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GeoBlocks 3D - Interactive Geologic Blocks

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Abstract: One of the important goals of undergraduate geology courses is to help students learn how to visualize geologic structures in three dimensions. Students are asked to visualize structural geometries from geologic maps, cross sections, block diagrams, and actual landscapes. Toward this goal, we developed GeoBlocks 3D, which contains interactive QuickTime Virtual Reality movies illustrating the three-dimensional nature of geologic structures within blocks. Students can rotate the blocks, make them partially transparent to view their internal structure, cut through or erode them, displace faults, and more. The movies are designed so that students must be actively engaged, interacting with the blocks by clicking and dragging, either up or down or left and right. The GeoBlocks 3D materials have been used in introductory geology courses and undergraduate structural geology, both with great success.

Keywords: Structural geology, introductory geology, three-dimensional visualization, block diagrams, geologic blocks, QuickTime.

Introduction

GeoBlocks 3D contains interactive QuickTime Virtual Reality (QTVR) movies exploring the three-dimensional nature of geology, specifically geologic structures within blocks. Students can rotate the blocks 360 degrees around a vertical axis, in ten-degree increments. In most movies, the blocks can also be made partially transparent to reveal their internal structure. Some blocks can be cut through from the top or sides, to help students understand successive map and cross-section views. In other movies, fault blocks can be displaced, and the uplifted side can be eroded. For movies with unconformities, the layers overlying the unconformity can be removed to reveal the underlying structure.

QuickTime Virtual Reality movies do not have a control bar – instead the student rotates or otherwise changes a block by clicking and dragging the cursor (left and right, or up and down) inside the movie. Clicking and dragging left and right generally rotates the block, whereas clicking and dragging up and down does some other action, like making a block partially transparent, displacing a fault, or eroding an uplifted fault block.

A key feature of the GeoBlocks 3D movies – something that simply cannot be done on paper versions of block diagrams – is that the student can make the block partially transparent to reveal the internal structural geometry. This ability helps the student understand why a face of the block looks the way it does, by switching the block back and forth from opaque to partially transparent. Students can visualize for themselves concepts that often are difficult to grasp, such as apparent dip.

Another unique aspect of the GeoBlocks 3D materials is that in many movies students can sequentially cut through a block, either from the top or the sides. This permits the student to easily see serial sections along folds or how the outcrop pattern of a geologic structure will change as it is successively eroded downward.

These 3D block movies were created in Corel's Bryce4. To construct these blocks, we used Bryce's abilities to combine objects using boolean functions, for example, having a layer be cut by a block. In this way, complex geologic features could be limited to within a block, and the entire block could be successively cut into by an invisible block to reveal serial sections. Some fold structures were created as objects in other 3D programs and imported into Bryce. Once the blocks were created, a series of camera positions were entered as an animation sequence. Individual images of the block were rendered at each step in the animation sequence. For blocks that rotate, the camera was moved around the block 360 degrees in ten-degree increments; that is, 36 images were rendered of the block to construct the movie. In many cases, the attributes of the block were changed, such as making the block partially transparent, and the animation sequence was rendered again. The sequence of images generated by Bryce were then combined into QTVR movies using the VR Toolbox program VR Worx.

Use of the Materials (linked below)

In this contribution, movies are accessed via the **blocks movie list** page. This page contains links to the different types of movies. The movies are organized by types of geologic structures: layers, folds, faults, intrusions, and unconformities. Links to and a brief description of the types of structures in each category are as follows:

Layers – Two layers with various attitudes: horizontal, gently dipping, moderately dipping, steeply dipping, vertical, and oblique to the side of the block.

Folds – Two layers folded into synclines and anticlines with various plunges: horizontal, gentle, moderate, steep, and vertical.

Faults – Two layers offset by vertical faults with dip slip, strike slip, or oblique slip. In other movies, the fault is dipping and has normal or reverse slip. For some movies, the fault blocks can be displaced or eroded into from the top or one side.

Intrusions – Intrusions of various sorts, including plutons, dikes, and sills. Some movies have cross-cutting relations between intrusions and folds and faults.

Unconformities – Unconformity separating tilted, folded, or faulted layers below from horizontal or gently tilted layers above. For some movies, the layers above the unconformity can be removed.

The movie list page contains links to each type of movie. The movie file names have conventions that contain information about the type of movie, but you will not need to remember these file conventions since there are annotated, direct links to each of the movies. The movie file names start with "b" for block. The next letters indicate the type of structure (l - layer, a - anticline, s - syncline, f - fault, i - intrusion, u - unconformity). The next letter indicates the attitude of the structure (h - horizontal, g - gentle, m - moderate, s - steep, v - vertical). If the file name has a "t", then the block can be made partially transparent. Fault movies may include "up" and "down", "dex" for right lateral, and "sin" for left lateral, followed by a number (20, 40, 60), which relates to the original 3D software we used.

Modules that use these movies are available at:
http://reynolds.asu.edu/blocks/.

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