Study of Hydrated Asteroids via Polarimetry: Correlation between Polarimetric Properties and Degree of Aqueous Alteration of Hydrated asteroids.

*Jooyeon Geem[1], Masateru Ishiguro[1], Hiroyuki Naito[2], Daisuke Kuroda[6], Koki Takahashi[3], Tomohiko Sekiguchi[3], Seiko Takagi[4], Tatsuharu Ono[4], Kiyoshi Kuramoto[4], Tomoki Nakamura[5]

1. Astronomy program, Dept of Physics and Astronomy, Seoul National University, 2. Nayoro Observatory, 3. Hokkaido University of Education, 4. Department of Cosmosciences, Graduate School of Science, Hokkaido University, 5. Department of Earth and Planetary Material Sciences, Faculty of Science, Tohoku University, 6. Okayama Observatory, Kyoto University

Hydrated asteroids have been attracting widespread interest due to the Hayabusa2 and OSIRIS-REx mission. These asteroids are considered as fragments that have experienced varying degrees of aqueous alteration in their parent bodies. Such aqueously altered asteroids have been extensively investigated by spectroscopic observations and laboratory experiments of carbonaceous chondrites. From spectroscopy, it is known that the spectral features in 0.7 μm or the 3 μm bands depend on the degree of aqueous alteration [2, 3]. On the other hand, mineralogical studies of chondrites found that the transition of composed minerals such as the cronstedtite converting to Mg-rich serpentine occurs as the alteration progressed [4]. While approaches via spectroscopy and meteoritics are widely employed, “polarimetry” has rarely been used to study hydrated asteroids.

Polarimetry has the advantage of being able to know the physical properties like albedo, particle size, and porosity of the target’s surface even without conducting space explorations [1]. The polarization degree (P) of reflected light from atmosphereless bodies exhibits the phase angle (α) dependence, where the α is the angle between Sun-Target-Observer. The $\alpha-P$ profile consists of several key parameters such as the minimum polarization degree (P_{min}) appearing at $\alpha \sim 10º$. The polarimetric parameters are useful diagnostic tools to estimate the surface properties. In this study, we examine “how the physical properties change depending on the degree of aqueous alteration” by utilizing polarimetry.

In 2020, we made the polarimetric observation for 35 nights with the visible Multi-Spectral Imager (MSI) attached on the 1.6m Pirka Telescope at the Nayoro Observatory. We observed 18 C-complex main-belt asteroids in the visible band, including Ch type asteroids (i.e., hydrated asteroids). These asteroids were observed at $\alpha \leqq 20º$, which allows us to obtain the P_{min} values of our targets. We also gathered archival data and derived the polarimetric parameters and spectral information of asteroids from the previous research.

As a result, we found that polarimetric parameters (e.g., the P_{min}) show a strong correlation with spectral features (e.g., the 0.7 μm and 3 μm range absorption). Because P_{min} is attributed to the physical properties (albedo, particle size, or porosity) of the surface materials, our observation suggests these physical properties changed as the aqueous alteration progressed. In this presentation, we will introduce our polarimetric observation, and discuss possible interpretations of these results.

[1] Cellino et al., 2015, MNRAS, 451,4.; [2] Fornasier et al., 2014, Icarus, 233, 163-178.; [3]Takir et al., 2013, Meteoritics and Planetary Science, 48, 9.; [4] Tomeoka et al., 1985, GCA, 49, 10.

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