A HOWARDITE-EUCRITE-DIOGENITE (HED) METEORITE COMPENDIUM: SUMMARIZING SAMPLES OF ASTEROID 4 VESTA IN PREPARATION FOR THE DAWN MISSION. J. M. Garber[1] and K. Righter[2], [1]Department of Geology, UC-Davis, One Shields Avenue, Davis, CA 95616, jgarber@ucdavis.edu, [2]Mailcode KT, NASA Johnson Space Center, 2101 NASA Pkwy., Houston, TX 77058.

Introduction: The Howardite-Eucrite-Diogenite (HED) suite of achondritic meteorites, thought to originate from asteroid 4 Vesta, has recently been summarized into a meteorite compendium. This compendium will serve as a guide for researchers interested in further analysis of HEDs, and we expect that interest in these samples will greatly increase with the planned arrival of the Dawn Mission at Vesta in August 2011. The focus of this abstract/poster is to (1) introduce and describe HED samples from both historical falls and Antarctic finds, and (2) provide information on unique HED samples available for study from the Antarctic Meteorite Collection at JSC, including the vesicular eucrite PCA91007, the "olivine diogenite" EETA79002, and the paired ALH polymict eucrites.

Background: The Howardite-Eucrite-Diogenite (HED) clan of achondritic, differentiated meteorites represents a suite of samples that likely originated from asteroid 4 Vesta [1-4], a differentiated planetesimal located in the Asteroid Belt. (Recent work (e.g., [5-7]) also suggests that mesosiderites, achondrites with both metal and silicate fractions, also originated on Vesta, but these are not addressed in the compendium.) Eucrites are basaltic rocks with mostly low-Ca clinopyroxene and plagioclase feldspar, whereas diogenites are orthopyroxene-rich (including some with olivine); howardites include a variety of eucritic, diogenitic, and other meteoritic clasts set in a finer-grained matrix. While the chemistry of these rocks is significantly more Fe-rich than differentiated igneous rocks in a terrestrial setting, this sample suite is broadly analogous to a cross-section through basaltic ocean crust, with diogenites representing gabbroic and ultramafic magma chambers and eucrites representing pillow basalts and lava flows. (However, howardites are unique to extra-terrestrial settings, as they are thought to be lithified pieces of the gardened surface regolith.) Surface processes on Vesta have brecciated, equilibrated, and metamorphosed most HED samples, but some samples appear to have preserved their original texture (e.g., cumulate eucrites and diogenites).

Though 4 Vesta is the largest remaining differentiated asteroid in the solar system, it has been proposed that the early solar system was populated by large numbers of these planetesimals but that most of these have been destroyed, probably by Solar-System scale events such as the Late Heavy Bombardment [8]. In contrast, Vesta's survival as an intact planetoid, its proximity to a major gravitational resonance (and thus a pathway to deliver asteroidal fragments to Earth), and the large number and variety of HED samples collected from meteorite falls and finds (n>1000) highlight the importance of HED meteorites in interpreting the early history of the Solar System.

The need for an HED compendium. Unlike other diagnostic meteorite suites (e.g., Lunar and Martian meteorites), there has been a noted lack of inertia in preparing an HED meteorite compendium to summarize observations and scientific analyses from over 100 years of study. The need for this compendium was made more urgent by the planned arrival of the Dawn mission to Asteroid 4 Vesta in late 2011 [9]. Satellite-based and meteorite powder spectral analyses (e.g., [3] and references therein) and preliminary mapping of Vesta's surface [4,10,11] provide a base reference for interpreting different units and structures, but this mission will be greatly aided by a comprehensive look at the variety of samples that have already been delivered to Earth.

Recent work, especially focused on literature reviews of HED studies, has resulted in a preliminary HED compendium that will be published online prior to the projected arrival of the Dawn mission in late 2011. The >1000 samples make it a daunting task to be all inclusive, especially given the large number of HED samples, which has increased exponentially due to Antarctic finds. Therefore, we have chosen to research and discuss samples that encompass the diversity of lithologies represented in the HED suite, as well as a subset of samples that are considered exceptional or particularly influential, as discussed below.

