

INSTRUCTIONAL ROCK KITS FOR EARTH AND SPACE SCIENCE EDUCATION. D. A. Crown¹, S. R. Buxner¹, S. W. Anderson², A. M. Baldrige^{1,3}, R. S. Berglin³, V. J. Bray⁴, T. L. Cañizo¹, S. K. Croft¹, and L. A. Lebofsky¹, ¹Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719, crown@psi.edu; ²MAST Institute, University of Northern Colorado, Greeley, CO 80639; ³Department of Environmental and Earth Science, St. Mary's College of California, 1928 Saint Mary's Road, Moraga, CA 94556; ⁴Lunar and Planetary Laboratory, University of Arizona, 1541 E. University Blvd., Tucson, AZ 85721.

Introduction: The Planetary Science Institute's Project WISER (*Workshops in Science Education and Resources: Planetary Perspectives*) is centered around a series of professional development workshops for elementary and middle school science teachers [1-5]. Project WISER provides teachers with in-depth content knowledge of fundamental concepts in astronomy, geology, and planetary science. Other key components of Project WISER include computer visualizations that simulate planetary motions and explore relationships between the Sun, Earth, and Moon and the development of instructional rock kits that are used in both professional development workshops and in K-12 classrooms. Teachers first use the instructional rock kits (as students) during professional development workshops; they then receive further in-depth training specifically focused on one of the four PSI instructional rock kits prior to classroom use.

Professional Development Workshops: In conjunction with the Tucson Regional Science Center, PSI offers the following professional development workshops: *The Moon-Earth System*, *Exploring the Terrestrial Planets*, *Impact Cratering*, *Asteroid-Meteorite Connection*, *Volcanoes of the Solar System*, *Deserts of the Solar System*, and *Astrobiology and the Search for Extrasolar Planets*. Since September 2008, 193 elementary, middle school, and high school science teachers from 98 schools in Tucson (AZ), Green Bay (WI) and San Antonio (TX) have attended 26 offerings of our workshops, impacting over 12,000 students. Sixty-eight teachers have attended more than one workshop, and 38 have attended three or more of the workshops. Teachers who have participated in our Tucson workshops represent schools with minority student populations ranging from 46% to 95%. Each workshop typically includes 3 sessions (2 focused on content and 1 on pedagogy) and consists of lectures, discussions, experiments, and hands-on activities, with exposure to NASA remote sensing data sets and natural rock specimens.

Instructional Rock Kits: PSI developed four instructional rock kits, described below, to illustrate core concepts in earth and space science and to facilitate understanding of geologic processes and solar system context. We teach fundamental geologic concepts using different suites of rock samples, with

the objective of having teacher and student participants explore and understand relationships between observed rock properties and the associated geologic process(es).

Prior to using a rock kit in their classrooms, teachers are required to complete at least one professional development workshop and a rock kit training session. The workshop provides foundational knowledge of earth and solar system processes and guided use of rock samples via hands-on activities. During rock kit training sessions, teachers receive focused training on a specific rock kit, deepening their background knowledge. They participate in activities designed for classroom use and then engage in metacognitive discussion about how to best foster student learning using the kits.

Impact Rock Kit. The Impact Rock Kit was designed to engage learners in knowledge of impact processes in the solar system at a variety of scales. This kit consists of hand samples gathered at the Haughton (Nunavut, Canada) and Ries (Germany) impact craters during field geologists' exploration of the craters. This rock kit is fully integrated with "The Explorer's Guide to Impact Craters" website [6-7] hosted by PSI (www.psi.edu/explorecraters/), which includes virtual tours of Meteor Crater, Haughton Crater, and Ries Crater, and indicates sample collection sites. Explanation sheets describe sample locations within and outside the impact crater rim, the impact process(es) that led to their formation, and their approximate ages. Related hands-on and classroom activities include 1) an identification activity helping students to recognize characteristics of the samples and the pre-impact rock types at each impact crater, and 2) a classification activity in which students compare and match similar types of impact rocks at the Ries and Haughton impact sites.

