# U-Pb systematics of Hayabusa particles: Constrains on the thermal and impact histories of 25143 Itokawa

K. Terada[1]*, Y. Sano[2], N. Takahata[2], A. Ishida[3], A. Tsuchiyama[4], T. Nakamura[3], T. Noguchi[5], Y. Karouji[6], M. Uesugi[7], T. Yada[6], M. Nakabayashi[1], K. Fukuda[8], H. Nagahara[8]

[1] *Graduate School of Science, Osaka University, Toyonaka 560-0043, Japan.*
[2] *Atmosphere and Ocean Research Institute, The University of Tokyo, Chiba 277-8564, Japan.*
[3] *Graduate School of Science, Tohoku University, Sendai 980-8578, Japan.*
[4] *Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan.*
[5] *Faculty of Arts and Science, Kyushu University, Fukuoka 819-0395, Japan.*
[6] *JAXA, Sagamihara 252-5210, Japan.*
[7] *JASRI/SPring-8, Hyogo, 679-5198, Japan.*
[8] *Graduate School of Science, The University of Tokyo, Bunkyo-ku 113-0033, Japan.*

Understanding the origin and evolution of near-Earth asteroids (NEAs) is an issue of scientific interest and practical importance because NEAs are potentially hazardous to the Earth. However, when and how NEAs formed and their evolutionary history remain enigmas. Here, we report the U-Pb systematics of Itokawa particles for the first time. Ion microprobe analyses of seven phosphate grains from a single particle provide an isochron age of 4.64±0.18 billion years (1σ). This ancient phosphate age is thought to represent the thermal metamorphism of Itokawa's parent body, which is identical to that of typical LL chondrites [1]. In addition, the incorporation of other particles suggests that a significant shock event might have occurred 1.51±0.85 billion years ago (1σ), which is significantly different from the shock ages of 4.2 billion years of the majority of shocked LL chondrites [2] and similar to that of the Chelyabinsk meteorite [3]. Combining these data with recent Ar-Ar studies on particles from a different landing site [4], we conclude that a globally intense impact, possibly a catastrophic event, occurred ca. 1.4 Ga ago. This conclusion enables us to establish constraints on the timescale of asteroid disruption frequency, the validity of the crater chronology and the mean lifetime of small NEAs [5].

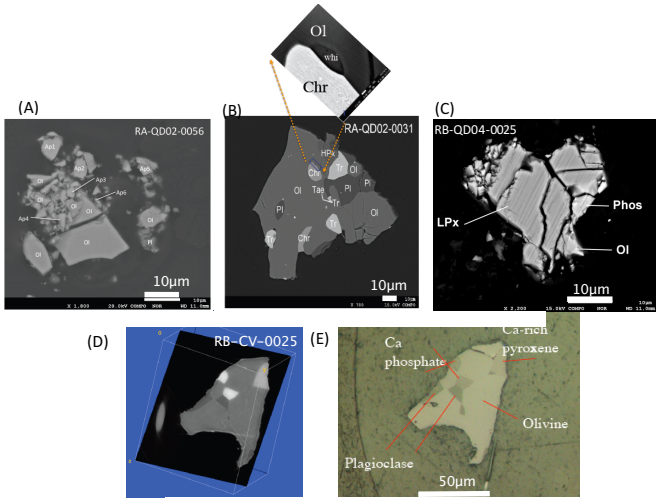


Figure 1. Cross sections of the Itokawa particles.

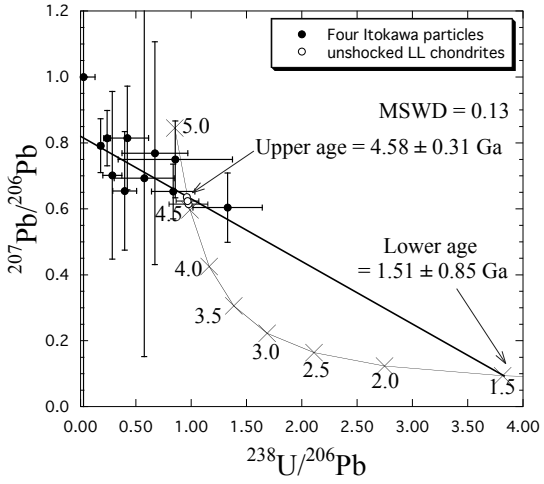


Figure 2. Tera-Wasserburg diagram of four Itokawa particles.

**References**

[1] Göpel C. et al. 1944. *Earth Planet. Sci. Lett.* **121**, 157-171.
[2] Swindle T. D. and Kring D. A. 2008. In: Workshop on Early Solar System Impact Bombardment, Lunar & Planetary Institute (abstract #3004).
[3] Righter K. et al. (2015) *Meteoritics & Planetary Science* **50**, 1790–1819.
[4] Park J. et al. 2015. *Meteoritics and Planetary Science* **50**, 2087-2098.
[5] Terada et al. 2018. Scientific Reports 8: 11806.