HED Meteorites, Carbonaceous Chondrites, Vesta, and Space Weathering. T. Hiroi[1,2] and Sho Sasaki[3], *[1]Dept. of Geological Sciences, Brown University, Providence, RI 02912, USA, [2]Antarctic Meteorite Research Center, National Institute of Polar Research, 10-3, Midori-cho, Tachikawa, Tokyo 190-8518, Japan, [3]RISE Project, National Observatory of Japan, Oshu, Iwate 023-0861, Japan.*

Introduction:

Howardites, eucrites, and diogenites (HEDs) are a group of basaltic meteorites, many of which are breccias but known to contain small amounts of carbonaceous chondrite clasts. Studying HEDs allows scientists to study the evolution of a basaltic body which could not become large enough to be called a planet and a possible connection with the largest basaltic asteroid 4 Vesta. NASA Dawn spacecraft made a rendezvous with Vesta (presumed parent body of HEDs) and mapped the surface with Framing Cameras (FCs, a set of stereoscopic cameras with multicolor filters) and Visual and Infrared Spectrometer (VIR). Among its findings was the possible subsurface presence of dark materials (DMs) similar to carbonaceous chondrites (CCs) or C-type asteroids [1, 2, 3]. This presentation will focus on the significance of the mixing of carbonaceous chondrite materials in the crust of Vesta on the trend and rate of its space weathering.

Compositional Dependency of Space Weathering:

The fact that the degree/rate of space weathering highly depends on the bulk iron content of the target material was known [4] even before the recovery of lunar samples by Apollo 11 mission. In addition, the difference in the rate of space weathering was found between olivine and pyroxene of similar iron contents [5]. CCs which contain phyllosilicates and carbon show totally different visible-NIR spectral change caused by space weathering [6], where the spectra become bluer instead of reader as in the case of igneous materials. Based on the above facts, the rate of reddening is believed to have the following order:

Olivine > Pyroxene > Plagioclase > Phyllosilicates

Ordinary chondrites > HEDs > CCs

Dark Materials on/in Vesta:

Recently, Dawn spacecraft rendezvoused with Vesta and color-mapped the surface. At least one of the DMs [1] are distributed over the area of high H contents [3], and the presence of pitted terrains strongly indicates that volatile materials exist in the subsurface layer(s) [2]. These findings are consistent with the idea that CC materials are buried in the near-surface of Vesta and the fact that HEDs contain CC clasts. Although the suggested content of CC as 40% in one area seems far higher than the amount of CC clasts contained in HEDs, there are paired howardites PRA 04401 and 04402 [7] which seem to contain CC materials by far larger amounts than other HEDs.

Space Weathering on Vesta:

Another finding of Dawn was that no clear evidence of space weathering was identified. Because HEDs contain pyroxene and plagioclase with almost no olivine or metallic iron, they are highly resistant against space weathering but should still get space-weathered to some extent. In addition, FCs and VIR may have not been sensitive enough to detect subtle evidences of space weathering on Vesta. However, a significant possibility exists that CC materials in the subsurface layers of Vesta could be preventing HED materials on Vesta from getting space-weathered. Carbon and hydrous minerals in the CC materials could easily absorb energies implanted from solar wind and micrometeorite bombardments.

Selective Delivery of Meteorites:

Just as we do not find hydrous minerals among Martian meteorites, no other HEDs are dominated with CC clasts as PRA 04401-04402. If Vesta is truly the parent body of the majority of HEDs, there should be more meteorites containing large amounts of CC clasts. A possibly explanation is a selection effect based on physical strength, wherein ejection from Vesta and atmospheric entry to the Earth both give advantages to physically strong rocks to survive as mateorites. If so, there must be more CC-bearing HEDs, hydrous Martian rocks, and CCs on their parent bodies than those found in meteorites.

Summary:

The discovery of DMs on Vesta and its implication on space weathering may have a significant influence on the investigation of parent bodies of other types of meteorites such as E and ordinary chondrites and iron meteorites.

References: [1] Reddy V. *et al.* (2012) *Icarus* (in press). [2] Denevi B. W. *et al.* (2012) *Science* 1225374. [3] Prettyman T. H. *et al.* (2012) *Science* 1225354. [4] Hapke B. W (1966) In *The Nature of the Lunar Surface*, 141-154 (Johns Hopkins Press). [5] Hiroi T. and Sasaki S. (2001) *Meteorit. Planet. Sci.* 36, 1587. [6] Hiroi *et al.* (1994) *Lunar Planet. Sci.* 35, Abstract #1616. [7] NASA Antarctic Meteorite Newsletter, http://curator.jsc.nasa.gov/antmet/amn/amnfeb07/petdesPRA04401.cfm.

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