THERMAL INERTIA CHARACTERIZATION OF THE PROPOSED PHOENIX LANDING SITES. T. N. Titus,[1] T. H. Prettyman,[2] [1]U.S. Geological Survey, Flagstaff, AZ 86001 (ttitus@usgs.gov), [2]Los Alamos National Laboratory, Los Alamos, NM 87544.

Introduction: With recent detection from the GRS suite of instruments of a widespread water ice table in the Mars polar regions and the impending landing of the Phoenix Lander, it is important to understand the thermal inertia and hydration states of both the ice table and the top layer of soil that covers the ice table. We use Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) temperature observations immediately following the springtime disappearance of seasonal CO_2 to estimate the depth to the ice table and the thermal inertia of both the soil and ice-table at the 3 proposed Phoenix landing sites. (See Fig. 1.) We compare the depth and thermal inertia estimates derived from TES in the center of each proposed landing site with the depths and water-ice content estimated from neutron counts.

In addition to the inter-site comparisons, we do a detailed analysis of both Site A and B. The results from site B are presented in this abstract.

KRC Model and TES Data: We used the thermal bolometer brightness temperatures and solar albedo from the MGS TES to constrain the depth of the soil overburden covering the ice table. We use a thermal model originally written by Hugh Kieffer, KRC [1], to fit the rise in both the 2AM and 2PM brightness temperatures following sublimation of seasonal CO_2 frost. This approach has proven successful in detecting the presence of exposed H_2O ice, as well as estimating the overburden for buried H_2O ice [2].

Several thermal models with a range of soil depth, soil thermal inertia, and ice table thermal inertia values are generated. We then use a least-squares best-fit approach to match the brightness temperatures with the model that provides an estimate of both the depth and thermal inertia of the soil and the thermal inertia of the ice-table. The results of these best-fits are shown in Fig. 1 and Table 1.

Neutron Spectrometer: The abundance of water in the ice table and thickness of the dry soil covering the ice table at the Phoenix landing sites are estimated by comparing the thermal and fast neutron counts [3,4,5]. Sites A and C give very similar count rates for fast and thermal neutrons in the summer. Site B gives a similar fast neutron counting rate, but higher thermal counting rate than A and C. So, the most obvious interpretation is that the underlying layer contains approximately 50% water by mass. Sites A and C are very close to 15 g/cm^2. It should be clear that the water abundance of this layer doesn't have much of an influence on the determination of thickness of the top layer. Site B is closer to 10 g/cm^2 and between 20% and 50% for the ice table water abundance.

Results:

Inter-site Comparisons: Estimates of the depth and composition of the soil and ice table derived from the diurnal and seasonal temperature trends and the neutron counts are in general agreement. At all three sites, the soil overburden has a thermal inertia of ~200 J m^{-2} K^{-1} s$^{-1/2}$, consistent with non-cemented fine sand-sized particles. If one assumes the soil has a density of 2.5 gm/cm^3, then the depth estimates are in general agreement, with the possible exception of site C. The thermal trends were binned at a spatial resolution of 60km, approximately an order of magnitude higher resolution then the Neutron Spectrometer footprint. Because of the higher resolution of the thermal data, the KRC depth estimates should be more sensitive to local variations in soil depth. Thermal fits also suggest that Site B has an ice-table with lower thermal inertia than either Sites A or C. This is consistant with the neutron counts which suggest that Site B has a lower water content than the other two sites.

*Site B Results***:** Fig. 2 shows the results for Site B based on binning the data in 2º (Longitude) by 1º (Latitude) boxes for the entire landing site region. The majority of the top layer has a thermal inertia between 150 J m^{-2} K^{-1} s$^{-1/2}$ and 250 J m^{-2} K^{-1} s$^{-1/2}$, suggesting a surface of unconsolidated fine sand-sized particles. This picture may be oversimplified as recent HiRISE images of Site B suggests a high rock abundance [6]. The regional distribution of the bottom layer thermal inertia varies from 150 J m^{-2} K^{-1} s$^{-1/2}$ to 1200 J m^{-2} K^{-1} s$^{-1/2}$. North of latitude 68ºN, the bottom layer thermal inertia is consistently above 600 J m^{-2} K^{-1} s$^{-1/2}$, suggesting that we may be seeing local variations in the H_2O abundance of the ice table. South of latitude 68ºN, the thermal inertia decreases from ~600 J m^{-2} K^{-1} s$^{-1/2}$ (68ºN) to ~200 J m^{-2} K^{-1} s$^{-1/2}$ (65ºN). Due to these low thermal inertia, it is unlikely that we are accurately determining the thermal inertia and depth to the ice table, but are instead only setting constraints on the depth. North of latitude 68ºN, the depth to the ice table varies between a few millimeters and ~5.5 cm, suggesting local variations. South of latitude 68ºN, the depth estimates only provide a lower limit to the ice table, generally greater than ~3 cm.

References: [1] Kieffer, H.H. (1977) *JGR*, **82**, 4249-4291. [2] T. Titus et al. (2003), *Sci*, **299**, 1048-

1051. [3] T. H. Prettyman et al. (2004), *JGR*, **109**, E05001, 10.1029/2003JE002139. [4] Titus et al. (2005) *AGU Fall Meeting*, Abstract #P31A-0197 [5] Titus et al. (2006) *LPSC XXXVII*, Abstract #2161 [6] McEwen et al. (2006) *AGU Fall Meeting*, Abstract #P33A-02 [7] Boynton et al. (2002) *Science*, **297**, 81-85. [8] Feldman, W. C. et al. (2004), JGR, 109, E09006, 10.1029/2003JE002160.

