ASTEROID THREAT ASSESSEMENT PROJECT - METEORITE LABORATORY. K. L. Bryson[1,2] and D. R. Ostrowski[1,2], [1] NASA Ames Research Center, Moffett Field, CA, 94035, kathryn.bryson@nasa.gov, [2] Bay Area Environmental Research Institute, 625 2nd St. Ste 209 Petaluma, CA 94952.

Introduction: With the increasing realization that asteroids are impacting the Earth, brought to everyone's attention by the fall of the Chelyabinsk meteorite in early 15th February, 2013, NASA has launched an initiative to detect threatening asteroids, deflect them away from Earth if possible, and to study the effects of entry and impact should deflection fail. The Meteorite Laboratory is part of the NASA Ames Asteroid Threat Assessement Project (ATAP). The laboratory measures the physical properties of meteorites. The data are then used to support calculations and other studies that will help us understand the processes that happen as the object flies through the air and possibly impacts. The data will also be placed in an on-line database for community access.

Laboratory Measurements: The Meteorite Laboratory is composed of multiple stations to measure the physical properties of meteorites (Fig. 1). Results from this lab can be seen in papers presented at this conference [1,2].

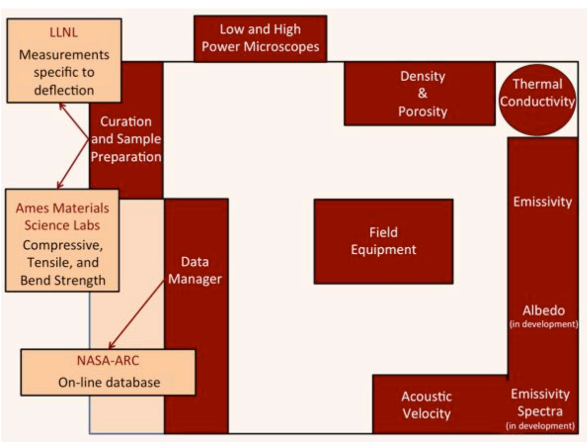

Figure 1. *Meteorite laboratory schematic. Samples are examined by all the different techniques to create a full suite of physical characteristics of the meteorite.*

Curation and Sample Preparation. Meteorite samples coming into the laboratory are irregular fragments. For the measurements undertaken here they need to be cut into 1.5 cm cubes for the physical measurements or 5 x 2 x 1 cm bars for the measurement of their strength to be provided to the Ames Material Science Labs. This is achieved at this station which consists of rock cutting saws and grinding and polishing equipment.

Low and High Power Microscopes. A petrographic section of every meteorite sample submitted to the ARC Meteorite Laboratory for physical measurement will be examined under the Leitz Orthoplan research microscope to check for unusual features that might affect the data. The unusual features might consist of unusual voids or cracks, shock features such as veins or mineralogical changes, or even weathering effects since even observed falls can suffer alteration once on Earth.

Figure 2. *The NextEngine 3D laser scanner and Quantachrome Multipycnometer are used in combination with weight to determine density and porosity of the samples. The inlay is a 3D image of Sikhote-Alin Iron IIAB meteorite.*

Density and Porosity. Density and porosity are key determinants in meteor behavior in the atmosphere and deflection [3]. The volume of samples is determined by a NextEngine 3D laser scanner and then the density is calculated from the weight. The NextEngine 3D laser scanner has a dimentional accuracy of ±0.005" to ±0.015" depending on settings and does not have a limit on sample size. The porosity is determined using a Quantachrome Multipycnometer using nitrogen gas displacement. The pycnometer has a digital pressure display resolution of 0.001 psi and an accuracy better than 0.2% when thermally equilibrated and sample occupies greater than 75% sample cell volume.

Acoustic Velocity. Acoustic velocity gives insights to the wave propagation through a meteorite which gives the internal structure and porosity [4]. The velocity of sound is being measured in three directions through each meteorite sample using an Olympus 45-MG meter with longitudinal and shear wave transducers. From these measurements the elastic modulus is calculated.

