THE EFFECT OF BULK DENSITY ON THE THERMAL CONDUCTIVITY OF PARTICULATE MATERIALS UNDER MARTIAN ATMOSPHERIC PRESSURES. *M.A. Presley-Holloway (Dept. of Geology, Box 871404, Arizona State University, Tempe, AZ 85287-1404 mpresley@asu.edu.*

Introduction: On December 3, 1999, the DS-2 Mars Microprobes will impact into the surface of Mars. The friction of those impacts will heat the surface materials surrounding the probes. Over a period of several hours, and hopefully days, two thermistors on each probe will measure the temperature, and hence the rate of cooling of the surrounding surface materials. From these measurements and previously derived thermal models, we will be able to deduce the thermal conductivity of the materials that the probes penetrate [1].

Previous laboratory measurements have shown that under martian atmospheric pressures, the thermal conductivity of particulate materials depends on the particle size [2-5], and in particular, may be empirically related to particle size and atmospheric pressure [6]. At a minimum, then, we should be able to estimate the particle size of the materials that the probes penetrate.

However, particle size and atmospheric pressure are not the only parameters that can determine the thermal conductivity of martian surficial deposits. As previously discussed [7,8], the transfer of thermal energy due to collisions of gas molecules that exist between the particles is the predominant mechanism of thermal conduction in porous sediments not under vacuum. The mean free path of gas molecules at the martian surface will vary between 3 and 42 µm [8], and is approximately the same order of magnitude as the effective distance over which conduction takes place between the particles. Conduction occurs primarily near the points of contact between the particles [9], and the effective conduction distance is approximately one-sixth the particle diameter or less [5]. Gas molecules are thus as likely to collide with the solid particles as they are with each other, and the average heat transfer distance between particles, which is related to pore size and shape, will determine how fast heat will flow through a particulate material [10]. Particle shape, bulk density of the material, and particle size sorting, as well as particle size, will affect the average heat transfer distance between particles and, therefore, the thermal conductivity of the deposit.

In particular, the impact from the probes is expected to increase the bulk density of the impacted materials by approximately 20% [11]. The dependence of thermal conductivity on bulk density, therefore, must be known in order to properly characterize the deposits. In a previous paper, this relationship was briefly examined. On the basis of three different densities of samples consisting of the same particle size, the thermal conductivity appeared to increase linearly with an increase in bulk density [8]. However, in order to reach a reasonable conclusion about the physical properties of the materials at the DS-2 impact site, this relationship needs to be determined more thoroughly.

Experimental Procedure: The line-heat source method will be used to measure the thermal conductivity of sample materials, due to its relative simplicity and proven reliability [12,6]. Although this technique will not reproduce the conditions of the probe technology applied on the Mars Microprobes, the line-heat source allows several measurements to be made over various atmospheric pressures under the same time frame that it would take to reproduce one probe experiment [*e.g.*, 13]. In addition, smaller samples may be used for the line-heat source technique, so changing samples is easier and significantly faster.

The labarotory set up was previously described in [5], and is the same one used in [5] and [8], with an upgrade to the computer and analog to digital circuit board.

Samples: Thermal conductivity measurements will be made on samples of crushed quartz, separated into size fractions of 25-30 µm, 70-75 µm and 16-20 µm. Each size fraction will be examined at several different bulk densities, prepared as discussed in [8]. Although quartz has not been identified on Mars, previous work has indicated that the thermal conductivity of particulate materials is independent of the composition of those materials [*e.g.*, 4], and the crushed material was conveniently already sorted and ready for use.

Measurements: A calibration run using 500-525 µm glass beads is currently underway, due to the upgrade of the computing equipment. Once the thermal conductivity lab is demonstrated to produce repeatable measurements [compare to 5], the thermal conductivity of the series of samples listed above will be determined at several different bulk densities. The results of these measurements will be presented.

Application: These measurements are also useful for estimating physical properties of surficial materials on areas of Mars other than the DS-2 impact sites. The Thermal Emission Spectrometer on board Mars Global Surveyor is currently gathering surface temperature data that will be used to determine the thermal inertia of the entire surface [14,15]. The thermal inertia data that was computed by the Viking Infrared Thermal Mapper has been previously used by several authors to determine the physical properties of the martian surface [e.g., 15-17]. These additional laboratory measurements, in combination with the higher resolution data now being gathered, will significantly improve the ability to characterize the martian surficial deposits, and hence will improve our understanding of the history of erosion, transport, and depositional processes that formed them.

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