SUBLIMATION OF EXPOSED SNOW QUEEN SURFACE WATER ICE AS OBSERVED BY THE PHOENIX MARS LANDER. W. J. Markiewicz[1], K. J. Kossacki[2], H. U. Keller[1], S. F. Hviid[1], W. Goetz[1], M. R. El Maarry[1], B. J. Bos[3], R. Woida[4], L. Drube[5], K. Leer[5], M. B. Madsen[5], M. T. Mellon[6], P. Smith[4], [1]Max Planck Institute for Solar System Research, [2]Institute of Geophysics of Warsaw University, [3]NASA Goddard Space Flight Center, [4]Lunar and Planetary Laboratory, [5]Niels Bohr Institute, [6]Laboratory for Atmospheric and Space Physics.

One of the first images obtained by the Robotic Arm Camera (RAC) on the Mars Phoenix Lander was that of the surface beneath the spacecraft. This image, taken on sol 5 (Martian day) of the mission, was intended to check the stability of the footpads of the lander and to document the effect the retro-rockets had on the Martian surface. Not completely unexpected the image revealed an oval shaped, relatively bright and apparently smooth object, later named Snow Queen, surrounded by the regolith similar to that already seen throughout the landscape of the landing site (see sol 5 panel in Fig. 4). The object was suspected to be the surface of the ice table uncovered by the blast of the retro-rockets during touchdown.

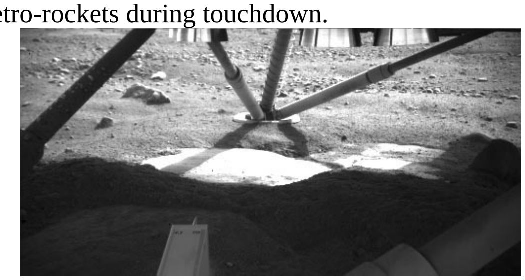

Figure 1 "Holy Cow" as imaged by the RAC. Thruster rockets can be seen at the upper edge of the image.

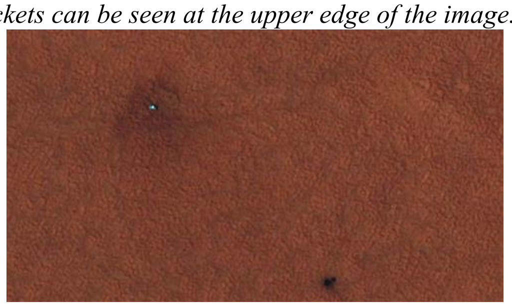

Figure 2 HiRise image of the Phoenix Mars Lander.

Further evidence that the thruster rockets cleared the surface just before the touchdown was obtained with another under the lander image of the so-called "Holy Cow", which is most likely freshly exposed relatively clean ice (Fig. 1). High resolution HiRISE image of the landing site from orbit, show a roughly circular dark region of about 40 m diameter with the lander in the center (Fig. 2). A plausible explanation for this region being darker than the rest of the visible Martian Northern Planes (here polygonal patterns) is that a thin layer of the material ejected by the retro-rockets covered the original surface. The ejected grains should be coarser than any atmospherically deposited dust and hence appear darker. Alternatively the thrusters may have removed the fine surface dust during the last stages of the descent. A simple estimate requires that about 10 cm of the surface material underneath the lander is needed to be ejected and redistributed to create the observed dark circular region. 10 cm is comparable to 4-5 cm predicted depth at which the ice table was expected to be found at the latitude of the Phoenix landing site. Let $h\pi r^2$ be the volume of the material ejected by the rockets. Take depth to ice h=10 cm and r=1m (scale of the Lander). Let πR^2 be the area of the dark oval and assume R=10 m. Then the thickness of the redistributed material within the oval is $10(r/R)^2$ = 1 mm.

Snow Queen was further documented on sols 5, 6 and 21 with no obvious changes detected. The following time it was imaged was on sol 44, 23 sols after the previous observation. This time some clear changes were obvious. Several small cracks appeared, most likely due to thermal cycling and sublimation of water ice, appeared. Nevertheless, the bulk of Snow Queen surface remained smooth. The next image of Snow Queen was taken on sol 73. This time its appearance was dramatically different. The surface had become much rougher and many cracks of at least 1 mm depth and decimeter scale length had appeared. The surface colour of Snow Queen was now no longer different from that of the surrounding regolith. This observation is compatible with the ice table sublimating away, leaving behind a lag deposit of thickness of the order of 1 mm. Images taken on sols 113 and 142 show further increase in roughness and developments of cracks (Fig. 5).

