THICKNESS ESTIMATE OF POSSIBLE ERODED OVERBURDEN AT MERIDIANI PLANUM FROM MER OPPORTUNITY MI IMAGES.

M. G. Chapman[1], K. E. Herkenhoff [1], D. M. Galuszka[1], T. M. Hare[1], M. R. Rosiek[1]; [1]Astrogeology Team, U. S. Geological Survey, Flagstaff, AZ 86001 USA (mchapman@usgs.gov).

Introduction: Instruments onboard the Mars Exploration Rover (MER) at Opportunity (Site MER B) have revealed alluvium overlying rocky outcrops [1,2]. Basaltic sand grains and hematite-rich spherules (4 to 6 mm in diameter) randomly-distributed throughout the rocks and also weathered out indicate that the alluvium is a surface lag unit accumulated via erosion of overlying deposits [1,2]. In the summer of 2006, crossing the Meridiani Planum on its way to informally named Victoria crater, the MER B rover encountered surfaces that show indications of intergranular volume loss due to burial. Specifically, targets of the Microscopic Imager (MI) Camera on sols 811-924 showed evidence for grain-grain compaction, deformation, and possible suturing (MI targets B811Pecos River, B811Fort Sumner, B880Fort Graham, B910Isabella, and B924Hawkins). This study utilizes data from MI target B910Isabella and derived DEMs to estimate the intergranular volume and hence suggest possible thicknesses of overburden (overlying deposits) that may have been removed to generate this Meridiani surface.

Intergranular Volume Estimates: MI images are 1024 x 1024 pixels in size, with a scale of 31 microns/pixel at best focus and the radial distortion is less than 0.33 ± 0.03 pixel [3]. The target B910Isabella is a 5 x 2, stereo, 5-stack set of 54 MI images; the entire mosaic is 121 mm long and 63 mm wide. The rock clasts of this target have diameters ranging in size from 2 to 6 mm (Fig. 1). Many are spherules "Mars blueberries" that average 2.5 mm in diameter and others are sub-angular likely weathered basaltic grains (Fig. 1). Target B910 Isabella and those from sols 811 to 924 show small spherules and angular granules that have been compacted together until the grains are sutured and ductile grain deformation has taken place (best observed at arrows on Fig. 1). This grain to grain deformation and perhaps suturing has resulted in 'blueberries' that show pits and a loss of sphercity (Fig. 2) and angular grains that are packed tightly together (Fig. 3). Stereo images have been used by the MER team to generate topographic digital elevation models (DEMs) to view the 3-dimensional character of target surfaces [3]. To visually demonstrate these grain shape changes we generated DEMs of the Isabella mosaic (Fig. 4 a,b). The inferred grain deformation and packing requires pressure from overlying sediments (overburden) to mechanically compact the deposit. Here we present estimated possible overburden thicknesses that may have been removed at Meridiani Planum using terrestrial data as analogs.

Studies on Earth confirm that quartz and feldspar sands compact mechanically and intergranular volume declines rapidly, from about 41% at the surface, to about 28% at 1500 m [4]. Between 1500 and 2500 m, intergranular volume continues to decline slowly, until the framework stabilizes around 26% (maximum porosity in the absence of cement; [4]). No other mechanical changes were observed to the depth of the terrestrial data set at 6700 m [4].

