HOW REPRESENTATIVE OF AN ASTEROID'S MINERALOGY ARE SAMPLES FROM ITS PONDED DEPOSITS?

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Introduction: An unexpected observation of asteroid 433 Eros by the NEAR mission was the ponded deposits [1-2]. Hayabusa recently returned to Earth with dust from the surface of a ponded deposit on asteroid Itokawa [3-5]. Thus the nature of asteroid ponds is of considerable interest. While ponded deposits should initially be global samples, various asteroid surface processes can modify them. Thus, how representative of a bulk asteroid is a sample from a ponded deposit?

Pond Samples: Compared to the bulk asteroid, ponds are distinctly bluer, and depleted in S and Fe, possibly due to loss of species by settling or sputtering [1,2,6]. We have previously proposed that we have meteoritic samples of ponds from at least one asteroid, the parent body of Vigarano (CV3) [7-8]. There are clasts found in Vigarano which consist nearly entirely of fine-grained olivine, of a composition that is identical to that of the host meteorite. The most distinctive features of these clasts are cross-bedded, arcuate bands which contain a high proportion of the finest-grained, iron-rich olivine. The relatively fine-grained bands are located at the bottom of each bed. Given that the Vigarano clasts mineralogy´s are consistent with what we already know about ponds on Eros, we think these crossbeds formed from impact-induced seismic shaking. On a suitably small, airless body, this process can result in grain-size separation with fine-grained materials "percolating" through a coarse matrix to the bottom [9] which is exactly what we observe in the Vigarano clasts. Thus the mineralogy of a sampled pond varies according to where in the pond's vertical column the sampling is made.

We have recently found another clast we believe to be from a ponded deposit. The clast is in the SAH 98328 L4 chondrite, and is a porous agglomeration of anhedral to euhedral crystals of olivine (Fa21-29, peak at Fa25-26), low Ca pyroxene (Fs17-35, no peak), plagioclase, troilite, metal and minor phases. The host meteorite has the same mineralogy and mineral compositions, except that the host has a narrower range of olivine and pyroxene compositions. Unlike the Vigarano clast there is no mineralogical layering in the SAH clast, which would suggest that this clast derives from within a single pond layer.

Implications for Sampling Missions: How representative are sample return missions that sample only smooth, flat, pond deposits? The smallest asteroids have low G, and so settling may be minimized. Largest asteroids have sufficient mass to prevent ponds from forming. The mid-range is where the setting effects are most pronounced, and mineralogical differentiation will be greatest. The implication of these results will be discussed.

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