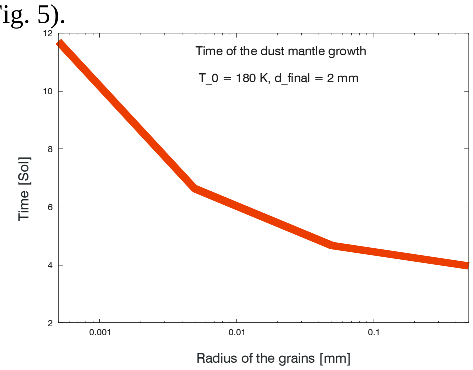

Fig. 3

By modelling the observed rate of sublimation we have hoped to learn something about the grain sizes and the initial ice contant. Unfortunetely, although these parameters play a role, by far the most important parameter is the IR radiation from the Lander. This is however not known precisely enough to constrain the model. We also know however that ice exposed in the trench away from the lander took about 6 sols to sublimate down to about 2 mm. Fig. 3 shows result of a thermal/sublimation model which includes growth of a dust mantle for some surface region not effected by the heat from the Lander. We show here the time it takes for the dust mantle to grow to 2 mm as a function of the assumed grain size. If this time is about 10 sols than the grain size is of the order of 1 micron which is consistent with atmospheric dust and Phoenix imaging at all scales. Fig. 4 shows one high resolution (40 microns) RAC image of the material in the Robotic ARM scoop acquired from the surface.

Fig. 4

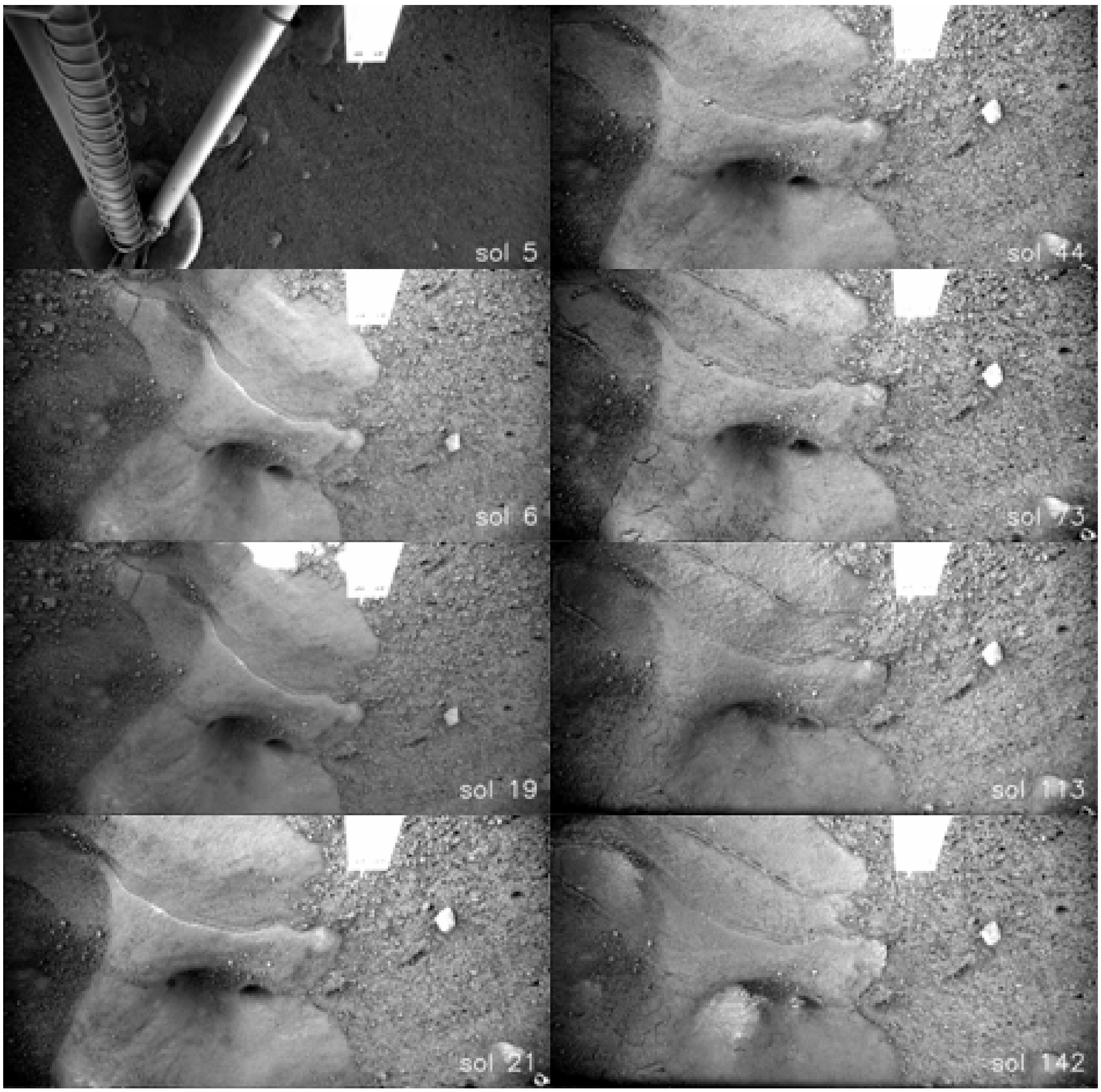

Fig. 5 RAC images of Snow Queen throughout the mission