THE COSMIC-RAY EXPOSURE AGE PROBABILITY DENSITY DISTRIBUTION OF HAYABUSA GRAINS

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Background: The analysis of He and Ne in individual mineral grains brought back by the JAXA space probe Hayabusa from near-Earth asteroid Itokawa has revealed that these grains all have exposure times to galactic cosmic rays (cosmic-ray exposure = CRE ages) of <8 Ma [1-5]. This is surprisingly short given the expected survival time of Itokawa in the inner solar system (on the order of a few 10 Ma) [6], and the observed crater distribution on Itokawa (at least 75 Ma) [7], suggesting higher exposure ages for grains from that asteroid. Possible explanations include: 1) a high surface erosion rate on the order of ~0.1-1 m per Ma [1]; 2) a relatively recent (<8 Ma) mass-shedding/re-surfacing event, either through break-up and re-assembly, partial tidal disruption [3,4] or YORP-induced effects [8]; 3) a local effect, i.e., most of the grains sampled by Hayabusa derive from a nearby boulder or "ridge" on the surrounding surface in "Muses Sea" (where Hayabusa touched down on Itokawa) which was exposed <8 Ma ago by, e.g., a small impact; 4) a coincidence favored by small-number statistics; 5) a combination of different scenarios. Scenarios 1-4 should result in characteristic (although perhaps not unique) shapes of the CRE age probability density distribution. For example, a single event leading to the simultaneous exposure of all grains would result in a single large peak in the probability distribution, while a continuous, constant CRE in a regolith would result in a flat distribution.

Methods & Results: We use published (as well as our own, yet unpublished) data for He, Ne amounts. For grain masses, we either use Synchrotron X-Ray Tomographic Microscopy (SRXTM) at the Swiss Light Source/TOMCAT beam-line of the Paul-Scherrer-Institute in Switzerland for volume determination (and subsequent mass determination via density from #Fo [2]), or volumes determined from available SEM grain images from the Hayabusa grain database, combined with a statistical model linking cross-sectional areas with volumes (calibrated by SRXTM [2,9,10]). We then construct the cosmic-ray exposure age probability density distribution for all Hayabusa grains analyzed for their He, Ne content up to the time of the meeting.

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