RELATIONSHIPS AMONG MORPHOLOGY, MINERALOGY, AND NOBLE GAS ISOTOPIC SIGNATURES OF FOUR ITOKAWA GRAINS.

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Introduction: Fine grains from the asteroid Itokawa preserve the effects related to the processes on and near the surface of the asteroid. Various types of surface modification were found on the very surface (<100 nm) [1-6]. The textures observed by TEM suggest that irradiation by solar wind (SW) plays an important role for their formation. However, the mechanisms and periods of the surface modification of Itokawa grains are still unresolved. In addition to the SW irradiation, there seems to have been another mechanism that modified the morphology and surface features of the grains. Some Itokawa grains were aggregates composed of subgrains with stepped surfaces, suggestive of evaporation and/or condensation [3]. Noble gas mass spectrometry is another tool to infer the individual history of each Itokawa grain. Nagao et al. [7] argued that a grain experienced multiple processes: exposure to SW, burial in the regolith layer, and removal of its external surface. We intend to investigate the relationships among morphology, surface modifications, and noble gas isotopic signatures to discuss the history of each Itokawa particle from various perspectives. In the previous meeting HAYABUSA 2014, we reported a relationship between grain morphology and noble gas release patterns. Here we report TEM observation of the grains and discuss the histories of the grains by combining all the data.

Results and discussion: All the grains except for a grain with steps on its surface have space weathered rims and solar flare tracks. The grain containing the highest amounts of ^{4}He and ^{20}Ne has the highest track number density. On the other hand, the thickness of the rims seems to be comparable with each other, suggestive of a steady state. The grain with stepped surfaces shows a different ^{4}He release pattern; ^{4}He was released only below 200 ^{o}C. This fact suggests that deeply implanted He, which is probably related to He released above 600 ^{o}C, was completely reset by severe heating. Absence of solar flare tracks in this particle is consistent with this interpretation. The steps on the surfaces of this grain may have been formed by evaporation and/or evaporation and subsequent recondensation by a heating event, which released He from the interior of the grain. SW irradiation for a short period is necessary to explain the ^{4}He released below 200 °C. It is unlikely that such a severe heating event occurred on or in the present Itokawa.

References: [1] Noguchi et al. (2011) Science 333, 1121-1125. [2] Noguchi et al. (2014) Meteorit. Planet. Sci. 49, 188-214. [3] Matsumoto et al. (2013) 44th Lunar Planet. Sci. Conf. abstr. #1441. [4] Thompson et al. (2014) Earth Planet. Space 66, 89-99. [5] Keller and Berger (2014) Earth Planet. Space 66, 71-78. [6] Noguchi et al. (2014) Earth Planet. Space 66, 124-134. [7] Nagao et al. (2011) Science 333, 1128-1131.