METEORITE ANALOGS OF ASTEROID 25143 ITOKAWA: SEEING BEYOND THE EFFECTS OF GRAIN SIZE AND SPACE WEATHERING. Takahiro Hiroi[1], Masanao Abe[2], Kohei Kitazato[3], Shinsuke Abe[4], Sho Sasaki[5], Masateru Ishiguro[6], Yasuhiko Takagi[7], Beth Ellen Clark[8], Olivier S. Barnouin-Jha[9], and Tokuhiro Nimura[3], [1]Dept. of Geological Sci., Brown Univ., Providence, RI 02912, USA (takahiro_hiroi@brown.edu), [2]JAXA Inst. of Space & Aeronautical Sci., 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan, [3]Dept. of Earth & Planet. Sci., Univ. of Tokyo, Tokyo 113, Japan, [4]Graduate School of Sci. & Tech., Kobe Univ., Kobe 657-8501, Japan, [5]Mizusawa Astrogeodynamics Obs., National Astronom. Obs. of Japan, Mizusawa 023-0861, Japan, [6]School of Earth Environ. Sci., College of Natural Sci., Seoul National Univ., Seoul 151-742, Korea, [7]Toho Gakuen Univ., 3-11 Heiwagaoka, Meito-ku, Nagoya 465-8515, Japan, [8]Ithaca College, 267 Center for Natural Sci., Ithaca, NY 14850-7288, USA, [9]Johns Hopkins Univ. Appl. Phys. Lab., Johns Hopkins Rd., Laurel, MD 20723-6099, USA.

Introduction: The Near-Infrared Spectrometer (NIRS) onboard the Japanese Hayabusa spacecraft observed the surface of asteroid Itokawa in the wavelength range of 0.76-2.1 µm [1]. These observations suggest that Itokawa is made of LL5 or LL6 chondrite material [1] in a developing stage of space weathering [2, 3]. To follow up on previous work [1], we applied the Modified Gaussian Model (MGM) [4] to the natural logarithm reflectance spectra of ordinary chondrites and Itokawa in order to identify the meteorite counterpart of the asteroid.

Experiments: Twelve LL, four L, and two H chondrite samples were variously prepared as chips and/or powders of <125 and 125-500 µm in grain size, including samples used in [5]. Not all the ordinary chondrite samples were prepared in all the above physical forms. Some of the chip samples were irradiated with a 7-ns pulse YAG laser according to the method described in [6, 7] at 20-mJ energy once and twice. Reflectance spectra of the samples were measured at 30° incidence and 0° emergence angles over the range of 0.3-2.6 µm in wavelength, of which only data in the range of 0.76-2.1 µm were used for comparison with the NIRS data [1].

NIRS data of Itokawa used in this work were for major landmarks and some unnamed bright areas from September 28 to October 19, 2005, close-up (<7 m) observations on November 19, and bright and dark areas on October 25 used in [2]. Spectral data for each location were averaged to obtain a better S/N ratio. Photometric corrections were only applied to the data from [2].

Modified Gaussian Model Analysis: Shown in Fig. 1 are MGM deconvolutions of natural log reflectance spectra of Hamlet LL4 chondrite samples of different forms (chip, 125-500 µm, and <125 µm). The chip spectrum shows a blue (decreasing toward longer wavelength) continuum, and the powder spectra show redder continua and deeper absorption bands. In spite of those differences, the MGM band centers, widths, and relative strengths do not seem to change much except for the 2-µm band. This band cannot be well defined due to the NIRS incomplete coverage, and thus will not be used for analyses in this paper.

Shown in Fig. 2 are MGM deconvolutions of natural log reflectance spectra of the Appley Bridge LL6 chondrite chip of different degrees of space weathering (untreated, irradiated with pulse laser at 20-mJ energy

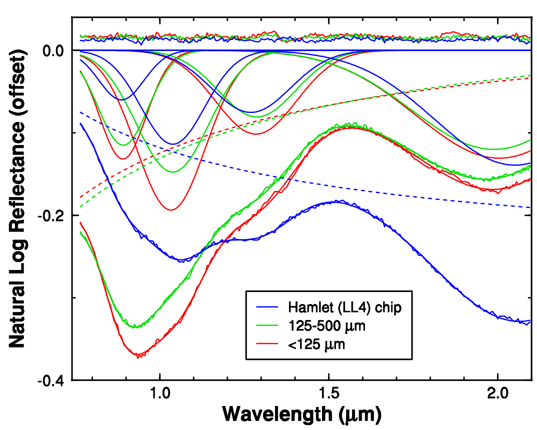

Fig. 1. MGM deconvolutons of natural log reflectance spectra of Hamlet LL4 chondrite samples of three different physical forms.

