# ASTEROID ITOKAWA'S HISTORY STUDIED BY CORRELATED SPECTROSCOPY, X-RAY TOMOGRAPHY AND NOBLE GAS MASS SPECTROMETRY.

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**Introduction:** During two "international AO" rounds, JAXA allocated several samples returned by the Hayabusa spacecraft to our consortium, in order to study their noble gases and, thereby, the history of asteroid Itokawa. We used Raman and IR spectroscopy to non-destructively analyze the mineralogy, and Synchrotron X-ray tomography (SRXTM) for structure and precise mass determination. Here, we summarize our efforts [e.g., 1-4].

**Current experimental status:** Raman spectroscopy has been performed on all samples of both allocations. Six of the seven first round particles have been examined by SRXTM [3]. Noble gases have been measured in three grains [3-4].Currently, both high-sensitivity mass spectrometers at ETH Zurich (He, Ne) and at the Univ. of Manchester (Kr, Xe) are not available, but we expect to present new noble gas results at the symposium.

**Results and discussion:** We detected Xe in two particles (~82,000 and 7,000 atoms $^{132}$Xe, respectively [4]). While the concentration in one grain is close to the expected range, closer to type LL4 rather than LL5, though, the large concentration in the other grain might be due to contamination, possibly introduced during sample preparation for SXRTM, or, less likely, due to a gas-rich "pocket" in the grain. No $^{129}$Xe from in-situ decay of $^{129}$I has been found, in contrast to a similarly-sized H5 Allegan grain (~3000 atoms $^{132}$Xe), illustrating the capability of RELAX.

More significantly, we precisely determined the cosmogenic $^{21}$Ne concentrations. All six grains from Itokawa examined so far show remarkably similar, short cosmic-ray exposure ages of <8 Ma [3,5]. The most precise age of $1.5 \pm 0.4$ Ma is strikingly similar to the exposure ages observed in some LL chondrites (e.g., Chelyabinsk and Appley Bridge [6,7]). This would suggest a catastrophic impact event 1.5 Ma ago. However, the remarkably fresh and uniform Itokawa regolith may also reflect a gentler, more general asteroidal surface processing. This could be "seismic settling", with movement of particles down the slopes between head and body of Itokawa after a relatively recent rubble pile formation [8] or the recent suggestion that small asteroids are eroded -much faster and more efficiently than possible by micrometeorite impact- by diurnal heating and cooling and erosion through "thermal fatigue" [9].

**References:** [1] Böttger U. et al. (2014) *LPSC 45*, #1411. [2] Busemann H. et al. (2013) *LPSC 44*, #2243. [3] Meier M.M.M. et al. (2014) *LPSC 45*, #1247. [4] Busemann H. et al. (2014) *M&PS Suppl. 49*, #5362. [5] Nagao K. et al. (2011) *Science 333*, 1128-1131. [6] Nishiizumi K. et al. (2013) *M&PS Suppl. 48*, #5260. [7] Cressy Jr. P.J. & Bogard D.D. (1976) *GCA 40*, 749-762. [8] Connolly Jr. H.C. et al. (2014) *M&PS Suppl. 49*, #5075. [9] Delbo M. et al. (2014) *Nature 508*, 233-236.