SOLAR NOBLE GASES IN EIGHT HAYABUSA SAMPLES FROM ITOKAWA'S SURFACE WITH SHORT DURATION OF COSMIC RAY EXPOSURE.

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Introduction: Solid materials on the surface of small asteroids without atmosphere are exposed to particles emitted from the Sun, and the particles are implanted into surface layer (≤ μm) of the materials. The asteroidal surface is also bombarded to the depth of several meters by energetic galactic cosmic-rays, producing cosmogenic noble gases with characteristic isotopic compositions through nuclear reactions. The cosmogenic and solar noble gases show histories of cosmic ray irradiation, surface gardening, and surface erosion rate of small asteroids. We have measured noble gases of eight Hayabusa grains: RA-QD02-0015, RA-QD02-0053, and RA-QD02-0065 (Initial analysis, [1]), RA-QD02-0144 and RA-QD02-0160 (1st A/O, [2]), RB-CV-0001, RB-CV-0009, and RB-CV-0039 (2nd A/O).

Experimental Method: The samples were heated stepwise using a Nd-YAG CW laser at 200, 300°C, and melt (initial analysys), 200, 300, 800°C and melt (1st A/O), and 100, 200, 400°C and melt (2nd A/O). In the 1st and 2nd A/O analyses, thin W-Re thermo-couples (25 μm in diameter) were set at each position of the samples to measure temperature during the heating of samples for noble gas extraction. Extracted noble gases at each temperature were measured with a modified-VG5400 (MS-III) at the University of Tokyo. About 50% of Kr and Xe of the 1st and 2nd A/O samples were sealed in gold tubes and sent to the University of Manchester for ultra-sensitive mass spectrometry.

Results and Discussion: He and Ne of solar wind (SW) origin were detected for all the Hayabusa samples. SW-gases were mostly released at the lowest heating temperatures (100 or 200°C), except for RA-QD02-0015 which released at melt. Concentrations of SW He and Ne for the samples are as high as those for interplanetary dust particles or micrometeorites. The observation confirms that the samples were collected on Itokawa's surface, where the grains were irradiated by solar wind. $^{3}He/^{4}He$ ratios are similar to that of SW-He [3] or slightly lower. Ne isotopic compositions were close to SW-Ne when enhanced release of Ne from the samples was observed. He/Ne ratios are lower than the SW-ratio, which might be caused by selective loss of He from the samples during the SW irradiation.

Concentrations of galactic cosmic-ray produced noble gases, e.g., ^{3}He and ^{21}Ne, were almost negligible within experimental errors. Although we proposed that the cosmic-ray exposure age for the surface materials of Itokawa is no more than 8 My [1], much shorter exposure age, ≤0.5 My, is inferred from the large sample RB-CV-0009 allocated as the 2nd A/O.

References: [1] Nagao et al. 2011. *Science* 333:1128–1131. [2] Nagao et al. 2013. Abstract #1976. 44th Lunar and Planetary Science Conference. [3] Heber et al. 2009. *Geochimica et Cosmochimica Acta* 73:7414–7432.