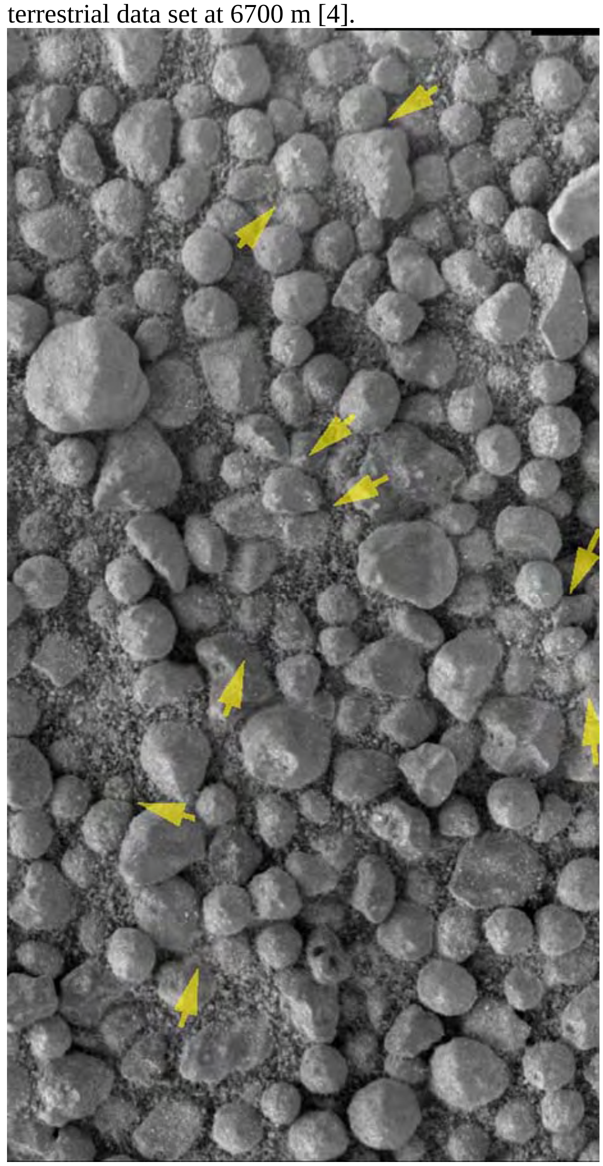

Figure 1. Part of MER B MI mosaic of target Isabella sol 910, size = 32 x 60 mm; arrows denote sutured grains.

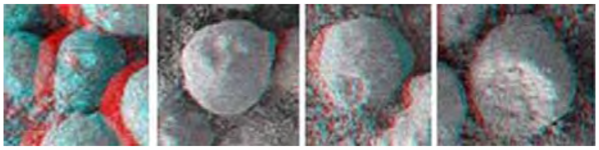

Figure 2. Anaglyphs (3D views) of pits on B910 Isabella spherules.

Intergranular volumes less than 26% are due to chemical compaction and pressure solution that results in suturing of grains and concurrent cementation [4].

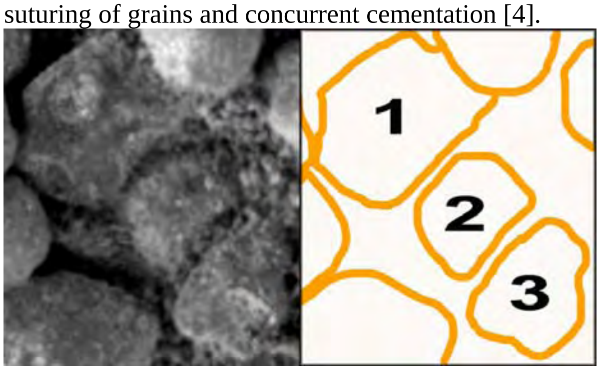

Figure 3. Target Isabella angular grains (1-3) that are packed tightly together, grain '1' perhaps sutured.