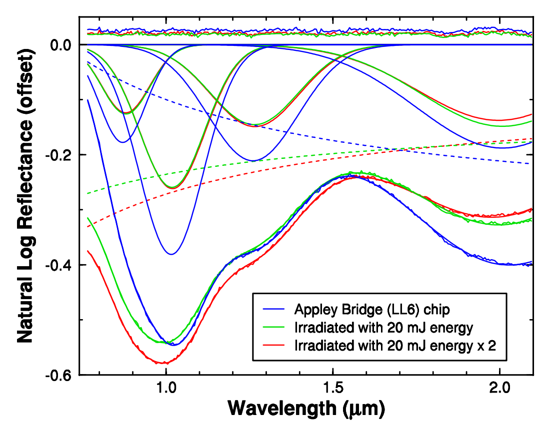

Fig. 2. MGM deconvolutions of natural log reflectance spectra of Appley Bridge LL6 chondrite chip of different degrees of space weathering.

once, and twice). The continuum becomes redder as the degree of space weathering increases, while keeping band centers, widths, and relative strengths almost exactly the same. Results shown in Figs. 1 and 2 demonstrate that the band centers, widths, and relative strengths are good indicators of the compositon of the material regardless of the physical condition and the degree of space weathering.

Shown in Fig. 3 are some of the results of MGM deconvolutions of natural log NIRS reflectance spectra of Itokawa surface locations. MGM bands are uniformly consistent for the three short-wavelength bands considered in this paper. Even the close-up observations (black stars in Fig. 3) show similar band fits. This suggests that Itokawa's surface is highly uniform whether it is observed on scales of tens of meters or centimeters.

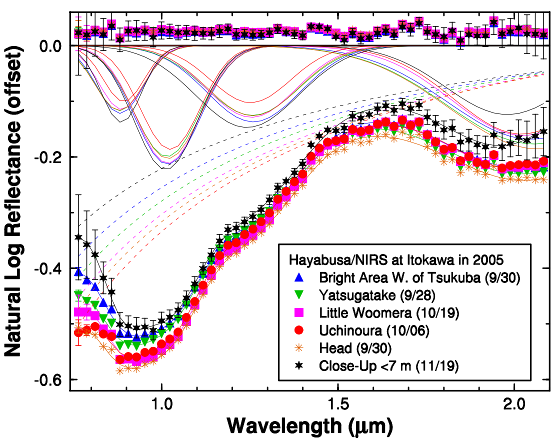

Fig. 3. MGM deonvolutions of natural log NIRS reflectance spectra of surface locations of Itokawa.

The calculated band parameters are plotted in Figs. 4 and 5. One of the clearest relationships between Itokawa's surface locations and ordinary chondrite samples is revealed in the relative band strength plot shown in Fig. 4. Itokawa's surface is consistent with LL chondrite samples. In order to further identify which metamorphic type of LL chondrite is most consistent with Itokawa surface, the band center and relative strength for Band 3 are plotted in Fig. 5. This figure suggests that LL6 chondrites are most consistent with Itokawa's surface.

Summary and Discussion: The surface composition of Itokawa is likely to be uniform and compositionally most similar to LL6 chondrites. Further studies should be performed using more meteorite samples and NIRS data points. Employing a better model than the MGM may have to be considered in that process.

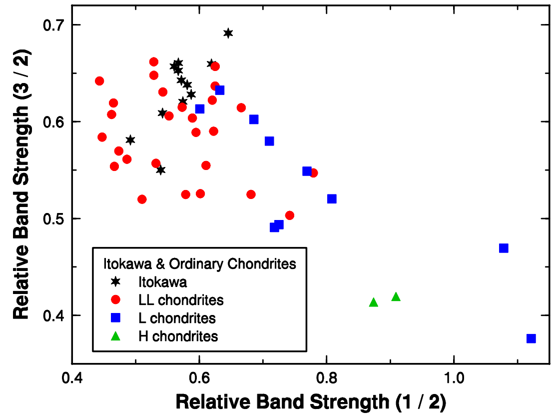

Fig. 4. Comparison of relative band strengths of Itokawa surface locations and ordinary chondrite samples.

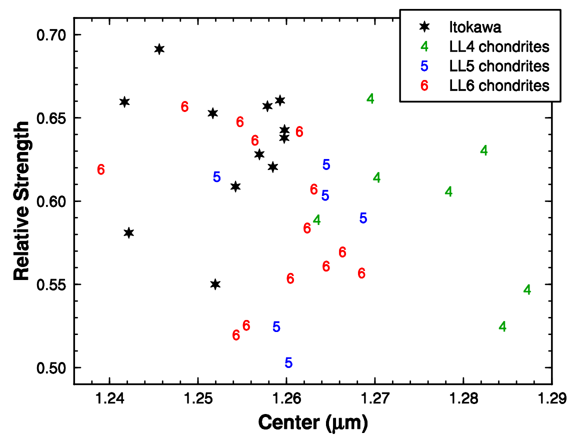

Fig. 5. Plot of band center vs. relative strength (3/2) of Itokawa surface locations and LL chondrite samples.

References: [1] Abe M. et al. (2006) *Science 312*, 1334-1338. [2] Hiroi T. et al. (2006) *Nature 443*, 56-58. [3] Ishiguro M. et al. (2006) *LPS XXXVII*, Abstract #1533. [4] Sunshine et al. (1990) *JGR 95*, 6955-6966. [5] Hiroi T. et al. (2006) *LPS XXXVII*, Abstract #1396. [6] Yamada M. et al. (1999) *EPS 51*, 1255-1265. [7] Sasaki S. et al. (2006) *LPS XXXVII*, Abstract #1705.

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