EVIDENCE FOR MICROIMPACT IN AN OLIVINE-DOMINATED HAYABUSA DUST PARTICLE

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Introduction: Hayabusa is the first sample return mission to an asteroid, aiming at understanding surface processes (space weathering, impacts) on an asteroid (Itokawa). In the first international call for Hayabusa sample investigation we have received two precious samples: RA-QD02-0115 and RB-QD04-0042. Here we report detailed results of RB-QD04-0042, originally described as mainly composed of olivine. The defect microstructures were studied using focused ion beam (FIB) prepared slices and analytical TEM. Prior to that grains and their morphology were recorded by SEM.

Results: The olivine grain (40 x 50 µm) contains an intimate 10 µm wide intergrowth of FeNi alloy and iron sulfide on its surface. Furthermore a 6 µm diameter diopside inclusion emerged during FIB cutting.

TEM analyses of the FeNi alloy show a high Ni content of about 50 atom% and electron diffraction patterns reveal a face-centered cubic structure with superstructure reflections, both being compatible with tetrataenite [1]. Diffraction patterns of the iron sulfide attest to the stoichiometric iron sulfide troilite.

In terms of their defect microstructures, olivine contains locally a high density of [001] dislocations, while in other regions olivine is devoid of defects. Tetrataenite exhibits many mechanical microtwins and dislocations. Troilite contains some stacking faults with partial dislocations but is mainly characterized by a recrystallization texture with numerous subgrains. Diopside is basically defect-free.

Discussion: In line with previous studies [2] the compositions of silicates and FeNi alloy point to an ordinary chondrite signature of Hayabusa dust. The majority of defects found in RB-QD04-0042 minerals are known to form by shock metamorphism, in particular the [001] dislocations in olivine and the microtwins in tetrataenite. The exclusive occurrence of defects on one side of the olivine particle indicates that the grain was affected by a micro-impact. Comparison with short-pulsed shock experiments suggests that the shock was induced by the impact of a small (2-3 µm) particle [3].

References: [1] Uehara M. et al. 2011. *Earth and Planetary Science Letters* 306: 241-252. [2] Nakamura T. et al. 2011. *Science* 333: 1113-1116. [3] Langenhorst F. et al. 1999. *Earth and Planetary Science Letters* 173: 333-342.

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