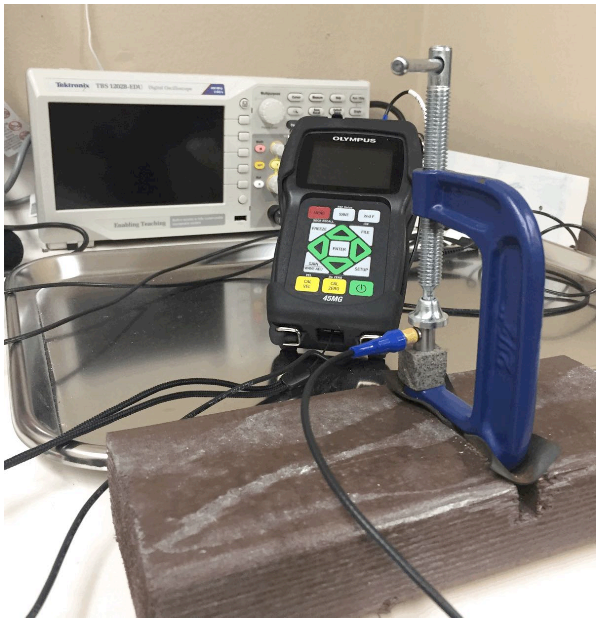

Figure 3. *The Olympus 45-MG meter and longitudinal transducer are used to determine the acoustic velocity through a sample of Tamdakht H5 chondrite.*

Thermal Properties. Thermal conductivity, heat capacity, and thermal emissivity provide a way of characterizing the meteorite's composition and its physical state [5]. Also thermal properties help constraints on determing YORP for matched asteroids. Emissivity is measured from room temperature up to 1600°C using two infrared guns (EnnoLogic eT6500 and GEATEX GXTP75) and specially modified ovens and tube furnaces. Both infrared guns have a spectral response of 8 to 14µm and a resolution of 0.1°C. The EnnoLogic has an accuracy of ±1% temperature plus 1°C with an optical resolution of 10:1, while the GEATEX has an accuracy of ±2% with an optical resolution of 50:1.

Thermal conductivity and heat capacity are being determined using an Anter Unitherm 2101 Comparative Cut-Bar Thermal Conductivity meter using the ASTM E1225 test method, allowing for a bulk determination. Samples may be tested from approximately 50 °C to 1000 °C. The overall accuracy of this test method is between 5 and 10%. At the time of submission of this abstract this instrument is being retrofited.

References: [1] Ostrowski D.R. and Bryson K.L. (2016) *LPS XLVII,* Abstract #2642. [2] Bryson K.L. and Ostrowski D.R. (2016) *LPS XLVII,* Abstract #2619. [3] McCausland P.J.A., Samson C. and McLeod T. (2011) *Meteoritics & Planet. Sci.,* 46, 1097-1109. [4] Flynn G. J. (2004) *Earth, Moon, and Planets,* 95, 361-374. [5] Opeil C. P. et al. (2010) *Icarus,* 208, 449-454.

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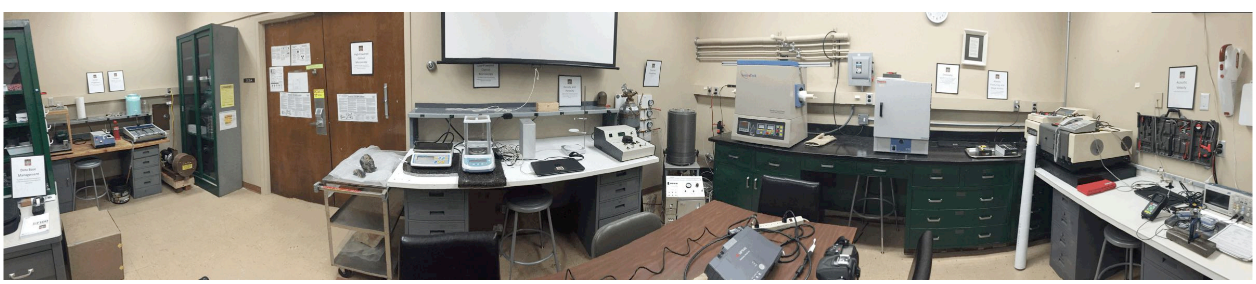

Figure 4. Photograph of the ATAP Meteorite Laboratory