COLISIONAL HISTORY OF ASTEROID ITOKAWA RECOVERED FROM EBSD AND ^{40}AR/^{39}AR ANALYSES OF TWO PARTICLES

F. Jourdan[1], N. Timms[1], C. Mayers[1], A. Frew[1], E. Eroglu[2], M. Schmieder[1,3], P. Bland[1], M. Abe[4], T. Yada[4]. [1]Dept. of Applied Geology & JdL centre, Curtin University, Australia. F.jourdan@curtin.edu.au. [2]School of Chemistry and Biochemistry, University of WA, Australia. [3]School of Earth & Environment, University of WA, Australia. [4]Japan Aerospace Exploration Agency, Japan.

It has been suggested that the first-generation parent body of Itokowa must have been initially as large as few tens of kilometers and subsequently destroyed by an impact. The resulting fragments were then re-agglomerated to form a rubble pile asteroid that may have been further fragmented by subsequent impacts [1]. In this study, we investigate the deformation (shock) state of two plagioclase + olivine + pyroxene composite grains of 165 µm and 91 µm in diameter (#0030 and #0013) using electron backscattered diffraction (EBSD) analyses presented in 2013 at the first Symposium, and new ^{40}Ar/^{39}Ar analyses successfully carried out for the first time on single particle using a low volume customized ARGUS VI noble gas instrument.

Results: EBSD analyses show that the minerals from particle #0030 do not show sign of shock. ^{40}Ar/^{39}Ar dating was at the limit of the technique, but still allowed to recover an age of 4.6 ± 1.7 Ga and where other regression solutions suggest that the age of this particle is rather located near ~ 4.6 Ga. Particle #0013 shows clear signs of shock deformation likely associated with pressure levels of 15-35 GPa and is associated with an well-defined plateau age of 2289 ± 139 Ma (P=1.0) suggesting an impact at this time.

Discussion: Diffusion models taking into account porous and non-porous target rocks suggest that particle #0030 was never affected by any shock-induced thermal event. These results have important implication as they demonstrate that the breakup of the proto-Itokawa asteroid was a relatively low temperature process, at least for some parts of the parent asteroid. This is in agreement with low-energy breakup models of pre-shattered asteroids [2].

Similar calculation for particle #0013 suggests that the reset ^{40}Ar/^{39}Ar age of 2.3 Ga is likely to represent a minimum age for the proto-Itokawa asteroid breakup. Level of deformation of the grain allows the post-shock temperature to reach the Ar reset point of albite only in the case of significantly porous material [3, 4] hence suggesting that Itokawa was already formed at the time of the 2.3 Ga impact. This age might even represent the age of the breakup itself or a secondary breakup event although more grains would be needed to confirm the latter statements.

[1] Michel and Handerson, Astronomy & Astrophysics 2013; [2] Michel et al., Icarus 2004 ; [3] Schmidt et al., Lunar and Planetary conference, 1994 ; [4] Davidson et al., Geochimica Cosmochimica Acta, 2012.