ASTEROID 25413 ITOKAWA CHRONOLOGY BY ARGON ANALYSES.

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Introduction: Argon isotopes in three particles collected by the Japanese Hayabusa mission from the S-type, rubble pile asteroid 25143 Itokawa [1,2], were measured for Ar age dating. The purposes of this work are (i) to investigate the chronology of the asteroid [3], and (ii) to assess the age in the context of published $^{40}Ar/^{39}Ar$ ages of LL chondrites, whose chemical composition and mineralogy resemble those of Itokawa particles [4].

Samples and Experimental methods: Three plagioclase bearing Itokawa particles, RA-QD02-0199, RB-CV-0002, and RB-CV-0051, were selected by the Japan Aerospace Exploration Agency (JAXA). The allocated particles were irradiated and analyzed as one sample for Ar isotopes at Rutgers University. The estimated total mass of these particles is ~2.0 μg.

Results: The total ^{40}Ar concentration of $\sim 1.6\times10^{-5}$ cm^3STP/g seems consistent with values reported for other Itokawa particles [5]. The measured $^{40}Ar/^{39}Ar$ plateau age is 1.26±0.24 Ga and the inverse isochron age is 1.32±0.33 Ga [see also 3]. We cannot be sure that the particles analyzed (~2 μg) are representative of the mass returned by the mission (~ 1 mg) [6], much less of the entire asteroid ($3.58\pm0.18 \times10^{10}$ kg [7]. Additional age determinations for other Itokawa particles are planned [8].

Discussion: The Ar age of ~1.3 Ga is very young compared to those of most LL chondrites. Among the $^{40}Ar/^{39}Ar$ ages published for ~35 chondrites [9], ~24 LL are in the range of ~4.0-4.4 Ga. Two LL chondrites, Y-790964 (LL-shocked) [10] and an H-chondrite xenolith in St-Mesmin [9] have ages close to that of Itokawa. Appley Bridge, whose cosmic-ray exposure age [11] agrees with Itokawa's [12], has an $^{40}Ar/^{39}Ar$ age of over 3.9 Ga [9]. The young age of Itokawa can be interpreted in several ways: It could have been reset by impact (1) before, (2) during, or (3) after the rubble pile formation. Although we cannot constrain the timing of the Ar disturbance on Itokawa, we prefer either (1) or (2). The 1.3 Ga-old $^{40}Ar/^{39}Ar$ age sets an upper limit on the time of assembly and suggests that rubble pile creation has continued in the inner Solar System for at least 3 Ga.

References: [1] Fujiwara A. et al. 2006. *Science* 312:1330-1334. [2] Tsuchiyama A. 2014. *Elements* 10:45-50. [3] Park J. et al. 2014. Annl. Meteorit. Soc. 77, #5197 (abstract). [4] Nakamura T. et al. 2011. *Science* 333:1113-1116. [5] Nagao K. et al. 2011. *Science* 333:1128-1131. [6] Zolensky M. et al. 2012. Lunar Planet. Sci. Conf. 43rd, #1477. [7] Abe S. et al 2006. Science, 312:1344-1347. [8] Ueisugi M. et al. 2014Annual Meteoritical Society Meeting 77th, #5226 (abstract). [9] Swindle T. D. et al. 2014. *in Advances in $^{40}Ar/^{39}Ar$ Dating: from Achaeology to Planetary Sciences* (eds Jourdan, F., Mark D. F. & Verati, C.) 333-347. [10] Takigami Y. and Kaneoka I. 1987. *Mem. Natl Inst. Polar Res., Spec.* 46:133-143. [11] Heymann D. et al. 1967. *Geochim. Cosmochim. Acta*, 31:1793-1809. [12] Meier M. M. M. et al. 2014.. *Lunar Planet. Sci. Conf.* 45th, #1247 (abstract).