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Interactive 3D Geologic Maps

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Abstract: A goal of introductory geology and structural geology courses is to teach students how to understand and visualize geologic maps. Students are asked to recognize how geology and topography interact, visualize geology in the subsurface, and reconstruct geologic history from maps and cross sections. Traditional geologic maps, which show the distribution and orientation of rock units and geologic structures at Earth's surface, have long served as effective tools for conveying spatial geologic information, but the three-dimensional aspects of these maps are commonly difficult for students to visualize. Also, students have great difficulty focusing their concentration on individual aspects, such as contacts, structural geometries, and topographic contours
We have taken traditional geologic maps to the next level by adding a third-dimension perspective in order to helps students better visualize the individual components of geologic maps. Interactive 3D Geologic Maps contains QuickTime Virtual Reality (QTVR) movies of geologic maps draped over digital topography. Students can spin the draped terrain around a vertical axis to obtain views from any perspective. Other movies are QTVR panoramas that give students the ability to scroll and zoom in or out on a specific map area. Interactive 3D Geologic Maps have been used in laboratories for introductory geology and structural geology courses with great success.

Keywords: Geologic maps, introductory geology, structural geology, three-dimensional visualization, QuickTime.

Introduction

Geologic maps, in our view, are the most important type of geologic information. Geologic maps provide the basis for exploring for energy and mineral resources, evaluating geologic hazards, and making decisions about land use. Teaching students to understand geologic maps is a fundamental goal of an undergraduate geology curriculum.

We have found that movies and images of geologic maps draped over digital topography provide an excellent way for students to learn how to read geologic maps and visualize the geology depicted on such maps. Interactive 3D Geologic Maps contains QuickTime Virtual Reality (QTVR) movies where traditional geologic maps are transformed into interactive three-dimensional geologic maps. We have generated two types of these movies. In QTVR object movies, students can spin the map-draped geologic terrain 360 degrees around a vertical axis to view the geology and the topography from any direction. In QTVR panorama movies, students can tour an entire 3D geologic map by clicking and dragging on the movie to scroll or zoom in and out on any location. A QTVR panorama of the scanned geologic map, along with a legend, accompanies each map area.

In Quick Time Virtual Reality movies, the student spins or otherwise moves across the map by clicking and dragging the cursor inside the movie. For panorama movies, students can click the + or – buttons in the control bar to zoom in or out of a particular area of interest on the map. Once students have zoomed in on the map, they may click and drag in the movie to pan around to different parts of the map. In object movies, students click and drag left or right to spin the terrain, and can zoom in and out using the control bar.

A significant feature of Interactive 3D Geologic Maps is that students can easily observe how the geology and the topography relate. Another unique aspect of Interactive 3D Geologic Maps is that students can zoom in or out on an area, enabling them to focus on the geology at a specific location.

These interactive 3D maps were created by scanning published geologic maps and draping them over digital topography using Corel's Bryce4. Most of the geologic maps are from the U.S. Geological Survey (USGS); the digital topography files (Digital Elevation Models - DEMs) are from the USGS and were manipulated (mostly converted to grayscale, elevation maps) using MicroDEM written by Dr. Peter Guth. Bryce4 was configured to automatically generate 36, 72, 108, or 144 three-dimensional perspectives (bitmap images) for each map, each image being 800K to 3 Mb in size. These images were combined into a QuickTime Virtual Reality (QTVR) object movie using the program VR Worx. The standard QTVR object movies were derived from 800 X 600 pixel images, and mostly are between 1 and 3 Mb in size. Larger movies have been created from 1600 X 1200 pixel or 1200 X 900 pixel images; these are spectacular, and are available at:

http://reynolds.asu.edu/geomap3d/geomap3d_home.htm.

Use of the Materials

In this contribution, the different types of movies are accessed via the links listed below. The movies are organized alphabetically by location as follows:

Bald Mountain, Wyoming
Laramide (Late Cretaceous to Early Tertiary) uplift in the Big Horn Mountains flanked by Mesozoic sedimentary rocks:

legend
flat map
panorama map movie
spin movie

Calabasas, California
Deformed Tertiary and Cretaceous sedimentary and volcanic units, with numerous erosion features:

legend
flat map
panorama map movie
spin movie

Hollidaysburg Folio, Pennsylvania
(30-minute quad) Amazing folds of lower Paleozoic formations in the Martinsburg area of the Ridge and Valley Province:

legend
flat map
panorama map movie
spin movie

Mescal Mountains, Arizona
Strike ridges and dip slopes of Paleozoic and Precambrian strata; Tertiary normal faults; Late Cretaceous pluton:

legend
flat map
panorama map movie
spin movie

Mingus Mountain, near Jerome, Arizona
(15-minute quad). Basalt mesa; several unconformities; Precambrian structures:

legend
flat map
panorama map movie
spin movie

Sunland, California
Tilted and locally folded late Cenozoic units and older metamorphic and granitic rocks near Los Angeles:

legend
flat map
panorama map movie
spin movie

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