THE HERA NEAR-EARTH ASTEROID SAMPLE RETURN MISSION: AN OVERVIEW. M. A. Franzen and D. W. G. Sears, Arkansas-Oklahoma Space and Planetary Sciences, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR 72701 mfrazen@uark.edu.

Introduction: The obvious success of the NEAR Shoemaker mission has energized the scientific community into thinking about what missions should be proposed in the immediate future. The amount of information received from the high resolution photographs and spectral data have allowed us to start making connections between meteorites and asteroids. However, returned samples from asteroids could provide the vital link enabling us to understand the geological contexts of these samples and provide the answers to many other long standing questions regarding laboratory and astronomical investigations of asteroids[1]. The proposed Discovery class mission Hera will be the opportunity to return asteroid samples for the scientific community to study.

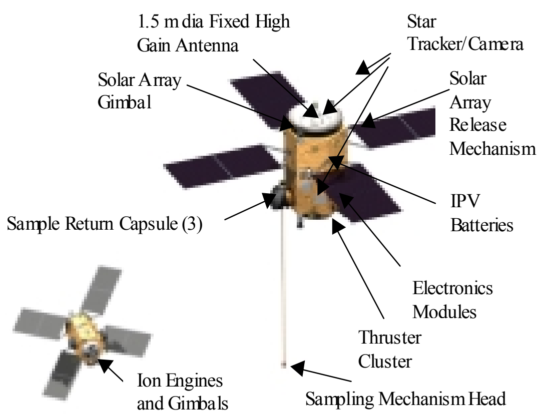

Fig. 1. The Hera spacecraft according to concept studies by SpaceWorks, Inc. and design by the NASA Glenn Research Center. (Figure courtesy of SpaceWorks, Inc.)

The Hera Mission: The Hera mission (Fig. 1.) will visit three near-Earth asteroids and collect samples from three scientifically significant sites on each. The sites will be determined during a two to twelve month survey of each asteroid by Hera. Once the sites are selected, Hera will descend, collect the samples, and then return them to earth. Since this is a small Discovery class mission, the sample collector should be as simple as possible with the minimum amount of moving parts to reduce cost and prevent damage to the sampler during the collection process [1, 2].

The first collector examined by the Hera team was a device designed by Honeybee Robotics. The collector consisted of two counter-rotating cutters, attached to a boom, that projected samples into a canister located behind the cutters. Once the sample is collected, the boom retracts, and the sample is dropped inside a sample return capsule. During laboratory tests, the collector preformed satisfactorily [4]. When it was tested on the KC-135 in microgravity conditions (Fig. 2), the collector had difficulty keeping the sample in the collection cavity and collecting fine grained material.

Fig. 2. The collector test fixture aboard the KC-135 microgravity test facility, with experimenters Melissa Franzen (Univerity of Arkansas), Paul Bartlett (Honeybee Robotics), John DiPalma and Jeff Preble (SpaceWorks, Inc).

The current idea is to use an adhesive tray to collect samples from the asteroid (Fig. 3.). The adhesive tray touch-and-go-sampler would include a 30 cm diameter tray attached to a boom. There would be three booms with collectors for each asteroid. Once the sample has been collected, the boom will place the sample tray in a sample return canister. The booms will allow the spacecraft to collect samples with a minimum amount of disturbance from the 1- to 2- second encounter with the asteroid by the adhesive tray. The adhesive tray would be able to sample the surface regolith including 1 to 2 cm clasts.

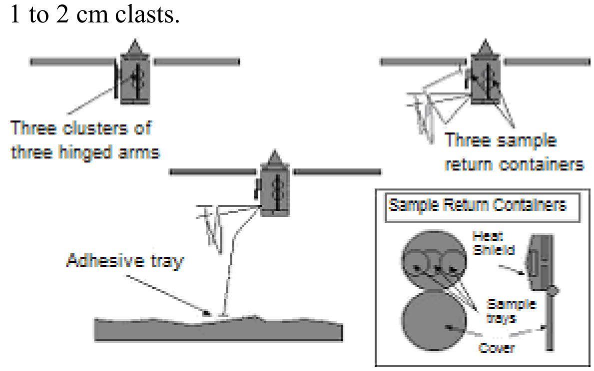

Fig. 3. The adhesive tray collector designed by SpaceWorks, Inc.

