A TALE OF TWO DESERTS: THE SOUTHWESTERN U.S. AND MARS IN THE CLASSROOM

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Overview

"A Tale of Two Deserts" is a set of educational exercises that introduces educators, students and the public to water-formed features in desert environments on Earth and potentially similar landforms on Mars. These computer-based exercises familiarize educators and students with landforms important to NASA's "follow the water" strategy for Mars exploration to help them share more actively in the discoveries from ongoing and future Mars missions. The exercises are student-centered, inquiry-based, and have been designed in direct alignment with state and national science teaching standards (e.g., the National Research Council's National Science Education Standards. Educators may determine which portions of the NSES are being covered by particular sections of the exercises by clicking on an icon.

The exercises synergistically combine satellite images of desert landforms on Earth with those from recent Mars missions (e.g., Mars Global Surveyor and Mars Odyssey), and climate data from Earth and Mars to allow users to explore the stability of water on both planets, as well as the landforms themselves. A hands-on model-building exercise is also included, that gives students the opportunity to create an analog landform of sedimentary strata and then erode it with simulated "wind" and "rain".

Due to the large size of the exercise files, standard distribution has been via CD-ROM. However, the exercises will also be made available online in English and Spanish at http://europa.la.asu.edu by following the links to the educational exercises page.

Background

Access to spacecraft images of planetary landforms, particularly those on the surface of Mars, has become increasingly easy through the Internet. Beginning with the Mars Pathfinder mission in July 1997, NASA has been posting images to the Worldwide Web within hours to days of acquisition. This has produced a wealth of images for educator use, but typically with little or no information to tie these images to comparable-format images of similar landforms on Earth. Indeed, a web search for "sand dune is likely to turn up more "hits" for Mars mission data than for earth-based information. In addition, most images of Earth available on the Web are in color; they often have little or no annotation providing scale information, and are commonly surface- rather than aerial- or satellite-based images. This has historically made it very difficult for educators to fully utilize the wealth of the Mars images in their earth and space science courses, for lack of directly comparable terrestrial images that help illustrate that features being called sand dunes on Mars really *do* look like those seen in deserts on Earth. Our project seeks to help fill this void.

Goals and Objectives

The goal of this project is to create a unique, innovative and user-friendly set of standards-based educational exercises that will encourage teachers to incorporate new NASA Mars image data into their science lesson plans. The project seeks to introduce educators, their students, and the general public to water-formed features in desert environments through image analysis of both the desert southwest of the United States and of Mars. The activities familiarize educators and their students with landforms seen in desert landscapes that are key to Mars exploration in NASA's "follow the water" strategy. This is intended to increase the ability of teachers and students to "share in the discoveries" being made by current and future missions to Mars. A leveraging goal is to train educators in remote locations via videoconference.

The objectives of this project are to create the exercises, then train a core group of approximately 20 "master-teachers" from grades 9-12, primarily from underserved or underrepresented school populations, in image analysis and the use of the exercises.

Overview of the Exercises

The series of exercises is image-based and covers the types of erosional and depositional landforms commonly seen in desert environments on the Earth, with primary focus on localities in the Mojave Desert of California and adjacent areas of Arizona, Nevada, Utah and New Mexico. We compiled grayscale aerial images of such landforms as sand dunes, playas, alluvial fans, and eroded mesas, at resolutions

from 16 m/pixel down to 2 m/pixel (the approximate scale of high-resolution images from Mars Global Surveyor). The primary image source used for this project is USGS grayscale aerial photography accessed via the clearinghouse-style "Terraserver" website at http://terraserver.homeadvisor.msn.com.

Examples of features in or adjacent to major southwestern metropolitan areas (e.g., Phoenix, Tucson, Las Vegas, Albuquerque, and El Paso) have also been included. All terrestrial images have been keyed to a clickable map of the desert southwest. A second version of this base map allows access (at the click of a button) to historical climate data for each of the imaged locations. An illustrated discussion of water stability on planetary surfaces is also included, with an fully annotated water phase diagram as its core component. Users are asked to evaluate landforms and climatic conditions to determine the likely origin of features seen in the images and to determine if (and in what form) water is stable at the surface in each location. Similar clickable maps of Mars have also been included, allowing users to explore nearly two dozen selected locations on Mars that illustrate landforms and processes analogous to those seen in deserts on Earth as well as (using derived data from Mars Global Surveyor) local surface conditions near each Martian site. Users are asked to compare Mars landforms with terrestrial features and to evaluate the stability of water at each location. Both open-ended and focused questions are provided at key points throughout the exercises, as well as suggestions for "teachers as guides" and indicators of student success.

The physical modeling portion of the exercise provides step-by-step directions for construction and general guidelines for the erosion component. This allows educators and students to customize their model experience, including options such as more extended erosional periods, time-lapse photography, and different eroding elements (e.g., more or less acidic "rain"). Users are asked to evaluate the likeness of the model to landforms seen in the terrestrial images, as well as the relative importance of water and wind as erosional agents. The model-based exercise results in both realistic processes (weathering, erosion, transport, sorting, and deposition) and landforms (e.g., erosional channels ending in fan-shaped sloping piles of alluvium), and uses inexpensive, easily obtainable, non-toxic materials.

Results

To date, over thirty educators have been introduced to and trained in the use of the exercises; copies of the exercises have been distributed to several more teachers. A videoconference was conducted with a group of high school teachers at the University of New Mexico in Albuquerque, organized by Dr. Horton Newsom. The videoconferenced seminar was coordinated through NASA's Astrobiology Institute, through the Astrobiology Program at ASU directed by Dr. Jack Farmer. The initial use and feedback period for the exercises is taking place during the winter of 2002-03. The final version of the exercises, which includes a Spanish-language version, is being compiled and will be available for general distribution by March 2003.

Summary

Through the use of comparable images of desert landforms on both the Earth and Mars, these computer-based exercises provide a unique resource for educators to use in their earth and space science classrooms. High-resolution images of water-, gravity- and wind-formed features on both Earth and Mars, combined with data on the climatic conditions at each site are presented to the users in an image-based format. The inquiry-based nature of these exercises encourages users both to explore the existing exercises and to delve further into the subjects covered. The model-building portion of the exercise provides for a student-centered hands-on/minds-on learning experience. Synergistic combination of several complementary, multidisciplinary datasets allows students to cover areas within the fields of physics, chemistry and meteorology, in addition to the primary geological focus of the exercises. The exercises are viewable with standard web browser software (Netscape or Internet Explorer, with Flash plug-in) on both PC and Mac platforms. Initial distribution of the exercises to educators has been via CD-ROM, but they will be available for download by March 2003 at http://europa.la.asu.edu/epo/activities.html under the link labeled "A Tale of Two Deserts". Comments, inquiries and requests for copies of the exercises should be sent to the authors at kadel@asu.edu.