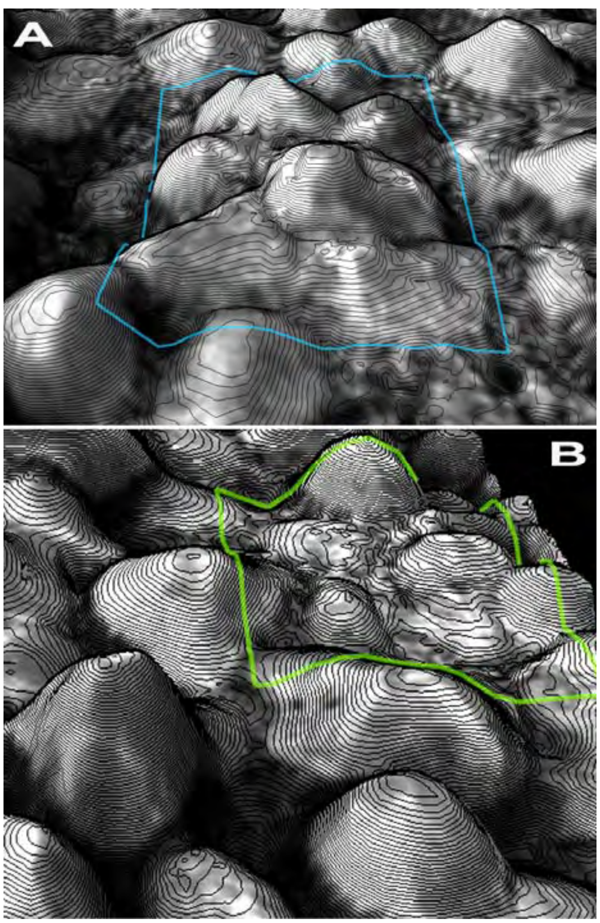

Figure 4. DEMs of (A) area 1 and (B) area 2 (locations on Fig. 5).

Terrestrial intergranular volume was measured conventionally by point counting of 368 petrographic thin sections (~25 x 35 mm), adding the sum of pore space, cement, and matrix [4]. Basically, all non-grain void area was counted as intergranular volume.

In our attempt to emulate the terrestrial study, we used GIS methods to isolate two 12 x 16 mm areas from MI target Isabella that showed fairly dust-free examples of grain-grain compaction, drew polygons around pebbles, and calculated the non-grain volumes for area 1 = 33% and area 2 = 30% (large percentages, as suturing may have occurred). Comparison between these numbers and terrestrial compaction curves [4] indicate overburden thickness of 1 km (3 km scaled to Mars gravity).

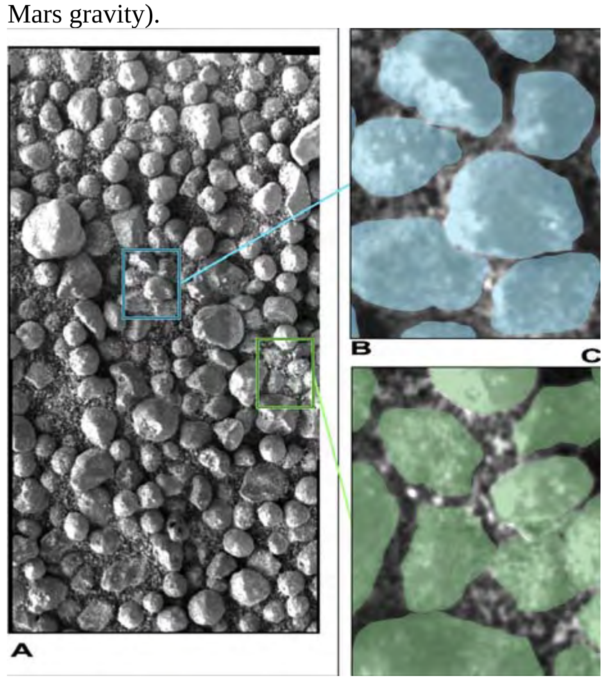

Figure 5. (A) Target Isabella mosaic showing box locations of measured areas; (B) Area 1 grain polygons; (C) Area 2 grain polygons.

Discussion: The MI overburden thickness estimates are limited by our inability to directly measure a petrographic thin section. In addition, we do not know the hardness values of the grains and how this data would affect our estimates. For example, although concretions on Earth can be quite hard, Mars "blueberries" may be more friable and compact easier than terrestrial quartz and feldspar grains. However, basaltic grains are fairly hard and would compare well with the terrestrial analogs.

References: [1] Squyres, S. W. (2004) Science 306(5702), 1698-1703. [2] McLennan, S. M. et al. (2005) EPSL 240, 95-121. [3] Herkenhoff, K. E. (2006) JGR-Planets 111, E02S04, doi:10.1029/2005je002574. [4] Paxton S. T. et al. (2002) AAPG Bull. 86(12), 2047-2067.