THE EFFECTS OF SPACE WEATHERING AND PARTICLE SIZE VARIATIONS ON ITOKAWA FROM HAYABUSA NEAR-INFRARED SPECTROSCOPY. K. Kitazato[1], M. Abe[2], B. E. Clark[3], S. Abe[4], Y. Takagi[5], T. Hiroi[6], P. Abell[7], S. M. Lederer[8] and F. Vilas[9], [1]Department of Earth and Planetary Sciences, Kobe University, Kobe, Hyogo 657-8510, Japan; [2]JAXA, Institute of Space and Astronautical Science, Sagamihara, Kanagawa 229-8510, Japan; [3]Physics Department, Ithaca College, Ithaca, NY 14850, USA; [4]Institute of Astronomy, National Central University, Jhongli, Taoyuan 32001, Taiwan; [5]Toho Gakuen University, Nagoya, Aichi 465-8515, Japan; [6]Department of Geological Sciences, Brown University, Providence, RI 02912, USA; [7]NASA, Johnson Space Center, Houston, TX 77058, USA; [8]Department of Physics, California State University, San Bernardion, CA 92407, USA; [9]MMT Observatory, Tucson, AZ 85721, USA.

Introduction: The Japanese Hayabusa spacecraft made a successful close-up exploration of the S-type near-Earth asteroid 25143 Itokawa in three months from early September 2005 [1]. The preliminary analyses have revealed a rubble pile structure for this sub-kilometer sized small asteroid, in contrast to the other large S-types that spacecraft have visited so far, judging from the bulk density, inferred composition, and evidence for global geomorphologic features. Additionally, Hayabusa imaged the asteroid surface piled up with numerous angular boulders, not covered with fine regoliths formed by impacts, suggesting the surface would preserve the relatively early conditions on the asteroid formation.

During its rendezvous with the asteroid, the Near-Infrared Spectrometer (NIRS) instrument on Hayabusa acquired more than 80,000 spatially resolved 0.75 to 2.20 microns reflectance spectra from the asteroid surface under varying lighting and viewing geometry. These data allow not only to map the distribution and abundance of minerals, but also the first photometric investigation of blocky asteroid surface by narrow-band multiwavelength approach. The results for photometric study has been published in Icaurs [2]. Here we report the results of spectral mapping analyses on the global Itokawa surface using the NIRS data and discuss the surface heterogeneities and these geological context.

Mapping of NIRS spectra: Detailed analysis of disk-resolved reflectance and spectral variations requires corrections for effects of illumination and viewing geometries. The measured reflectances were corrected to a standard photometric geometry circumstance by utilizing a globally averaged photometric function at each wavelength. Then the average spepctrum on individual plate of the asteroid shape model of [3] was derived from a full set of spectral data containing its plate within the instrument FOV. The plate size composing the asteroid shape model used in our analyses is typically several meters, sufficiently small compared to the observational spatial resolution.

The derived spectral map indicates that the NIRS observations have covered almost entire disk of Itokawa (~85%), except for high-latitude areas. NIRS has revealed variations in reflectance across Itokawa's surface; the reflectance at 1.57 microns within the NIRS coverage has the full 0.132 to 0.145 range, with about 10% variation. The reflectance uncertainties induced by the shape model inaccuracy and spatially different photometric function can be considered to be fall on within 1%. As with albedo contrasts, Itokawa was found to exhibit subtle color variations, for example, of about 10% in the 0.95-microns/1.57-microns reflectance ratio. In the case of Eros the surface materials exhibit albedo contrasts of 30-40% at 0.95 microns, with associated spectral variations at a much lower level of 4-8% at spatial scales of 620 m [4]. Thus, on Itokawa, albedo contrasts are lower than Eros, but color contrasts would be almost consistent with Eros.

Modeling of the spectral variations: Among the effects of surface properties on asteroid spectra, composition is the dominant factor contributing to the optical properties of an asteroid surface. However, the wavelength shift of diagnostic mineral absorption bands were not detected so that the chemical composition of the asteroid surface materials appears to be homogeneous. The actual albedo contrasts and associated spectral variation trends were well modeled by a combination of both effects of the particle size variations and space-weathering optical maturation using Hapke's model [5-6]. Finally, we found that the surface area far from the asteroid barycenter are highly weathered, which surface heterogeneities would be related to the emplacements of impact ejecta or the asteroid formation processes.

References: [1] Fujiwara, A., et al. (2006) *Sicence, 312,* 1330-1334. [2] Kitazato, K., et al. (2008) *Icarus, 194,* 137-145. [3] Gaskell, R. W., et al. (2006) AIAA, 2006-6660. [4] Clark, B. E., et al. (2001) *Meteoritics & Planet. Sci., 36,* 1617-1637. [5] Hapke, B. (1993) *Theory of reflectance and emittance spectroscopy*, Cambridge Univ. Press. [6] Hapke, B. (2001) *JGR, 106,* 10039–10074.