PHOENIX MISSION TRENCHING IN ARCTIC MARS. Amy Shaw[1], Raymond E. Arvidson[1], H. Uwe Keller[2], Mark Lemmon[3], Michael T. Mellon[4], Ashitey Trebi-Ollennu[5], Matthew Robinson[5], Kirsten Siebach[1] , Richard Volpe[5] [1]Washington University in St. Louis (ashaw@levee.wustl.edu, Campus Box 1169, 1 Brookings Dr., St. Louis, MO 63130), [2] Max-Planck Institute for Solar System Research, Max-Planck-Str. 2, Katlenburg-Lindau 37191, Germany [3] Texas A&M University (3150 TAMU, College Station, TX 77843) [4] Laboratory for Atmospheric and Space Physics (392UCB, LASP, University of Colorado, Boulder, CO 80309), [5]Jet Propulsion Laboratory, California Institute of Technology (4800 Oak Grove Drive, Pasadena, CA 91109)

Introduction: The Phoenix Mars Lander (touched down May 2008) dug twelve trenches in the polygonal terrain of the high northern latitudes on Mars [1]. These trenches, dug with a 2.4 m long robotic arm, were named after fairy tale characters and are as follows (in the order they were first dug): DodoGoldilocks, Snow White, Runaway, Upper Cupboard, Neverland, Lower Cupboard, Stone Soup, Burn Alive 2, Bear's Lodge, Pet Donkey, La Mancha, and Ice Man (not including the smaller sample trenches). See Figure 1 for the layout of the trenches. Forces measured while digging these trenches help to compare the properties of the soils in which the trenches were dug. The trenches sample a range of locations from the tops of the polygons that cover the ground to the troughs between them. The forces necessary to dig the trenches can further be compared with the forces required to dig trenches in a laboratory-style setup in the University of Arizona Payload Interoperability Testbed (PIT).

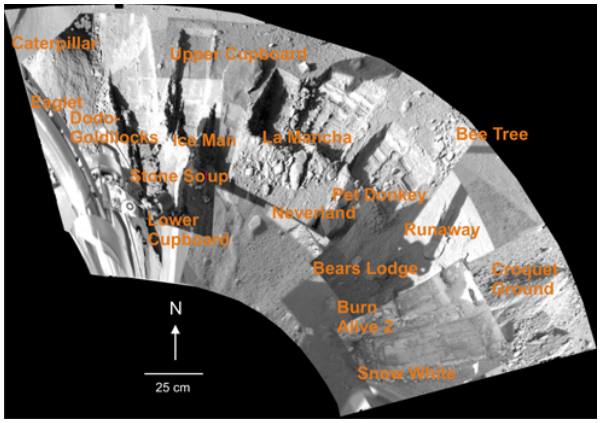

Figure 1. Workspace of the Phoenix lander showing trenches dug during the mission.

Force Data: Force data were acquired (derived from motor currents) during the mission partly because they relate to cohesion of soils [2]. Higher force values during trench digging indicate a more cohesive soil. The most straightforward way to intercompare the trenches is through cumulative percent force. Figure 2 illustrates the cumulative force distributions for several of the trenches as well as for one PIT test. The figure does not represent all of the trenching completed, but shows a selection biased towards initial trenching activity in each region. For some trenches, there are multiple force distributions shown in the figure. This is because trenching was an ongoing process and many trenches were revisited later in the mission. The sol numbers listed in these cases refer to the martian day, with the start of the mission as the zero-reference. It can be seen from the data for both the Snow White trench, which was dug at the top of a polygon, and the Stone Soup trench, which was dug closer to the bottom of a trough, that the soil is more difficult to dig through as the dig progresses deeper. At the end of the Sol 22 trenching in Snow White, it was seen that icy soil was revealed, which is probably responsible for some of the higher forces seen. But even at its deepest, Snow White was not as difficult to trench as the PIT test would have indicated. The PIT test used an icy soil analog consisting of soil cemented together with a resulting compressive strength of 2 - 5 MPa. The curves show significant variations between trenches as well: the surface material at Stone Soup appears to be softer than the surface material at Snow White. This would be expected of material in a trough as troughs can consist of looser material, such as stones transported in from other areas of the polygon.

