# Highly Porous Asteroid 162173 Ryugu Derived from Lowest Temperatures in a Day

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**Introduction:** Thermal inertia is the index of thermophysical properties of materials on earth and planetary bodies, which is derived from the temperature profile in a day-night cycle. Lower thermal inertia indicates a granular or porous materials, while higher thermal inertia suggests a dense, consolidated materials. In the Hayabusa2 mission, global, local, and close-up thermal images have been taken using a thermal infrared imager TIR to investigate the distribution of thermal inertia on the C-type asteroid 162173 Ryugu [1]. As a result comparing with the calculations for a given uniform thermal inertia from 50 to 1000 [J $m^{-2}$ $K^{-1}$ $s^{-0.5}$: hereafter, tiu] on the asteroid shape model, and confirming the temperatures of boulders of various size range from < 1 to 100 m scales, it is concluded that the global thermal inertia of Ryugu is about 300 ±100 tiu, which lower than the typical thermal inertia of carbonaceous chondrites, and that Ryugu is a rubble-pile asteroid composed of highly-porous materials, accreted from impact fragments of a "porous" parent body, and the most part of the parent body was in the low degree of consolidation [2].

**Thermal Inertia Estimate by TIR:** There are several ways to derive the thermal inertia of an asteroid: 1) peak temperature in a day, 2) delay of peak temperature from the local noon, 3) fitting the diurnal temperature curves (hopefully considering the surface roughness), 4) cooling rate after sunset, 5) warming rate after sunrise, 6) lowest temperatures just before sunrise. For the initial analysis, we have taken the methods 1) to 3) to derive thermal inertia, but not considering the surface roughness, which is enough to characterize the thermal inertia much higher than the case of sandy or granular regolith (<100 tiu), and much lower than the typical primitive meteorites (> 600 tiu) or even dense rocks (> 1000 tiu) [2]. Afterwards, we considered the surface roughness at the same time to fit the diurnal temperature profiles much better to derive it thermal inertia of 225 ±45 tiu, with the roughness of 0.41 ±0.08 [3].

In this study, we used the method 6), when we observed the asteroid from a large phase angle of > 40° and at the solar distance of 0.98 to 0.99 au, during Box-B observations on 22 to 24 August 2019. The surface roughness is not considered but it is less effective in the nighttime. Temperatures before sunrise correspond to the apparent thermal inertia of 200 to 300 tiu, which is basically the same as the values derived from the daytime observations.

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