DETAILED MINERALOGICAL AND GEOCHEMICAL INVESTIGATION OF THE SURFACE AND INTERIOR OF HAYABUSA PARTICLES

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Introduction: The samples collected by Hayabusa from asteroid Itokawa provide a unique opportunity to investigate both the geological history of the body and its surface history. Anhydrous mineral grains (tens of microns to sub-millimetre in size) clearly survived the collection process, and most of the material studied so far indicates that Itokawa is an LL chondrite of petrographic grade 5 [1, 2]. However, some of the grains appear to be more unequilibrated, suggesting that Itokawa may exhibit a range of compositions that are sampled by the regolith [3]. Such grains might be the more friable phases typically found in the most unequilibrated chondrites, including fine-grained matrix and carbonaceous material. They may only survive as much smaller, submicron-sized, grains preserved on the surfaces of the larger grains. One of the important questions that we are seeking to answer is whether we can detect differences between the surface and interior of the grains, to see if modification of the grains by irradiation and impact on Itokawa's surface can be traced *via* changes in structural, isotopic or elemental composition. We received two particles from the Hayabusa collection: sample RA-QD02-0024 (mounted in resin and polished; slice removed by FIB prior to receipt) and sample RA-QD02-0162 (unmounted). We have undertaken Raman and SEM analyses of the grains, to verify the different phases present, before submitting them for ion microprobe measurement of oxygen isotopic composition (at Open Univ.) and trace elements (at Univ. Tokyo).

RA-QD02-0024: As the grain was already mounted and polished, only one side could be mapped by both Raman and SEM. Bot techniques showed that the dominant component of the grain was olivine, accompanied by a smaller grain of diopside. **RA-QD02-0162:** This grain was analysed by Raman spectroscopy within the sample shipping container; only one side was mapped as the grain adhered to the vessel wall. At least four anhydrous sub-grains (5-20 μm) were found: two olivines (Fo_{40-60}) and two (distinct) pyroxenes. Weak features associated with disordered organic carbon were also apparent in some spectra, although it is unclear if the phase is internal to the grain or surficial. No other phases were identifiable in the Raman spectra. Disordered carbon has not previously been reported from Hayabusa samples. Further investigation is planned in order to determine where the carbon is sited and whether it is indigenous to the asteroidal particle or terrestrial contamination.

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References: [1] Nakamura T. et al. 2011. *Science* 3333:1113–1115. [2] Yurimoto H. et al. 2011. *Science* 3333:1116–1118. [3] A. Tsuchiyama et al. 2013. *MAPS* DOI: 10.1111/maps.12177.