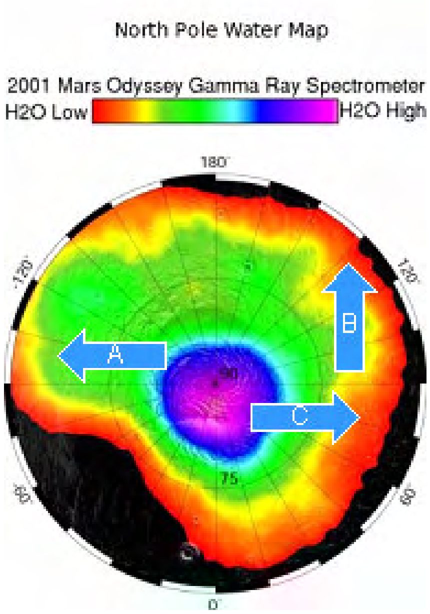

Figure 1: Water-ice map [7] of the northern hemisphere of Mars showing the 3 possible Phoenix landing sites (see also [8] for the water abundance determined by neutron spectroscopy).

Table 1: Comparison of regolith properties using the Thermal Emission Spectrometer (TES) and the Neutron Spectrometer (NS). The thermal inertia and depth estimates are based on thermal model (KRC) fits to TES data [4,5]. The Neutron Spectrometer overburden and ice content are estimates from Prettyman et al. [3] and Titus et al. [4,5].

Parameter	Site A	Site B	Site C
TES/KRC			
Thermal inertia of top layer	216	204	200
Thermal inertia of lower layer	1119	429	1040
Depth of top layer	6.4 cm	4.6 cm	3 cm
Neutron Spectrometer			
Overburden of top layer	~ 15 g/cm^2	10-15 g/cm^2	~ 15 g/cm^2
% Ice of lower layer	50%	20-50%	50%
Depth of top layer (assuming density = 2.5 g/cc)	~ 6 cm	4-6 cm	~ 6 cm

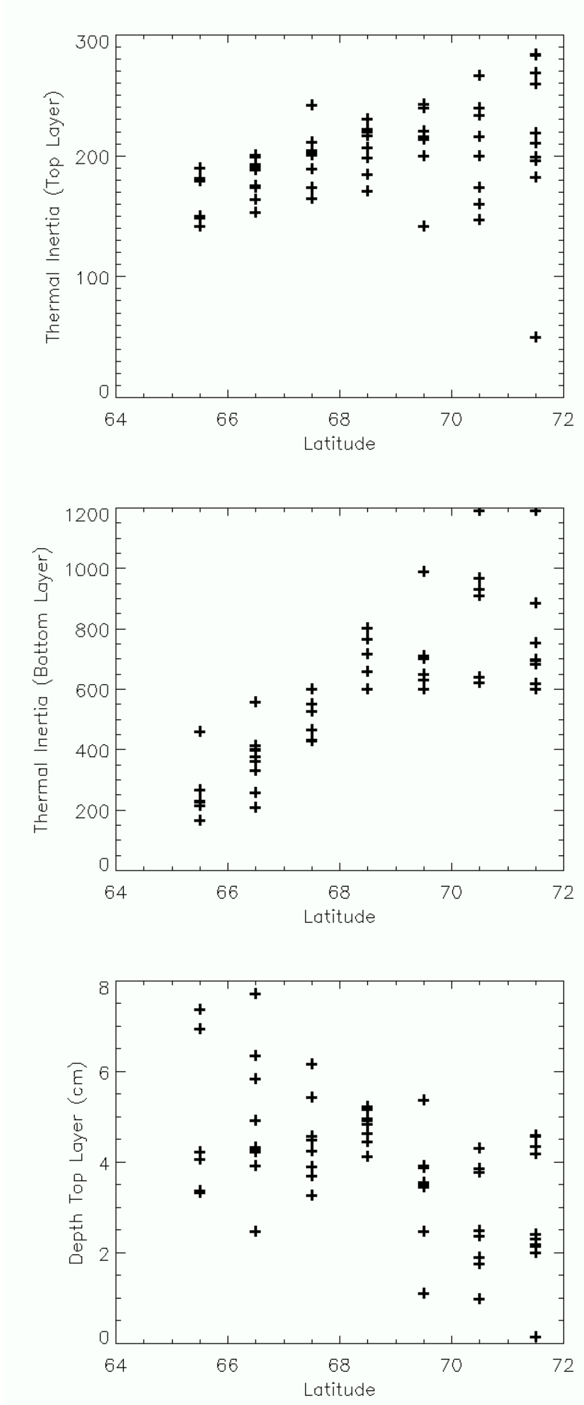

Figure 2: Results of Thermal Model Fits to 1°(Lat) x 2°(Lon) for Landing Site B. (Top) Plot of top layer thermal inertia vs. latitude. (Center) Plot of the bottom layer thermal inertia vs. latitude. (Bottom) Plot of the thickness of the top layer (cm) vs. latitude.