NOBLE GASES IN DUST RETURNED BY HAYABUSA – CLUES TO ASTEROID ITOKAWA'S HISTORY?

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Introduction: JAXA's Hayabusa spacecraft, the first sample return mission from an asteroid, brought back mostly LL5-6 chondritic material from S-type asteroid Itokawa [1]. Several grains were allocated to our consortium, mainly to determine their noble gas contents. Here, we report the first detection of Xe and discuss the results obtained so far for Ne.

Experimental: All grains are non-destructively analyzed by micro-Raman and Infrared spectroscopy for mineralogy and Synchrotron X-ray tomography (SRXTM) for structure and precise mass determination [e.g., 2-4]. The grains are then analyzed with ETH Zurich's compressor-source mass spectrometer for He and Ne [5] or with Manchester's resonance-ionization mass spectrometer RELAX for Xe [6]. Xenon in grains RA-QD02-0049-4 and -197 (0.359 and 0.111 ug, [5]) was extracted by step laser heating. A silicate grain from H5 chondrite Allegan of similar mass was analyzed for comparison.

Results and Discussion: Both grains showed Xe above the background. The isotope ratios are within large errors consistent with air, Q or solar wind. Particle 0049-4 was previously neutron-irradiated [7]. The hydrocarbon background at mass 128 did not allow the detection of an excess in I-derived ^{128}Xe. The ^{132}Xe concentration is ~1×10^{-9} cm^3/g, roughly consistent with that in type 4-5 LL chondrites. However, particle 0049-4 consists mostly of olivine, which is not expected to carry significant trapped Xe. The ^{129}Xe/^{132}Xe ratio of 1.09±0.11 is consistent with air, Q, and possibly a slight excess due to the decay of short-lived ^{129}I. Particle 0197, exclusively handled in N_2 atmosphere, showed an unreasonably high Xe concentration, possibly introduced during transfer onto/from the fluorocarbon thread required for SRXTM analysis [2]. The Allegan grain, however, showed the expected Xe concentration with an elevated ^{129}Xe/^{132}Xe ratio. Neon has now been determined in 6 Itokawa grains [5, 8]. All data are consistent with a uniformly short exposure to cosmic rays of <8 Ma, with one particle showing a precise exposure age of (1.5±0.4) Ma [5]. These results, suggesting a freshly rejuvenated regolith, may support the idea of extremely fast erosion on small asteroids by the diurnal thermal break-up of the rocks [9]. In contrast, the craters on Itokawa might have been accumulated for at least 75 Ma [10]. This would allow for a much longer exposure of Itokawa regolith grains to cosmic rays, which has not yet been observed.

References: [1] Nakamura T. et al. 2011. *Science* 333:1113-1116. [2] Busemann H. et al. 2013. *44th Lunar Planet. Science Conf.,* #2243. [3] Böttger U. et al. 2014. *45th Lunar Planet. Science Conf.,* #1411. [4] Meier M.M.M. et al. 2013. *44th Lunar Planet. Science Conf.,* #1937. [5] Meier M.M.M. et al. 2014. *45th Lunar Planet. Science Conf.,* #1247. [6] Crowther S.A. et al. 2008. *J. Analytical Atomic Spectrometry* 23:938-947. [7] Ebihara M. et al. 2011. *Science* 333: 1119-1121. [8] Nagao K. et al. 2011. *Science* 333:1128-1131. [9] Delbo M. et al. 2014. *Nature* 508:233-236. [10] Michel P. et al. 2009. *Icarus* 200, 503-513.