EVIDENCE FOR AN 800 KM DIAMETER IMPACT STRUCTURE IN MERIDIANI PLANUM AND ASSOCIATED CHANNELS AND BASINS: A CONNECTION WITH THE ORIGIN OF THE HEMATITE DEPOSITS?

H.E. Newsom[1], C. A. Barber[1], R. T. Schelble[2], T. M. Hare[3], W. C. Feldman[4], V. Sutherland[1], H. Gordon[1], I. E. Thorsos[1], A. Livingston[5], and K. Lewis[5] , [1]University of New Mexico, Institute of Meteoritics and Dept. of Earth and Planetary Sciences, Albuquerque, NM 87131, newsom@unm.edu, [2]Dept. of Earth Sci., Univ. of Southern California, Los Angeles, CA 90089, [3]U.S. Geol. Survey, Flagstaff, AZ, 86001, [4]Los Alamos National Laboratory, Los Alamos NM 87545, [5]Southwestern Indian Polytechnic Institute, Albuquerque, NM 87184.

Introduction: Topographic evidence for the existence of an early 800 km diameter multi-ringed impact structure (Fig. 1), and evidence for fluvial and lacustrine environments in Meridiani Planum [1] suggests a connection with the origin of the hematite deposits [2] present in the region.

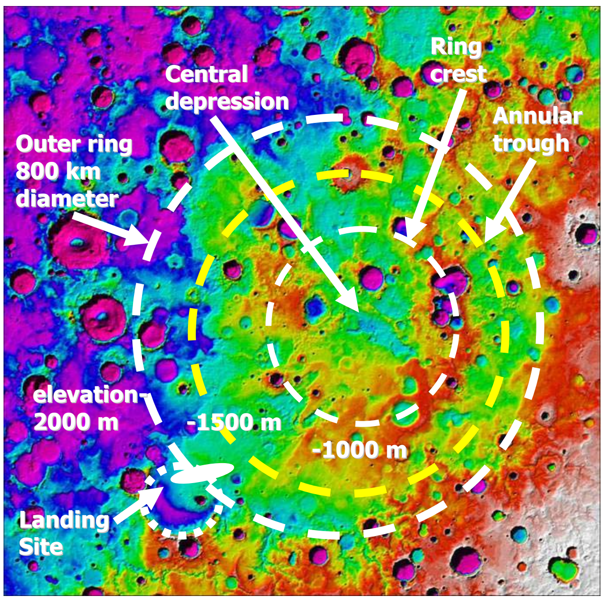

Fig. 1 Color coded MOLA topography showing concentric circular features in Meridiani Planum consistent with the presence of an 800 km diam. multi-ringed impact structure. The location of the MER landing site inside a 150 km diam. crater is also shown.

Discussion: Evidence for concentric circular structures in Meridiani Planum are seen in topographic data and stacked radial profiles from the MOLA experiment (Figs. 1, 2). This evidence includes a central basin, a 200 m high raised ring at a radius of 200 km (400 km diam.), and an annular trough at a maximum radius of about 400 km (800 km diam.). The western edge of the annular trough is missing, probably due to later erosion. The structure is very similar in size to the Cassini structure, which has a 400 km diam. rim and an 800 km diam. annular trough. Neither structure exhibits a gravity or magnetic anomaly.

In addition to the presence of hematite in the structure, Edgett [3] searched 116 MOC images in of craters throughout western Arabia Terra for the occurrence of dark mesa-forming units. The six occurrences of the dark mesa-forming units all appear to be located within the 800 km diameter feature, supporting the importance of this structure. These dark units are emplaced on previously eroded lighter material [4].

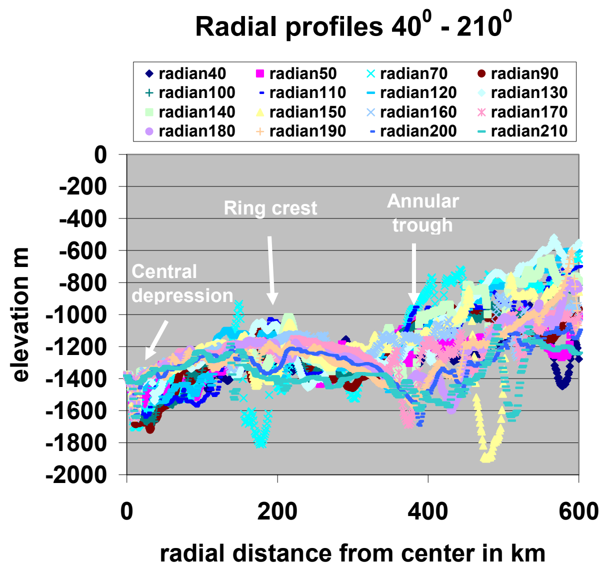

Fig. 2 Stacked radial profiles from the 40^0 azimuth to the 210^0 azimuth. Profiles are ten degree averages of one degree profiles. The data show the central basin, the ring crest at a radius of 200 km, the annular basin at 400 km, and a range of mostly higher elevations outside the structure beyond a radius of 400 km.

The overall relief of the structure is very small (<500m) and the low areas in the structure make up a series of basins. We have used topographic data and MOC and THEMIS images to show that the southern boundary of the hematite area (near the area containing the strongest hematite signature) was the site of a chain of paleo-lakes (Fig. 3). The MER Meridiani Planum landing site is on the northern buried rim of a 150 km diameter crater, which contained a paleo-lake in the southern portion based on MOC and THEMIS images. Our mapping shows that the paleo-lakes were fed by an extensive channel system covering 580,000 km^2, the size of Texas, originating near the Schiaparelli basin.