Meteorite Rock Kit. The Meteorite Rock Kit exposes learners to processes of solar system formation and evolution and the properties of meteorites. This kit is the focal point for the *Asteroid-Meteorite Connection* professional development workshop. The kit contains a representative selection of differentiated and undifferentiated meteorites, including samples from the asteroids Vesta, Hebe, the Moon, and Mars. Activities involving use of the Meteorite Rock Kit include: 1) *Meteorites in Your Hands*: an identification

activity during which participants in small groups use visual techniques as well as simple tools (hands lenses and magnets) to distinguish real meteorites from terrestrial rocks in the kits. 2) *Edible Rocks*: an activity during which participants “prepare” (cut) an “edible rock” (candy bar) then sketch and describe it in non-food terms. They then examine a real cut and polished meteorite, using the same techniques for description. 3) *Classification of Meteorites in the Kits: Defend It!* Given several meteorites from the kits, participants in small groups use knowledge gained in the workshop to describe characteristics of the meteorite (chondrules, metal flecks, etc.) that justify classification of the meteorite and its source from a differentiated or undifferentiated parent body.

Volcanic Rock Kit. Samples illustrate the main characteristics and diversity of volcanic rocks and provide a means to demonstrate how different volcanic processes are recorded in rock samples. The Volcanic Rock Kit consists of representative rocks from a variety of volcanic settings, including: 1) intrusive igneous rocks and their extrusive equivalents, 2) lava samples of similar composition but with differences in vesicularity, glass content, and crystal content, 3) lava samples of the same composition but different surface texture, and 4) a variety of pyroclastic rocks to illustrate the diversity of explosive volcanic phenomena. Classroom applications for the Volcanic Rock Kit are provided through the *Volcanoes of the Solar System* professional development workshop. Two classroom activities have been developed for this kit: 1) an identification activity helping students to recognize characteristics of the rock samples, and 2) a classification activity in which the students do self-classifications of kit samples and then compare with traditional classifications of igneous rocks.

Deserts Rock Kit. The Deserts Rock Kit, currently under development, consists of representative rocks from a variety of terrestrial desert settings and features rocks collected from the mountains surrounding Tucson and various sedimentary deposits derived from them. This kit is designed for use in the *Deserts of the Solar System* professional development workshop. Activities being developed for this kit focus on the student being able to “tell the story” of a rock, describing the processes that shape desert landscapes including mechanical and chemical weathering, erosion, transportation, and deposition.

Rock Kit Training Sessions for Teachers: Rock kit training sessions are designed specifically to prepare teachers to use the rock kits with their students. Each four-hour session includes hands-on experience with the kits and the activities that have been designed for them, detailed examination of the

rocks in the kits and how they can be integrated into the classroom curriculum, and a discussion of classroom management strategies, safety, and loan procedures. Kits are available for check out for any teacher or informal educator who completes the training.

We are currently developing science background information sheets, kit “maps,” activity directions, and student materials that will be included in hard-copy with each kit. These materials as well as additional support and instructional materials will be provided online at www.psi.edu/epo.

Rock Kit Use and Evaluation: Evaluations of rock kit training session have shown that teachers have increased content knowledge and confidence in engaging students in hands-on activities with the samples. Feedback from pilot training sessions supported the use of content workshops as a prerequisite for the rock kit training sessions to provide teachers with the appropriate content background.

During the first year of use in the classroom, teachers have reported success in engaging students in meaningful discussion and activities focused on the rock samples. The kits have been used with a variety of students in both urban and rural settings.

We have also developed and piloted a new protocol for assessing an individual’s knowledge of geologic processes from rock samples [8]. Participants examine rock samples and are prompted to list key characteristics and from those to formulate the “story” of the rock. Preliminary results show that this assessment is effective at measuring changes in novice understanding of geologic processes following instruction.

References: [1] Lebofsky, L. A. et al. (2010) *LPS XLI*, Abstract #1192. [2] Croft, S. K. et al. (2011) *LPS XLII* Abstract #2661. [3] Croft, S. K. et al. (2012) *LPS XLIII*, Abstract #1485. [4] Buxner, S. R. et al. (2012), in *ASP Conf. Ser.* 457, 221-224. [5] Kortenkamp, S. J. et al. (2013) *LPS XLIV*, Abstract #2575. [6] Chuang F. C. et al. (2005) *LPS XXXVI*, Abstract #2390. [7] Croft, S. K. et al. (2010) *LPS XLI*, Abstract #1460. [8] Berglin, R. et al. (2013) *AGU*, Abstract #ED53F-0682.

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Additional Information: Learn more about PSI’s educational programs and our instructional rock kits at <http://www.psi.edu/epo/rockkits>.