

BRINGING OUTER SPACE INTO THE CLASSROOM: LOANABLE SPACE SCIENCE MODULES FROM THE CENTER FOR METEORITE STUDIES AND MARS EDUCATION PROGRAM AT ARIZONA STATE UNIVERSITY. R. Hines¹, W. Taylor², M.E. Minitti¹ and M. Wadhwa¹. ¹Center for Meteorite Studies, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287-1404, ²Mars Space Flight Facility, Arizona State University, PO Box 856305, Tempe, AZ 85287-6305.

With specimens representing over 1550 individual meteorites, the Center for Meteorite Studies (CMS) at Arizona State University (ASU) is home to the world's largest university-based collection of meteorites. The collection is actively used for planetary, geological and space-oriented research by scientists at ASU and around the world, creating new knowledge about the origin of our planetary system and the formation of habitable worlds.

In order to share this knowledge with educators, students and the public, the CMS is dedicated to creating and providing educational opportunities that expand understanding and awareness of meteoritic research and impact both rural and urban communities.

The latest such CMS effort is a joint enterprise with ASU's highly successful Mars Education Program. CMS and the ASU Mars Education Program have developed and constructed loanable teaching modules designed to provide high-quality, user-friendly educational materials to local educators and students (grades 5-12) in both rural and urban regions. The modules contain a wide variety of educational materials, accompanied by comprehensive instructional guides, enabling teachers to bring space science into the classroom. Module lessons and activities are aligned with National Science Education Standards and Arizona Academic Content Standards, and seek to challenge students and inspire their interest in space and planetary science. Through the modules, CMS and the Mars Education program are able to reach beyond the ASU campus to positively influence classrooms throughout Arizona.

All module loans are provided free of charge, for a period of two weeks, to certified or informal educators through the CMS website, and contain actual specimens (rocks, minerals, meteorites), 3D models, media resources (movies, animations, posters, maps, flash cards, books), lesson plans, slide presentations, training videos, and a detailed user guide (please see below for detailed module content descriptions). Educators can choose from a series of engaging activities that utilize hands-on materials geared to help students develop logical thinking, analytical skills, and proficiency in science, technology, engineering and mathematics (STEM) disciplines. The first modules in this series, "Earth-Mars Comparison" and "The Origin of Meteorites" are now available.

The "Earth-Mars Comparison" module details the many differences and similarities between the two

neighboring planets, and contains inquiry-based activities employing authentic geologic specimens and data to spark future scientists' and explorers' interest in planetary science. Through the use of real meteorite and terrestrial impact specimens, the "Origins of Meteorites" module explores the "what, where, how and when" of meteorite formation. Topics of study include the different types of meteorites recovered on Earth, formation of impact craters, asteroidal and planetary origins of meteorites, and what scientists are currently learning from meteorites about the formation of our Solar System.



Figure 1. Participants at the ASU Fall 2009 Mars Educator Conference are instructed on the use of loanable classroom modules by CMS staff. On display is the "Earth-Mars Comparison" module.

Both modules were introduced to 150 local teachers at the ASU Fall 2009 Mars Educator Conference. Biannual module training will be offered as part of the upcoming Mars Education/CMS educator professional development schedule, and educators will have the opportunity to provide feedback on the effectiveness of the module lesson plans and activities in the classroom,

so that the module content can be continually improved.

Additional educator resources, such as educator guides and publications, meteorite information sheets, educational website links, slide presentations, and further hands-on activities, are available on the newly redesigned CMS website (<http://meteorites.asu.edu>) and the Mars Education Program website (<http://marsed.asu.edu>). With these online resources, the CMS aims to provide educators all over the world with interesting and inspiring new ways to present meteoritic science to a broad audience.

Module contents. All modules come securely packed in an easily transported storage locker on wheels, and contain a detailed instruction manual with material lists and additional resources, program CDs (including copies of most included materials), a lesson plan, and a MS Power Point slide show with embedded animations (on CD).

In addition, each “Earth-Mars Comparison” module contains:

- Ten sets of ring-bound and laminated Earth-Mars Comparison flash cards
- Ten sets of Mars Match cards
- Set of thirty Mars Science information cards
- Inflatable Earth globe
- Inflatable Mars globe
- Bicycle pump for inflating globes, in storage bag
- Our Local Universe Marble set of four planets
- Two MOLA elevation maps of Mars (24x36 laminated posters)
- Elevation map of Earth (24x36 laminated poster)
- Mars Revealed Chart (30x20 laminated poster)
- Twelve sets of THEMIS Visible images (set of eight 26x15 laminated THEMIS images)
- Twelve THEMIS Context images (black & white)
- Nova *Mars Dead or Alive* DVD
- Geological specimens with laminated labels:
 - Lava rock, AZ
 - Bread-crust lava bomb, AZ
 - Hematite (boytroidal), Africa
 - Hematite (specular), MI
 - Mars Soil Simulant, NASA JPL
 - Canyon Diablo iron meteorite, AZ
 - Tektite, China
 - Shattercones, Sudbury CA
 - Fall-back breccia, Sudbury CA
 - Impact melt, Sudbury CA
- Books:
 - *Touchdown Mars!*; P. Wethered (2000)
 - *Max Goes to Mars*; J. Bennett (2003)
 - *Destination Mars*; S. Simon (2004)
 - *Mars Rovers* (Kidhaven Library); L. Davis (2004)

- *Planet Mars* (SeeMore Reader 1); S. Simon (2006)
- *A Traveler's Guide to Mars*; W. Hartmann (2003)
- *Magnificent Mars*; K. Croswell (2003)
- Chain Reaction magazine, Mars edition; ASU

- Mars Image Analysis activity
 - Twelve sets of Mars Feature Identification Charts (five laminated charts)
 - Twelve plastic rulers
 - Twelve packs of wet-erase markers in four colors

Each “Origins of Meteorites” module contains:

- Ten sets of ring-bound and laminated Meteorite flash cards
- Meteorite Chart (24x36 poster)
- Meteorites A to Z (24x36 poster)
- Asteroids and Meteorites (24x36 poster)
- Impact Craters on Earth (24x36 poster)
- Bacalar Crater THEMIS poster (24x36 laminated)
- Set of four *Starry Night* DVDs
- National Geographic *Deadly Impact* DVD
- Discovery Channel *Fireballs from Space* DVD
- Geological specimens with laminated labels:
 - Meade Meteorite Collection kit with 24 meteorites
 - Canyon Diablo meteorite spherules, AZ
 - Canyon Diablo oxidized meteorite material, AZ
 - Canyon Diablo iron meteorite, AZ
 - Allende carbonaceous chondrite, Mexico
- Books:
 - *Rocks from Space*; O. Norton (1998)
 - *Field Guide to Meteorites and Meteors*; O. Norton and L. Chitwood (2008)
 - *Falling Stars: A Guide to Meteors and Meteorites*; M. Reynolds (2001)
 - *Meteorites and their Parent Planets*; H.Y. McSween (1999)
 - *Asteroids, Comets and Meteorites: Cosmic Invaders of the Earth*; J. Erickson (2003)
 - *Asteroids, Meteorites and Comets*; L. Elkins-Tanton (2006)
 - *Asteroids, Comets, and Meteorites* (First Facts); S. Kortenkamp (2006)
 - *Comets, Asteroids and Meteorites* (Starting with Space); C. Nicolson (1999)
 - *Meteorite Craters*; K. Mark (1995)

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