THERMAL CHARACTERIZATION OF THE THREE PROPOSED PHOENIX LANDING SITES. T. N. Titus,[1] T. H. Prettyman,[2] A. Colaprete,[3] [1]U.S. Geological Survey, Flagstaff, AZ 86001 (ttitus@usgs.gov), [2]Los Alamos National Laboratory, Los Alamos, NM 87544. [3]NASA Ames Research Center, Mountain View, CA 94089.

Introduction: With recent detection from the GRS suite of instruments of a wide spread water ice table in the Mars polar regions and the impending landing of the Phoenix Lander, it is important to understand the thermo-physical properties 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 with the depths and water-ice content estimated from neutron counts.

KRC Model and TES Data: We used the thermal bolometer brightness temperatures and solar albedo from the MGS TES to constrain the the depth of the soil overburden covering the ice table. We used 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 CO2 frost. Several models with a range of soil depth, soil thermal inertia, and ice table thermal inertia were used. We then used a least-squares best-fit to the brightness temperatures to estimate 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 as shown in Fig. 3 [2]. 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. The error bars measure the dispersion of counting rates that are averaged during the summer season. Note that the 50% water abundance curve passes very close to points A and C. So, the most obvious interpretation is that the underlying layer contains approximately 50% water by mass. Moving from the blue curve along the 2-50% corresponds to increasing the thickness of the dry top layer in steps of 5 g/cm^2 at first. Sites A and C plot very close to 15 g/cm^2. Note that the 2 and 7 in the notation 2-50% and 7-50% refers to the water abundance in the "dry" top layer. It should be clear that the water abundance of this layer doesn't much influence 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: 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, consistent with non-cemented sand sized particles. If one assumes the soil has a density of 2.5 gm/cm^2, 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 depths 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 interia 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.

References: [1] T. Titus et al. (2003), Science, 299, 1048-1051. [2] T. H. Prettyman et al. (2004), JGR, 109, E05001, 10.1029/2003JE002139. [3] Boynton et al. (2002) Science, 297(5578), p.81-5. [4] Feldman, W. C. et al. (2004), JGR, 109, E09006, 10.1029/2003JE002160.

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 the TES data as shown above in Figure 2. The Neutron Spectrometer overburden and ice content estimates are estimated from Figure 3.

Parameter	Site A	Site B	Site C
TES/KRC			
Thermal inertia of top layer	216	216	200
Thermal inertia of lower layer	1119	700	1040
Depth of top layer	6.4 cm	5.8 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 (density = 2.5 g/cc)	~ 6 cm	4-6 cm	~ 6 cm

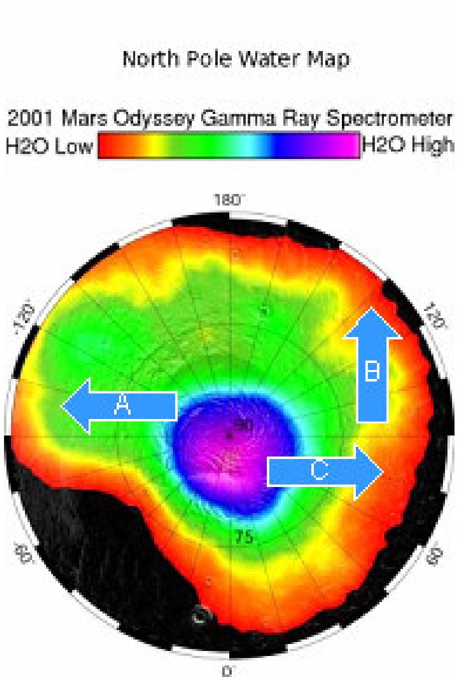

Figure 1: Water-ice map [3] of the northern hemisphere of Mars showing the 3 possible Phoenix landing sites (see also [4] for the water abundance determined by neutron spectroscopy).

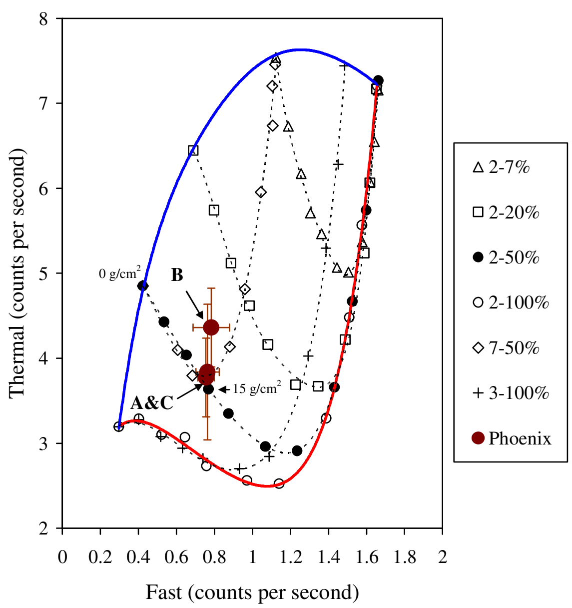

Figure 3: Model fits to thermal and fast neutron counts. [2]

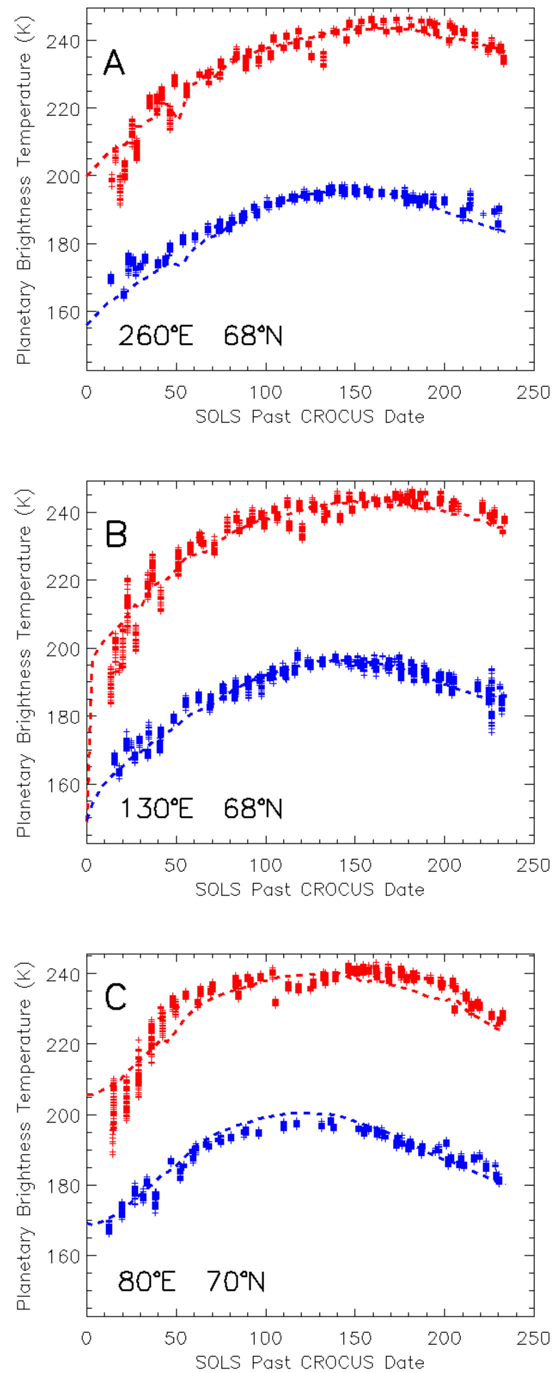

Figure 2: Best-fit thermal models (KRC) for TES observed temperatures and albedo at the 3 proposed Phoenix landing sites.