The presence of water in the basins in the recent past is suggested by MOC imaging and epithermal neutron data from Mars Odyssey (Fig. 4). The neutron data suggest the presence of an H_2O-equivalent hydrogen content in the Sinus Meridiani area of 3.5 ± 0.5 wt% bound water in clays, and/or oxyhydroxides, and buried beneath a 15–20 cm thick hydrogen-poor layer, assuming the Viking 1 soil has approximately 1 wt% water [5].

The discovery of the 800 km diameter structure provides a link between the Meridiani and Aram basin (500 km diameter) occurrences of hematite. Both deposits share the combination of location on an elevated region within a large impact feature combined with a long history of fluvial and lacustrine activity.

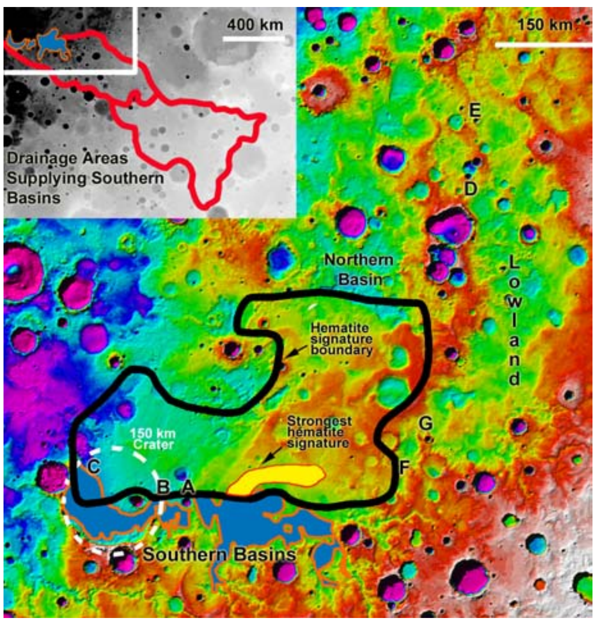

Fig. 3 Study area in Meridani Planum. MOLA topography map (Latitude 7 N to 5.6 S, Longitude 351.1 E to 5.5 E) showing the regional setting of the hematite-rich surface deposit labeled with areas and basin barriers [1]. The inset shows the drainage areas feeding the southern basins. The prominent crater on the top right side of the inset is Schiaparelli.

The connection between the impact structures and the origin of the hematite could involve precipitation from hydrothermal fluids associated with the heat from the impact, either in lakes (e.g. like banded iron formation), or directly in the observed layered deposits. Alternatively, the hematite could imply an iron enrichment process associated with the impact followed by aqueous processes that enhance or create the observed surficial hematite signature [e.g. 6]. Supporting the role of water is the presence of the strongest hematite signature in Meridiani (Fig. 3) on the topographic ridge that makes up the edge of the eastern basin at an elevation of –1350 m. to –1450 m, just above the current elevation of barrier A at about –1450 m.

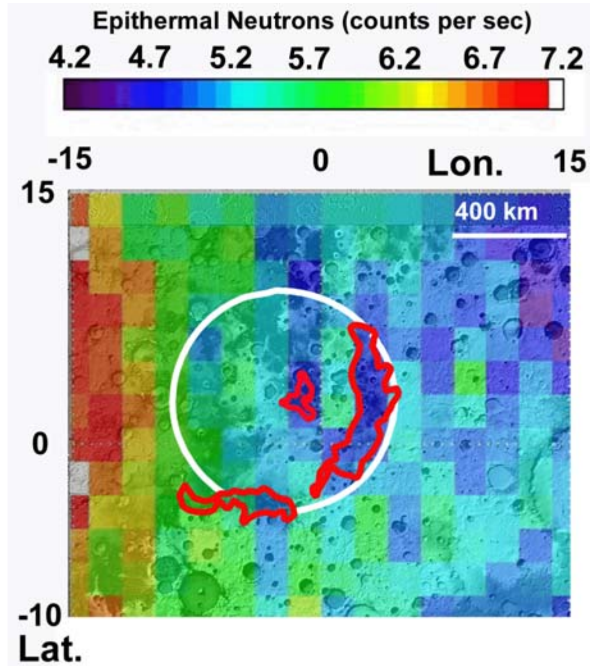

Fig. 4 Epithermal neutron data (2 degree bins) for the hematite locality with basins outlined in red and the 800 km diameter structure in white, with latitude and longitude shown. A decreased epithermal neutron flux indicated by the blue color is thought to be due to the presence of hydrogen, possibly in the form of 3.5 ± 0.5 wt% bound water [5].

These results also bear on the origin of the hematite at the MER landing site in a 150 km diameter crater (Figs. 1, 3), where the hematite is on top of layered material filling the crater. If the 150 km crater is older than the 800 km structure, the hematite could represent the top of an impact melt deposit. This would be consistent with the similar thin mantling nature of the hematite-bearing material throughout it's distribution. If the 150 km crater is younger, the hematite-bearing material may have been transported to the 150 km diameter crater location by fluvial processes.

References: [1] Newsom et al., (2003) *JGR*, submitted. [2] Christensen P.R., et al. (2001), *JGR 106*, 23,873. [3] Edgett (2002) *J. Geophys. Res.*, *107*(E6), doi:10.1029/2001JE001587. [4] Hynek and Phillips, (2002) *Geology* 29, 407. [5] Feldman et al. (2002) *Science 297*, 81. [6] Kirkland et al. (2002) *Lunar and Planetary Science XXXIII*, CD rom #1218.

Research supported by NASA Planetary Geology and Geophysics program NAG 5-8804, NAG 5-11496 and NASA OSS-MURED Partnership program NAG 5-10143.