

An Overview of the Moon Mineralogy Mapper / Chandrayaan-1 E/PO Program. C.R. Runyon¹, S. Shipp², K. Balch³, G. Tuthill⁴, K. Garver⁴ and J. Gutbezahl⁵, ¹Lowcountry Hall of Science & Math, College of Charleston, Charleston, SC 29403, runyonc@cofc.edu, ²Lunar and Planetary Institute, Houston, TX, shipp@lpi.usra.edu, ³U.S. Space & Rocket Center, Huntsville, AL katrineb@spacecamp.com, ⁴Montana State University, Bozeman, MT, Tuthill@montana.edu and kgarver@montana.edu, ⁵PERG, Lesley University, Boston, MA, jgutbeza@lesley.edu.

Moon Mineralogy Mapper / Chandrayaan-1.

Moon Mineralogy Mapper (M³) is one of eleven instruments selected to fly onboard India's Chandrayaan-1 spacecraft in March 2008. M³ was selected as a NASA Discovery Mission of Opportunity in May, 2004. M³ is a high spatial and spectral resolution spectrometer that will help scientists better understand the compositional variation of the Moon's surface.

M³'s overall science strategy to characterize and map the lunar surface composition in the context of its geologic evolution and exploration strategy to assess the Moon's mineral resources at high spatial resolution in support of NASA's "Vision¹ to Explore the Moon, Mars and Beyond ..."

M³ Education & Public Engagement Plan.

A robust education and outreach program is planned to help share the exciting results of the Chandrayaan-1 and M³ mission in support of NASA's education goals. The M³ Education and Public Outreach (E/PO) plan is built upon strategic partnerships between formal and informal education providers who will promote science, technology, engineering and mathematics (STEM) literacy and awareness of NASA's mission and Vision as well as the success of Chandrayaan-1 and M³.² By focusing on activities that enhance education and vision in STEM, we directly support the NASA and SMD Strategic Plan for Education and Outreach as well as the Office of Education as newly defined in March of 2006: *Formal education* is now defined as "the *intent* to increase learning, to educate students on specific science, technology, engineering or math (STEM) content areas, and to expand the nation's future STEM workforce". *Outreach* is now defined as "the *intent* to raise awareness of, or interest in, NASA, its goals, missions and/or programs, and to develop an appreciation for and exposure to science, technology, research and exploration."³

Three Unifying Themes for M³ E/PO.

Unlike NASA's Mars Public Engagement Program, within which exists a set of well vetted themes and strategies to share with the public, there is not yet an "official" Lunar Public Engagement Program, nor a fully vetted set of common lunar education themes.

We have identified three themes as unifying threads between the M³ science, engineering, technology and E/PO. Each theme may stand alone or support the others:

Geology of the Earth-Moon System. The objective of this thematic strand is to promote and enable student use of authentic scientific data, spectra, and imagery leading to an understanding of the processes that formed the Earth-Moon system and evolved their surfaces. Resources from NASA's previous lunar missions (e.g., Apollo, Clementine) will lay the foundation for understanding M³ imaging spectra and Chandrayaan-1 data.

Properties of Lunar Materials. The objective of this strand is to promote and enable student and public use of authentic scientific data and spectral imagery to analyze the physical properties of lunar materials. Resources from NASA's previous lunar missions (e.g., Apollo, Clementine) and laboratory data will lay the foundation for understanding M³ imaging spectra and Chandrayaan-1 data.

Science & Technology of Lunar Resources. The third thematic objective addresses a current void in science education by promoting the exploration and understanding of the physical, chemical, and geological properties of lunar surface materials that may permit their use as a future resource in support of extended human presence on the Moon.

The M³ activities and programs designed within the themes are inquiry-rich; meet the national standards in science, math and engineering, and have all been educator-vetted.

M³ E/PO Activities and Toolkit.

M³ E/PO activities and resources will permit students to learn how the Moon and different planetary surfaces form and understand how scientists and engineers explore these worlds. M³/ Chandrayaan-1 mission E/PO activities largely build upon two highly acclaimed, teacher-vetted, educator guides: 1) "*Exploring the Moon: A Teacher's Guide*",⁴ published by NASA to support the Lunar Education Sample Disk Program, and 2) the recent *Active Astronomy Program* generated by the SOFIA E/PO program.⁵ All curricula, resources and activities generated will become part of the M³ E/PO Toolkit. Included in this toolkit will be activities

and resources related to the current Chandrayaan-1 mission, the M³ instrument, spectroscopy, lunar history and more. These activities will all support one or more of the above themes making them applicable for future missions such as Lunar Reconnaissance Orbiter (LRO) E/PO program⁶ and more. Such kit materials will include formal curricular activities targeting Grades 4-12. Kit contents and curricula being developed include: A Lunar Timeline: History of Lunar Exploration; Geologic history of the Moon & Geologic Processes; Impacts/Cratering and Regolith formation; Volcanoes ; Mapping and Superposition ; Rocks and Minerals; Activities with the Lunar Samples and Sample Education Disks; Hand-held ALTA Spectrometers / Spectroscopy; Observing and Exploring the Moon; Thematic Posters with graphics and activities.

The classroom toolkits will be made available for loan to educators who participate in the M³ workshops on a short-term basis from our E/PO team members. More details to come once the kits are completed.

More informal means of involving the public include the use of:

- M³ website to engage families and students in lunar exploration and to share their photos & stories of the Moon
- Storytelling – multicultural stories of the Moon from indigenous cultures around the world for families are being collected by the Lunar & Planetary Institute (LPI). These will be available via the web , M³ exhibit(s), workshops and a CD when compiled.
- Museum exhibit(s) are being designed around the three themes by the U.S. Space & Rocket Center. Small, traveling versions of one or more of these will be made available for use in libraries, classrooms and smaller science centers.

Professional development opportunities for both formal and informal educators include workshops with the M³ scientists, engineers, and educators from across the country at the U.S. Space & Rocket Center. During these workshops participants receive background and content in lunar science, on M³, Chandrayaan-1 and upcoming missions such as LRO, hands-on experience with the mission E/PO activities and a chance to begin planning an exhibit and/or education program for their own classroom or science center/museum.

Participants will also receive follow-up instruction and mentoring via Web-based Classroom Tools (WebCT) through our partner at Montana State University. WebCT is a web-based distance learning program that will permit the M³ E/PO team to continue supporting and working with the participating educators while they are developing their lunar curricula and follow-up education programs.

M³ science and engineering team members will begin giving talks and presentations to local, state and national groups as well as reporting on their research results.

Formative and summative evaluations are being fully integrated into the M³ E/PO Program. Metrics for success will be monitored by PERG with assistance from the E/PO team.

In summary, our M³ E/PO program is highly leveraged, including resources and team experience from past and present lunar missions, 3 NASA Centers (JSC, JPL, MSFC), a minimum of 10 networked museums and science centers and ties to educators across the country. The integration of this resource network will lead to sustainability beyond the M³ mission.



Figure 1: Family viewing and discussing lunar geology and U.S. exploration history in their backyard using M³ E/PO tools.

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