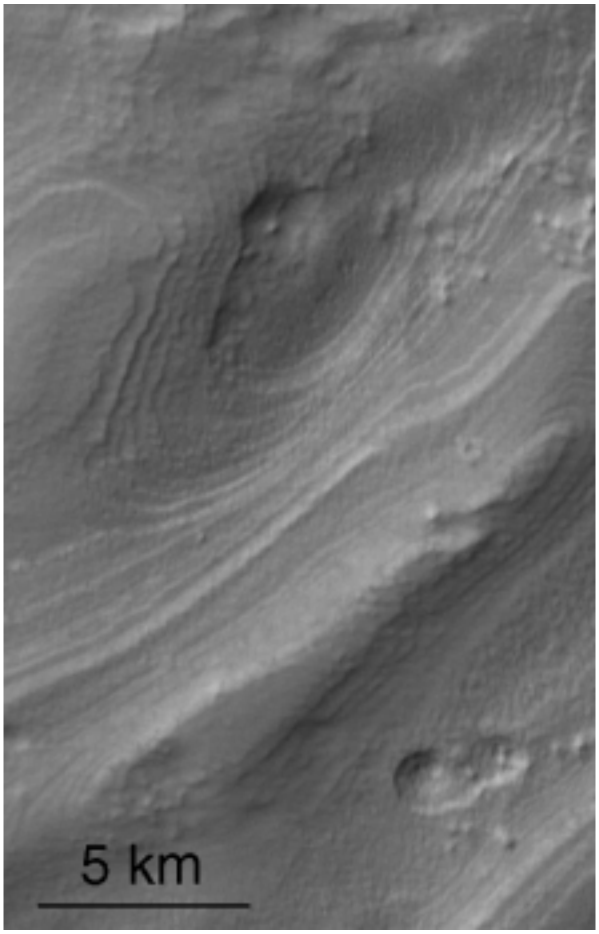

Fig. 4. Part of MOC image 06705 (32.5 m/pixel) showing SPLD on Planum Australe. Note secondary craters and lumps of ejecta from McMurdo crater (50 km to the east), which appear to be preferentially preserved in shallow troughs.