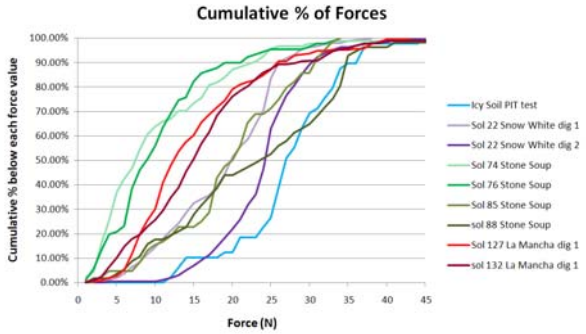

Figure 2. Cumulative % plots for various trenches dug during the Phoenix mission.

La Mancha was dug in the middle of a shallow truncated trough. La Mancha is unique morphologically as well. It is the only trench from which the robotic arm excavated large clods of coherent material. This can be seen in the tailings of the eastern sections of the trench as well as in the

dump pile called Bee Tree, please see Figures 3 and 4. Many of the clods have a platy character.

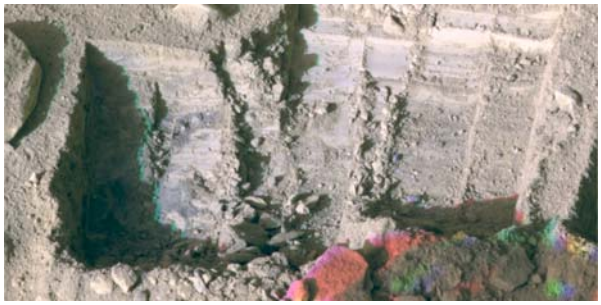

Figure 3. La Mancha trench false color image.

Figure 4. Comparisons of two dump piles created during the mission. (above) Material excavated from La Mancha. (below) Material representative of that excavated from the rest of the trenches.

It is also instructive to look at the variation of forces within each trench individually; see Figure 5 for plots showing this variation. Higher forces are again seen as the digs proceed deeper. It can also be seen from the depth data, that while each pass over the bottom of Snow White trench on sol 22 progresses deeper, the passes during the PIT test make little downward progress towards the end of the dig.

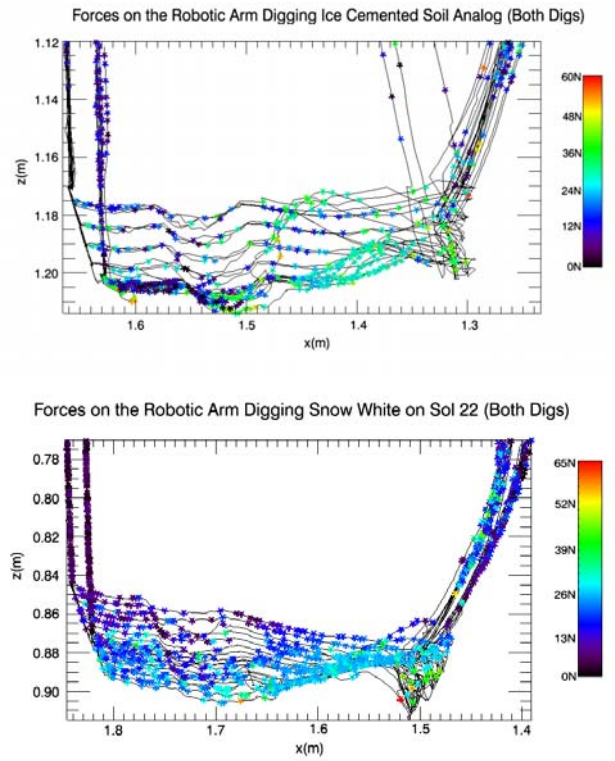

Figure 5. Curves of depth vs. horizontal distance. Data points are color-coded by force. (above) Laboratory tests with ice cemented soil analog. (below) Snow White from the first sol it was dug into. Snow White was the most frequented trench of the mission.

References:

[1] Arvidson, R. et. al. (2009), this volume. [2] Bonitz R. et al. (2008) *JGR, 113*, E00A01.

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