Multiband thermal radiometry and related laboratory studies, indicating possible origin and evolution of Ryugu

M. Hamm[1,2], M. Grott[2], H. Senshu[3], J. Knollenberg[2], J. de Wiljes[1], V. E. Hamilton[4], F. Scholten[2], K. D. Matz[2], H. Bates[5,6], A. Maturilli[2], Y. Shimaki[7], N. Sakatani[8], W. Neumann[2,9], T. Okada[7], F. Preusker[2], S. Elgner[2], J. Helbert[2], E. Kührt[10,11], T.-M. Ho[12], S. Tanaka[7], R. Jaumann[13,2], S. Sugita[14]

[1]Institute of Mathematics, University of Potsdam, Potsdam, Germany, [2]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany, [3]Planetary Research and Exploration Center, Chiba Institute of Technology, Narashino, Japan, [4]Southwest Research Institute, Boulder, CO USA, [5]Department of Earth Sciences, Natural History Museum, Cromwell Road, London, SW7 5BD UK, [6]Atmospheric, Oceanic and Planetary Physics, Oxford University, Parks Road, Oxford, OX1 3PU, UK, [7]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan, [8]Department of Physics, Rikkyo University, Toshima, Japan, [9]Universität Heidelberg, Heidelberg, Germany, [10]Institute of Optical Sensor Systems, German Aerospace Center, Berlin, Germany, [11]Qian Xuesen Laboratory of Space Technology, China Academy of Space Technology, Beijing, China, [12]German Aerospace Center (DLR), Institute of Space Systems, Bremen, Germany, [13]Freie Universität Berlin, Berlin, Germany, [14]University of Tokyo, Bunkyo, Japan

The MASCOT lander's radiometer [1] observed the diurnal variation of the surface temperature of single boulder on the surface of (162173) revealing a low thermal inertia and high porosity [2]. While the instrument observes the surface through six filters, two broad band filter and four bands pass transmitting the region between 6 and 16 µm, only the data of the 8 – 12 µm broadband filter was used in the previous studies [2, 3]. Coupling a thermophysical model to a combined DEM of boulder and landing site [4], and applying a data assimilation scheme for efficient parameter estimation [2], the analysis of the full radiometer data becomes feasible. The thermal inertia and emissivity of the surface within the filter's spectral ranges could be retrieved. The thermal inertia is estimated to be 255 – 265 J $m^{-2} K^{-1} s^{-1/2}$, corresponding to a high porosity of 46 ± 1 %. The emissivity in the broad filters is estimated to be 0.98 ± 0.1.

The emissivity estimates in the narrowband filters shows significant differences from band to band. In the 5.5 – 7 µm band the emissivity drops to band to 0.85 (-0.02, +0.01), reaches its maximum in the 8 – 9.5 µm band with 0.98 ± 0.01, drops in the adjacent 9.5 – 11.5 µm band to 0.94 (-0.02, +0.01), and rises again to 0.97 ± 0.01 in the 13.5 – 15.5 µm region. We form the ratios of the emissivity within the 9.5-11.5 µm band and the 13.5 – 15.5 µm band with respect to the emissivity within the 8 - 9.5 µm band and compare them to equivalent emissivity ratios of mid-infrared spectra of powdered and thin section samples of various carbonaceous chondrites. We find that respective ratios of aqueously altered CM and CI chondrites form a common trend and our results for Ryugu lies within this cluster of CM and CI chondrites. The CI chondrites appear to be the best spectral match in the mid-infrared. Our study indicates that despite the partially dehydrated appearance of the surface in the visible to near-infrared wavelength range [5,6,7], the mid-infrared shows strong signs of aqueous alteration, and the Ryugu materials might be less dehydrated than previously thought.

References

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