Introduction: Every year scores of suspect meteorites from all over the world are sent to the Institute of Meteoritics for identification. We are initiating a program in which some of these samples are handled as a collaboration between the Institute of Meteoritics (IOM) and the Southwestern Indian Polytechnic Institute (SIPI). The program is supported by the NASA OSS MURED Partnership program. This project not only helps with the identification of the samples, but also provides training for SIPI students in the scientific method, and some of the high technology instruments used in research. The objective is to use simple empirical tests to determine whether a sample is a meteorite or meteor-wrong. The students have an opportunity to run a scanning electron microscope (SEM) as part of their research on the samples. An important part of the process is writing the report to the sample owners describing whether the sample is a meteorite, and if not, what kind of material the sample actually is. An underlying goal of the collaborative effort is to give the students experience in a real scientific setting, and to address the misconceptions that most students seem to have about pursuing a career in Math, Science, Engineering or Technology (MSET) [1,2]. This program is an outgrowth of a program developed under a NASA PACE grant to demonstrate meteorite identification as an activity for middle school field trips [3].

Meteorite Identification: Meteorites consist usually of metal and rock, while meteor-wrongs, may consist of any unusual rocks or materials that are easily mistaken for meteorites, such as magnetite, hematite, basalt, obsidian, slag, milling balls, and/or heavily eroded sedimentary rocks. The materials needed for the preliminary examination of the samples include magnets, magnifying glasses, and ceramic streak plates.

In order for the students to be able to identify real meteorites, we introduce them to a few basic characteristics that meteorites may have, such as the presence of metal, fusion crust, regmaglypt textures, and chondrules. Almost all meteorites contain some iron-nickel metal and therefore will attract a magnet. The fact that meteorites contain some metal means that they will typically be heavier (denser) than an average rock of the same size. Other properties that can indicate a meteorite include: (1) Fusion crust - This thin, black-brown surface coating is produced when the frictional heat from atmospheric entry melts the outer surface of the meteor. (2) Regmaglypt texture - This texture, which looks like small dents in the rock, forms during the frictional heating associated with atmospheric entry. As the outer surface of the meteorite begins to melt, small pieces of material will be plucked away. (3) Chondrules – These are small, rounded, BB-sized pieces of silicate material that formed early in the history of the solar system. We also explain that the streak of a material can help us identify minerals often mistaken for meteorites such as magnetite and hematite.

Using the Scanning Electron Microscope (SEM) to identify meteorites: The second part of the identification procedure introduces the students to some of the high technology instruments that are used in planetary science, including the petrographic light microscope and the SEM.

Samples that are clearly rich in magnetic iron metal, or samples that we cannot otherwise identify, may need to be studied further in the SEM. The samples are analyzed using the Energy Dispersive Spectrometry system, to determine the composition...
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of the metal in the sample, and therefore identify if the sample is extraterrestrial or not based on the presence or absence of nickel in the metal. Meteoritic metal is composed of the elements iron and nickel together and this metal composition is not commonly found on the Earth.

The students begin the SEM work by selecting metal grains for EDS analysis. The brightest grains (in backscattered electrons) will be the most likely grains to contain iron-nickel metal. The SEM operator then centers the electron beam on a metal grain and proceeds to increase the magnification all the way up to 300,000X. At this magnification the other operator can start the EDS system and take a chemical analysis of the metal grain. The students use the computer display to identify the compositional peaks and determine what elements the metal is composed of. After three or four analyses the students will be able to make a sound determination if the sample is a meteorite or a meteor-wrong.

If a real meteorite is identified, the samples are prepared for further study by making mounts or thin sections for study with the petrographic microscope. Further analysis of the meteorite utilizes the electron microprobe to obtain quantitative elemental abundance data that is needed for a classification.

The SIPI partnership experience: During the course of this partnership we have developed and improved the meteorite identification process. Although this process has been conducted at the Institute of Meteoritics for more than 50 years, this is the first time that non-professional meteoriticists have been enlisted in the effort. The early success of this effort is due to a lot of help and input from the professional members of the team, Dr. Jones, Dr. Newsom, and Ph.D. student Mr. Karner, along with the support from the SIPI geology instructor, Dr. Simmons. The program involves training sessions, and identification sessions at UNM and SIPI, and sessions with the electron microscope at UNM. Principal student participants included Tadd Garcia and Dale Livingston, undergraduates from SIPI, and Brandon Townend, a high school student from Jemez Pueblo participating in SIPI weekend programs.

This process is complicated because of the need for proper response to the members of the public who have sent in their meteorites. Not only must the samples be examined as possible meteorites, but the owners expect to be told what the nature of the samples are if they are not meteorites. In some ways this is the most difficult job, because the samples are often very small, and because the description needs to be understandable by a non-professional geologist.

In addition, there is usually little or no geologic context for the sample.

By working together with the students, the professional staff has been able to improve the process, including compiling the best descriptive terms, and improving the documentation that is needed. This has led, for example, to the development of better forms for describing the samples, which will ultimately improve the process and the increase the good will of the public who send in the samples. Further progress is expected as the SIPI students continue this process, including the characterization of newly discovered meteorites.

Statement by Tadd Garcia, SIPI undergraduate: As a student, learning and experiencing new ground is always a beneficial factor in ones success. With the NASA program, I have learned the importance of mastering the basics in any field of study and working with a diverse group of different backgrounds. From the beginning to the end of the research program, geology was one of the most crucial and critical keys in the identification of meteorites and meteor-wongs.

After meeting with UNM professors, a UNM graduate student, and the high school student, I knew the environment was well staged and set up to be a learning experience. During that initial meeting we were all informed of our duties and introduced to the procedures and methods of identifying samples. Once introduced to the procedures, we slowly moved onto the technology part of the identifying procedure.

Using the SEM was quite an experience and realizing that I am capable of utilizing scientific equipment of that caliber let me understand that science is not as intimidating as I thought. In conclusion, I have found this experience to be very enlightening and educational.


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