

EXPLORING IMPACT CRATERS USING INTERACTIVE WEB TOOLS AND ROCK SAMPLES. J.A. Grier¹, E. Pierazzo¹, F.C. Chuang¹, G. Osinski² and D.A. Crown¹, ¹Planetary Science Institute, 1700 East Fort Lowell Rd., Suite 106, Tucson, Arizona, 85719, (jgrier@psi.edu); ²Canadian Space Agency (6767 Route de l'Aéroport, Saint-Hubert, Quebec, J3Y 8Y9, Canada; Gordon.osinski@space.gc.ca).

Introduction: We continue to improve and develop our core activities regarding impact crater investigations for students, teachers, and the general public. Understanding that there are many activities and websites for this subject already in place ([1, 2] for example), we have targeted areas where we can make a unique and substantial contribution to the body of educational material regarding impact craters and how they form. Our crater investigation program is centered on a highly interactive website, "The Explorers Guide to Impact Craters" [3], and is now augmented by physical rock samples that teachers can request on loan from the Planetary Science Institute (PSI; www.psi.edu).

At our poster we will have a computer with our website available for demonstration. We will have one of our 'Impact Crater Rock Kits' as well.

To ensure our materials are properly assessed and reaching their target audiences, we are conducting teacher training workshops and have partnered with the Adler Planetarium and Astronomy Museum (Chicago, IL) to create a physical model of a crater for use with students and tour groups. Our ongoing work includes an expansion of the computer simulations tool, the development of grade-appropriate user guides for teachers, and new teacher training opportunities. Evaluation and assessment is ongoing. We invite feedback from the science community, teachers, and the general public; visit the 'Feedback' section of our website.

A Unique Contribution: Impact craters are formed by dynamic processes, the story of which engages all age groups. The topic provides an interesting and valuable learning opportunity that involves both Earth and Space Science standards [4] and Benchmarks [5] for middle and high school students. Not surprisingly, there are several resources available to initiate one into the subject matter. We therefore moved to find key, unrepresented areas of impact crater education, and areas which lent themselves to the expertise and research programs of PSI scientists and staff. Our education program therefore concentrates on interactive tools unique to our research; the virtual crater tours offer in-depth views of how scientists study terrestrial impact craters, as well as interactive explorations of impact craters through state-of-the-art computer simulations.

'The Explorers Guide to Impact Craters' Interactive Web Tool: The cornerstone of our education program on impact craters is our interactive web site, 'The Explorers Guide to Impact Craters' (found at <http://www.psi.edu/explorecraters/>). The site contains several tools. Many of these tools are to be improved or expanded in the next year as a response to evaluation and to better address misconceptions in planetary science [6]. Visitors can explore impact craters through: background reading (introduction and FAQs, in place), grade appropriate guides (in development), virtual tours of impact craters (in place), probing of computer simulations (in place, but will be dramatically augmented over the next year), the 'Ask an Expert' section; as well as downloads and weblinks related to the site.

Feedback thus far has been constructive and often very positive. One submitted comment reads, "This is fantastic. I spent over 3 hours on a perfectly good Saturday morning enjoying the virtual tour of the Barringer Impact crater, clicking each link and learning more and more about a subject that has fascinated me ... I've only scratched the surface here and will be back ..."

Virtual Tours. Over the last year, the virtual tours of impact craters have been completed, although we continue to refine them using assessment data. Three tours are offered; Barringer (Meteor) crater (AZ, USA), the Ries crater (Germany), and the Haughton impact structure (Devon Island, Canada). In a virtual tour, the visitor is first presented with an overview of the crater, and a map showing sites that they will visit. These sites are those actually visited by scientists engaged in research at these craters. While there, the scientists collected samples, took pictures, and occasionally short movies. Each site on a tour may include looking at these pictures or movies, reading supporting text, and considering questions for thought. As the visitor moves from site to site, they build up an understanding of the crater much the way a scientist does. Subjects do not just include data about the crater itself, but what it is like to be a scientist exploring these environments (allowing the visitor a better appreciation of science as a career.) The tours can be augmented by use of the 'Impact Crater Rock Kits' available for request.

Computer Simulations. The 'Simulations' tool allows a visitor to engage with cutting edge impact simu-

lation data. Present on the site now are background text and the output of several simulations showing how speed, impact angle, and other variables effect the formation of an impact structure. This section will be completely overhauled in the coming year. We will run a larger number of simulations, covering a wider range of variables. These will be presented on the site such that a visitor will input the values for variables and then be presented with the data from a run that matches their request. This will then become a 'virtual simulation' for the visitor, allowing for a more inquiry-based exploration of the relationship between impact processes and impact crater formation.

Ask-An-Expert. Our site includes an opportunity for visitors to submit questions to our impact crater specialists. While we do offer a comprehensive FAQ (constantly updated), the chance to interact in this way with scientists is another avenue for making the process of science, and science careers, more real and relevant for visitors. It also is another means for evaluating the site, as it gives us the opportunity to see where questions develop and where they do not. Consistent with recent education research, we feel it is far more important to get a visitor asking interesting questions than answering questions they didn't know they had. This is more effective in addressing misconceptions related to the subject matter [7].

Rock Samples from Impact Craters: Our program now includes the opportunity for teachers to request an 'Impact Crater Rock Kit'. These rocks are actual samples of impact craters, collected while scientists were on site. Used in conjunction with the virtual tours, the kits make the tours more hands-on. As visitors reach certain sites on their tours, a rock can be matched to the site. Visitors can see where the rock was collected, and use a brief guide provided with the kit to understand what scientists learn from the rocks. The kits can also be used independent of the website as a support for other activities. For example, the rocks can be used in an earth science setting, comparing them to other rocks that have not been affected by impact alteration.

Teacher Training: Over the next two years, we will be adding new teacher training to be conducted at local workshops and at national and regional teacher conferences (e.g. National Science Teachers Association Meetings). We believe that teacher professional development is a key aspect of an effective education program to increase the capacity of teachers in STEM (Science, Technology, Engineering and Math) subjects, to ensure the effective use of materials we produce, and to provide opportunities for additional evaluation and piloting of our site and activities. Our teacher training is grounded in the principles of [8].

These training sessions will include general teacher professional development surrounding earth and space science, with an emphasis on the use of the Explorer's Guide website and rock kits, as appropriate.

Museum Partnership: Our program includes an aspect of informal education carried out with our museum partner, the Adler Planetarium and Astronomy Museum. We continue to work with the Adler to create a tactile, three dimensional model of an impact crater that can be used as a learning aid in conjunction with student tours and teacher training held in their Solar System Gallery. The model in creation is designed from highly accurate maps provided by PSI, and will link directly to rocks from the Rock Kit, which will be on hand with the crater during tours. Additionally, we have plans to expand our partnership to include more of these demonstrations, and to add value to teacher professional development opportunities they conduct. The Adler will also be providing evaluation and assessment information on certain materials produced.

Community Feedback: We invite and appreciate feedback on all aspects of our program. The 'Feedback' area of our website can be found at (<http://www.psi.edu/explorecraters/feedback.htm>). This form can be used to comment about the site directly, or if you have any other feedback or comments on related sites, education, teacher training, etc. We are especially interested in ideas on how to improve our products, and how we can expand our reach, distribution, and effective use of these products.

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References:

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