Using NASA-Unique Lunar Sample Disks and Resources to Inspire and Promote Scientific Inquiry. P.V. Graff[1], J.Allen[2], K.J. Willis[3], and S. Runco[4], [1]Jacobs, NASA JSC, Houston, TX 77058, (paige.v.graff@nasa.gov), [2]United Technologies Aerospace – Jacobs JETS, NASA JSC, [3]Oceaneering Space Systems – Jacobs JETS, NASA JSC, [4]NASA JSC, ARES, Houston, TX.

Introduction: The opportunity for educators and students across the nation to hold precious, NASA lunar samples in their hands and examine materials brought back by astronauts during the Apollo era is an experience and memory that can last a lifetime. Combine that experience with the opportunity to be engaged with hands-on activities that promote scientific inquiry and an understanding of the importance of these samples…now you are preparing our nation's future scientific explorers.

Lunar Sample Disks [1]: The Astromaterials Research and Exploration Science (ARES) Directorate at the NASA Johnson Space Center in Houston, TX houses and manages the distribution of the NASA lunar sample disks. These specially created six-inch Lucite disks contain three lunar rock and three regolith samples representative of the Moon. ARES science specialists are charged with the certification of educators who wish to borrow these lunar sample disks. These sample disks are available for educators to use in classrooms, museums, science centers, and public libraries for education activities and displays. Certification involves learning about basic processes such as accretion, differentiation, impacts, and volcanism as well as security requirements to ensure the safety of these precious samples. These lunar sample disks are valuable tools for engaging individuals in the exploration of Earth's Moon and solar system exploration in general. They are especially important in connecting the importance of the use of extraterrestrial samples in scientific research and understanding of our solar system. Providing students and educators with the opportunity to hold a record of the history of our solar system in their hands can be truly inspirational.

Promoting Scientific Inquiry: How do you help students gain an understanding of how the study of collected samples can help improve the understanding of the history of the Moon, the Earth, and solar system? How do you help students gain experience with scientific practices and the nature of science so they have a sense of the skills and practices used by professional scientists? ARES science specialists have addressed this through the recent development of an inquiry-based activity called, "Rocks, Soils, and Surfaces". This planetary sample and impact cratering unit is designed to introduce students in grades 4-10 to the significance of rocks, soils, and surfaces on planetary worlds. The activity focuses on the lunar samples collected by Apollo astronauts and the study of the most dominant geologic process across the Solar System, the impact process. The unit provides students with inquiry-based, hands-on experiences that help them model skills and practices used by both sample and remote sensing scientists. This helps students see the important integration and use of collected extraterrestrial samples along with remote sensing data. It also helps reinforce the value of future sample collection as NASA continues to explore the solar system.

Rocks, Soils, and Surfaces: The "Rocks, Soils, and Surfaces" unit promotes scientific inquiry through a set of activities and background information divided into five sections. The first section, "Observations and Preliminary Questions", asks students to make observations of images of lunar rocks, soils, and surfaces and pose questions based on their observations. This initial section engages students with the focus of the unit and through observation, opens up a sense of curiosity and intrigue.

The second section, entitled "Why Explore the Moon?", discusses the importance of lunar exploration in understanding not only the Moon, but the Earth and our solar system. This section includes background information only but is essential as it sets the stage for the importance of the ongoing studies of the lunar rock and soil samples, in additional to remote sensing data, as the progression of lunar science continues.

The third section of the activity, "Exploring Rocks, Soils, and Surfaces", provides students with background knowledge and hands-on experiences to gain an understanding of the significance of studying the rocks, soils, and surfaces of a planetary world. Students put their lunar geologist skills to work as they are trained to examine and classify lunar samples. They also gain an understanding of regolith formation through an exercise using graham crackers and rocks. They are also introduced to common lunar surface features, how they form, and then create their own model surface to gain both a tactile and visual sense reinforcing the formation of these surface features. The final portion of this third section enables students to apply what they have learned as they explore a lunar sample disk. The Teacher Guide encourages certified teachers to check out a lunar sample disk and provides additional ways students can further investigate lunar samples through the Astromaterials Research and Exploration Science Lunar Rocks and Soils website [2].

The fourth section of the activity, “Closer Look at Impact Craters Through Experiments”, has students initially experience making impact craters through the use of flour, cocoa, and marbles. It then challenges students to create their own experiment to answer a question of their own design. Students design and conduct their experiment, collect and compile data, and evaluate the process. They also report on their conclusions, helping them to complete the entire process of science.

The final part of the activity, “Crater Investigators”, extends students newly gained knowledge about impact craters and introduces them to identifying and investigating craters on Earth. Students discover how many impact craters have been identified on Earth and design a small investigation using a subset of data. This is followed by having students plan a potential investigation focusing on lunar craters.

The activity comes to a close by tying together and reiterating the importance of studying rocks, soils, and surfaces to better understand the history of the Moon, Earth, and our solar system.

Potential Research Extensions: “Rocks, Soils, and Surfaces” aims to spark interest in further investigations of lunar samples or lunar surface features. The activity lets students know that although they have focused on lunar samples and surface features, the skills they have gained can be applied to other planetary worlds. The Teacher Guide provides a number of potential research extensions teachers may consider using with their students. This includes having students complete a mini-research investigation on impact craters using the Crater Comparison Activity [3]. This activity enables students to gain experience conducting a structured investigation on impact craters on Earth, Earth’s Moon, and other planetary worlds. Other research extensions include having students design and complete a unique investigation focusing on lunar samples that students can observe through the ARES Science Lunar Rocks and Soils website [2]. Additionally, students may compare surface features found on the Moon with those observed on other planetary worlds. Another extension includes having students design a future human or robotic mission to visit and explore the Moon. The “Rocks, Soils, and Surfaces” unit and potential research extensions help foster scientific inquiry and creativity – both of which are important for today’s and our nation’s future scientific explorers.

Conclusions: Through the use of NASA lunar sample disks and resources designed to promote scientific inquiry, NASA has the unique ability to prepare and inspire the next generation of scientific explorers. Exposing students and teachers to these resources, as only NASA can, brings relevance to Science Mission Directorate content, research, exploration, and NASA’s overall mission.

References: [1] Astromaterials Research and Exploration Science (ARES) Lunar Sample Disk Program, http://ares.jsc.nasa.gov/ares/lmdp/index.cfm, [2] Astromaterials Research and Exploration Science (ARES) Lunar Rocks and Soils, http://curator.jsc.nasa.gov/lunar/index.cfm, [3] Crater Comparisons Activity, http://ares.jsc.nasa.gov/ares/eeab/CCA.cfm

Additional Information: For additional information on the lunar sample disks and resources, contact Jaclyn Allen (jaclyn.allen-1@nasa.gov) or Paige Graff (paige.v.graff@nasa.gov).