INSTRUCTIONAL ROCK KITS FOR USE IN PROFESSIONAL DEVELOPMENT WORKSHOPS, CLASSROOMS, AND INFORMAL EDUCATIONAL VENUES. S. K. Croft[1,3], A. M. Baldridge[1], S. R. Buxner[1,2], T. L. Cañizo[1], F. C. Chuang[1], D. A. Crown[1], S. J. Kortenkamp[1], L. A. Lebofsky[1,2], [1]Planetary Science Institute, 1700 E. Fort Lowell Rd., Suite 106, Tucson, AZ 85719 (scroft@psi.edu), [2]University of Arizona, Tucson, AZ 85721, [3]Science, Pima Community College, Tucson, AZ 85719.

Introduction: Hands-on learning allows students to understand science concepts through direct observation and experience. The Planetary Science Institute (PSI) is creating a series of instructional rock kits and related informational materials that are being introduced to elementary and middle school science teachers in Tucson, Arizona, through our series of NASA-supported professional development workshops [1, 2]. During our workshops, educators do inquiry-based activities using samples from rock kits relevant to the main workshop topics. The workshops and instructional rock kits instill greater confidence in teachers' abilities to teach earth and space science content.

In addition, PSI provides teachers with supporting materials and training so that they can use the rock kits as tools for students' hands-on learning in the classroom. Use of these instructional kits provides an important experience with natural materials that is essential to instruction in earth and space science and to addressing state and national science standards.

Instructional Rock Kits: We have developed three instructional rock kits and related informational materials that are used for a variety of hands-on activities in our professional development workshops, classrooms, and other educational settings. A fourth rock kit is in development. The kits are available for check-out by teachers desiring to involve their students more deeply in the study of important geologic processes and places in the Solar System, and are also available for loan to museums and other informal educators. Hands-on experiences with actual samples provide students with an understanding of processes shaping rocks on the terrestrial planets and asteroids, as well as practice in the same skills scientists follow in their study of the rocks.

Impact Rock Kit. The Impact Rock Kit consists of hand samples of impact rocks 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 [3, 4] 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 included with each kit describe where within (or outside) an impact crater these samples are found, the impact process(es) that led to their formation, and their approximate ages. Hands-on and classroom activities have been developed for this kit and are presented as part of the *Impact Cratering* workshop and Impact Rock Kit training sessions, respectively. These include 1) an identification activity helping students to recognize the characteristics of the samples and the pre-impact rock types at each impact crater, and 2) a classification activity in which the students compare and match similar types of impact rocks at the Ries and Haughton impact sites.

Meteorite Rock Kit. The Meteorite Rock Kit was initially developed to provide hands-on experience for students as a component of The Explorer's Guide to Impact Craters project. However, the kits have now become the focal point for the new *Asteroid-Meteorite Connection* professional development workshop as an integral part of the hands-on experience for the participating teachers. These kits contain a representative selection of differentiated and undifferentiated meteorites, including samples from Vesta and Hebe. These kits also include a small selection of "meteorwrongs." As a part of the *Asteroid-Meteorite Connection* workshop, we have designed three activities involving the use of the Meteorite Rock Kit: 1) *Classifying meteorites into basic types* (carbonaceous chondrites, ordinary chondrites, achondrites, stony-irons, and irons) using basic features such as color (black for carbon), presence of chondrules, and presence of metal flecks or massive metal. The objective is to let the teachers become familiar with the main meteorite types, their important characteristics, and minerals. 2) *Identifying geologic processes in meteorites* starting with the rock cycle and samples of terrestrial rocks. We emphasize processes relevant to meteorites such as sedimentation, melting and differentiation, and impact brecciation and melting, and show textures and minerals in terrestrial rocks. Teachers then identify the processes that have affected the meteorites in the kits. The objective is to help the teachers connect the meteorites in hand to real asteroidal "parent bodies" in space, such as Vesta, and infer what geologic processes have occurred on these bodies. 3) *Meteorites vs. Meteorwrongs*: a simple search activity in which students learn the distinct characteristics of meteorites from unusual terrestrial rocks using the samples in the kits.

Volcanic Rock Kit. The Volcanic Rock kit consists of representative rocks from a variety of volcanic settings: 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 (i.e., aa, various forms of pahoehoe, and blocky lava), and 4) a variety of pyroclastic rocks (e.g., cinder, spatter, pumice, accretionary lapilli, reticulate) 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 [5]. Two classroom activities have been developed for this kit and are presented as part of the workshop: 1) an identification activity helping students to recognize the characteristics of the rock samples, and 2) a classification activity in which the students do self-classifications of the kit samples and then compare with the traditional classifications of igneous rocks.

Deserts Rock Kit. The Deserts Rock Kit will consist of representative rocks from a variety of terrestrial desert settings and will also feature rocks collected from the mountains surrounding Tucson and various sedimentary deposits derived from them. This kit is being designed for use in the *Deserts of the Solar System* professional development workshop. Student activities are being developed for this kit as well.

Rock Kit Training Sessions for Teachers: We are also developing training sessions for use of the rock kits by teachers and informal educators as a prerequisite for borrowing the kits for use in their classrooms or other outreach events. Each session – a separate one for each kit - will last three hours and include: 1) hands-on experience with the kits and the activities that have been designed for them; 2) detailed examination of the rocks in the kits and how they can be integrated into the classroom curriculum; and 3) a discussion of classroom management strategies, safety, and loan procedures. Teachers participating in the workshops and training sessions will provide us feedback on both the training session and their experience in using the kits in their classrooms; this feedback will help us refine the associated educational materials.

Support Materials; in Kits and Online: We are 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.

Meteorite Rock Kit in an Informal setting.

Impact Rock Kit in a workshop setting.

Volcanic Rock Kit samples.

References: [1] Croft, S. K. et al. (2011) *LPS XLII* Abstract #2661. [2] Lebofsky, L. A. et al. (2010) *LPS XLI*, Abstract #1192. [3] Chuang F. C. et al. (2005) *LPS XXXVI*, Abstract #2390. [4] Croft, S. K. et al. (2010) *LPS XLI*, Abstract #1460. [5] Baldridge et al. (2012) *This Volume*.

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