Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PPS21-P11　　会場:コンベンションホール　　時間:5 月 20 日 18:15-19:30

表面層構造の効果による見かけの熱慣性
Effect of surface layering on the apparent thermal inertia

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Thermal inertia is a key property controlling diurnal temperature variation at the surface of planets. It is defined as a function of thermal conductivity, heat capacity, and density, all of which depend primarily on the physical structure of the surface layer. Thermal inertia of Mars has been derived from Viking, Mars Global Surveyor and Mars Odyssey data. It tells us a structure of the surface layer. For example, low thermal inertia indicates extensive dust deposits and higher thermal inertia suggests combination of particle size, rock abundance and induration of soils.

An extremely low thermal inertia values such as 5-60 tiu and 24-60 tiu have been reported in the equational and middle latitudes from these observations. Since the thermal conductivity is the most sensitive to the particle size under martian atmospheric pressure, such a low thermal inertia indicates small grain size as low as 10 micron. But, these particles can be easily blown away by a strong wind on Mars and it is difficult for them to form a uniform layer on the structure. In this presentation we consider the possibility that a layered structure yields apparent low thermal inertia.

To demonstrate possible effect of the layering we conducted laboratory experiments. We utilized the structure having an acrylic plate on top of a polystyrene form block or vesiculated particle layer. They are heated periodically by an infrared lump from above. Using the infrared thermometer and thermocouples, we measured the temperature at the surface, botom of the acrylic plate and inside the lower Polystyrene form and the granular layer.

Thermal relaxation time of this layered systems is the most fundamental factor here, which represents the time that the amplitude of temperature inside the material becomes 1/e compared with the surface.

We estimated the thermal inertia from experimental data. It is found that the thermal inertia is lower than the value calculated from the physical properties when the given period is longer than the thermal relaxation time of the surface layer. It is because the material behaves infinite body when the period is shorter than the thermal relaxation time.

On the other hand it behaves as a finite body if the period is longer than the relaxation time. In this situation the temperature at the bottom of the surface acrylic plate becomes high because of lower thermal conductivity of the lower layer. This means the thermal gradient becomes lower and the heat flux to the interior seems small, which results in apparently low thermal inertia

In our experiments we can demonstrate a simple layered structure; a thin layer having higher thermal conductivity on top of a layer with low thermal conductivity can produce apparently low thermal inertia. In the martian remote sensing diurnal temperature variation is used to infer the thermal inertia, which measures the value of the surface within the thermal penetration depth of several to 10 cm. If the layered structure exists in this range having lower conductivity of the lower layer.

We discuss several geological processes to produce layered structure on Mars.

Keywords: thermal inertia, geological structure, thermal relaxation time