Samples Addressed by the HED Compendium: Beyond the "HED" categorization of these meteorites, numerous researchers have established sub-classifications that have evolved with the discovery and analysis of new samples. A summary of recent classifications and divisions is contained in the introduction to the compendium, and individual summaries with the compendium were aimed at describing this variability. These include monomict and polymict brecciated eucrites (e.g., Stannern, Pasamonte, ALH-pairing group; Fig. 1), cumulate eucrites (e.g., Moore County), normal and olivine-bearing diogenites (e.g., Johnstown, EETA79002), vesicular eucrites (e.g., PCA91007), and howardites with unique features (e.g., Bununu). Further lithologies are encompassed by analysis of various clasts and lithic fragments within howardites such as EET87503 and EET87513 (Fig. 2). Both Antarctic finds and historical falls are included in the compendium, and we have also included meteorite processing histories (where possible) in order to direct researchers to possible sample sources.

Unique Samples for Study at JSC: With the discovery and classification of so many HED samples, a large body of HED work exists that has answered many lingering questions about the history and provenance of HED meteorites, and will be extremely useful in interpreting results from the Dawn Mission to Vesta. However, a number of unique HED samples may be crucial in interpreting anomalous or unexpected results from analysis of Vesta's planetary surface, and we suggest that further study of these unique HEDs may also be fruitful in answering outstanding questions about Vesta's geologic history. Here, we discuss some unique HEDs at in the JSC collection that merit further study.

PCA91007. Though officially classified as a eucrite, PCA91007 is one of only four reported eucrites to contain vesicles [12], and anomalous oxygen isotope values also suggest that PCA91007 is from a distinct parent body other than Vesta [13]. The vesicular nature has been attributed to either impact melting [14] or exsolution of magmatic gas [12]. However, further research on PCA91007 is required to clarify the setting of vesicle formation.

EETA79002. EETA79002 is one of a small number of olivine-bearing diogenites, and analysis of sixteen different samples revealed an origin from at least three separate source regions, most likely from three genetically related plutons. One of those plutons would have been a harzburgite, contributing both the olivine and the magnesian orthopyroxene to the breccia [15].

ALH pairing group. Fourteen separate meteorites from the 1976, 77, 78, 79, 80 and 81 field seasons comprise a large polymict eucrite pairing group. These samples contain a great diversity of igneous clasts that have not typically been analyzed using many of the newer micro-analytical techniques available for study such as LA-ICP-MS, SIMS, or FEG-SEM.

We are hoping that greater awareness of sample types and availability will aid in the interpretation of new information being acquired by the DAWN spacecraft.

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Figure 1: Details of the subdivision of a slab of ALHA80102, one of several paired masses of the ALH pairing group.

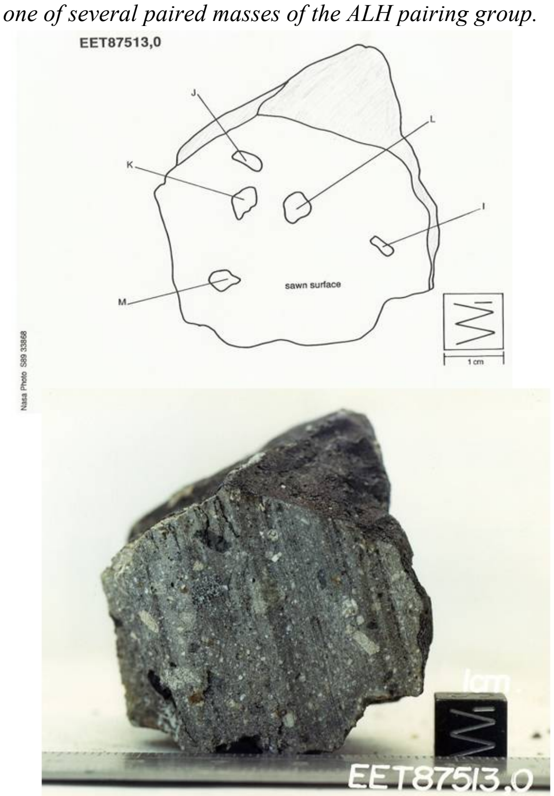

Figure 2: Locations of clasts in a cut face of the howardite EET 87513.