Returned Sample: The samples returned will likely contain new materials not represented by meteorite classes, because only the toughest materials survive entrance into the Earth's atmosphere. Therefore, the atmosphere is filtering out highly valuable extraterrestrial material. The returned samples will also be valuable in determining contextual information. These samples will allow us to discover how surface materials vary with site. The surface material will also provide a linkage between asteroids and meteorites as well as between laboratory observations of the same material [1] (Fig. 3).

If Hera rather than the NEAR Shoemaker would have been conducting the mission, the following types of sites would have been picked to be sampled [3]:

- Representative regolith
- Ponds
- Bedrock and boulders
- Crater transect (floor, wall, ejecta)

The crucial point is that every asteroid may be different. This list may obviously change for each of the three asteroids. That is why the reconnaissance portion of the mission is so important; we will obtain detailed information about each specific asteroid before the decision is made as to where to collect samples. Imaging as well as spectroscopic and altimetry information will all play a role in site determination.

Sample Size and Composition: Despite the ever present emphasis on obtaining a wealth of information from micro and even nano scale samples, the goal is different in this case. The amount of sample obtained must be enough to determine major physical properties such as density, porosity, and mechanical strength (Fig. 4.). At the same time, enough sample must be obtained to satisfy the scientific community so a comprehensive analysis can be accomplished, including investigations which require gram sized samples. The best estimation of the sample size needed is ~100 g. Most importantly the collection process must not alter:

- Composition (molecular, elemental, or isotopic)
- Physical properties
- Mineral and phase proportions
- Grain size distribution

Selection of Asteroids: Sample return from three asteroids would provide obvious advantages over sample return from just one asteroid. Asteroids are diverse and abundant and obtaining samples from three asteroids will allow for the comparison of analogous processes. Hera will return samples from contrasting classes of asteroids. At the moment there are twenty asteroids being considered, but only eight have been classified [4, 5]. These eight asteroids provide a rather diverse array with two S class asteroids, one C class asteroid, one B class asteroid, and two X class asteroids. The intention is to link various meteorites with the various classes of asteroids.

Careful consideration of each asteroid's physical properties must be taken into account before any selections should be made. The asteroid's size, shape, spin rate, spin state, and orientation of angular momentum are all important in determining how operations in close proximity should be done or if they can be done at all [4]. A mission that can deal with diverse situations would be most beneficial but very complex.

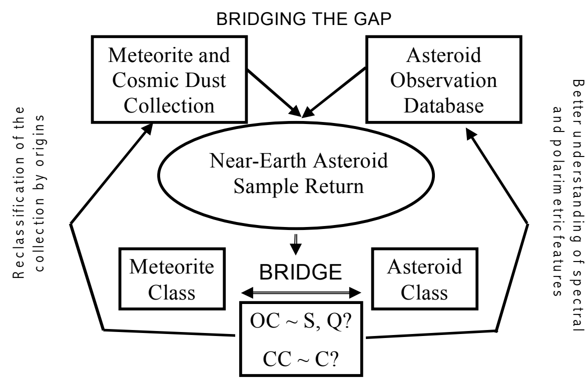

Fig. 4. Part of the science justification for sample return.

Summary: The NEAR Shoemaker mission has provided a wealth of information about the asteroid Eros. The Hera mission will visit three asteroids and collect three ~100 g surface samples using a adhesive tray touch-and-go-sampler. The sites will be determined during a three to twelve month exploration period. The collector must not alter the sample, so that the samples will retain the most scientific value possible. So far eight asteroids have the possibility of being visited and the list is continually growing. These eight asteroids fall into four diverse classes. The Hera sample return mission could ultimately provide us with the information needed to link meteorites and asteroids, and answer many other long standing questions.

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References: [1] Sears D. W. G. (2002) *ASR*, submitted. [2] Sears D. W. G *et al.* (2002) *LPS XXXIII*, Abstract #1583. [3] Britt D. T. *et al.* (2001) *MAPS*, 36, A30. [4] Sears D. W. G. (2002) *ASR*, submitted. [5] D. W. G Sears *et al.* (2002) *LPS XXXIV*, this volume.