Virtual Fieldwork in Introductory Geoscience Courses: Approaches and Possibilities

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Abstract

Immersive virtual field environments (IVFEs) are increasingly used in terrestrial and planetary geologic research. Given this trend, incorporating these environments into introductory geoscience curricula is an important step to familiarizing students with how contemporary geologic research is done. As these environments become more sophisticated, realistic, and economical they provide geoscience instructors with an alternative field-like experience whenever budget, time, accessibility, location, or liability limit field opportunities. They also provide a vehicle for preparing students for work in the field. This poster is an examination of current work in technical and educational IVFE design, use, and assessment. It is also a proposal for the development of a series of IVFE that would be used with students taking introductory geology at the undergraduate, high school, and middle school levels. The proposed IVFEs would be 3D digital models of several locations characteristic of Pacific Northwest geology. Each exposure would be designed around selected problems and activities appropriate to introductory level geology. The educational research component of this project would focus on the question of what is involved to construct an authentic IVFE that is meaningful to introductory students.

IVFEs in geoscience research

Terrestrial outcrops

Virtual outcrops are digital models of human scale outcrops created with ground-based LIDAR or photo-modeling software. These models enable teams of geologists to conduct collaborative analysis of field sites, review findings of their peers, and connect local geology with regional geologic structure (Clegg et al., 2005; McCaffery et al., 2005).

Planetary geology

Digital models of planetary sites are constructed from remote sensing data produced from planetary probes. Environments of this type enable planetary geologists to view and analyze surface data from Mars Pathfinder data in much the same way that field geologists would interact with a terrestrial outcrop (Head et al., 2005; Stoker et al.).

IVFEs in geoscience education

QuicktimeVR coastal cliff

This virtual environment is a simple 2.5D representation of a shoreline cliff in southern California. Though it is much less complex than many available virtual field sites, it is unique in that it was constructed and evaluated as part of a geoscience education thesis by a masters student in geology at San Diego State University (Browne, 2005).

Geology Explorer

GE is a role playing game designed to teach several concepts covered in general geology courses (rock and mineral identification, geologic mapping, and stratigraphic interpretation). In this game students play the role of researchers surveying the geology of an earth-like planet. GE is the product of the World Wide Web Instructional Consortium of North Dakota State University in Fargo ND (Slator et al., 2006).

Geowall field site

Faculty at Northern Arizona University (Flagstaff AZ) use virtual field sites in conjunction with a presentation technology called Geowall to prepare students for field camp (Kelly and Riggs, 2006). Geowall is a projection system that enables users to see digital objects and photographs in 3D using pairs of plane polarized images (Kelley and Riggs, 2006).

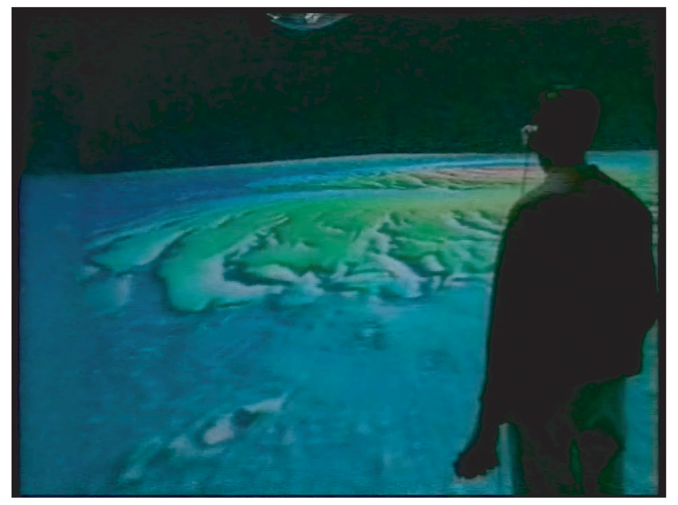
Terrestrial Outcrops

(Left)
Researchers examine a stereo projection of a virtual outcrop. Three dimensionality is acheived by viewing a stereo image pair through polaroid glasses, researchers navigate within the virtual environment using a hand held controller (This is being held by the researcher on the right).

(Right)
A virtual representation of an exposure of Permian Sandstone in NE England. A network of minor fault planes is shown projecting from the outcrop. Once such augmentations are inserted into the model, it can be embedded into models of regional geology to explore links between local and regional geologic structure.

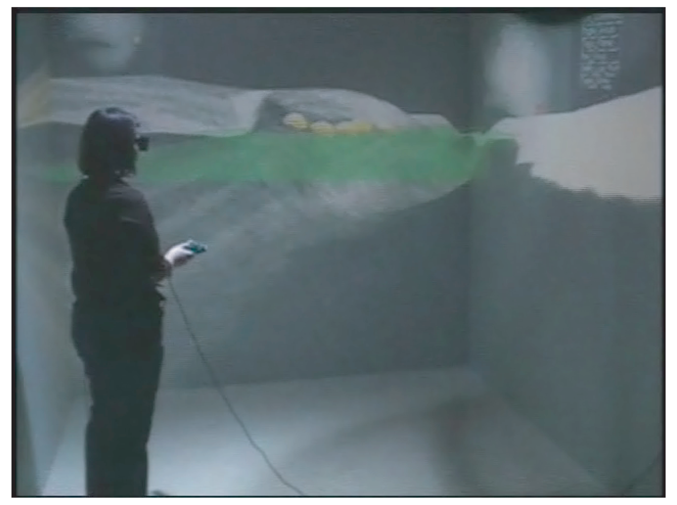
Images from Clegg and others (2005)

Planetary Geology



(Left) A researcher uses the ADVISER visualization system (Brown University) to fly over and examine Mars' north polar ice cap. The image is a polarized stereo pair being projected onto three walls of the visualization theater. Researchers using this system view the image with stereo glasses to see it in 3D. They navigate the virtual environment with a hand-held controller, and gather and view data using a modified PDA.

(Right) A geologist uses the ADVISER sytem to determine the strike and dip of a bedding plane in a Martian outcrop. This system gives users a number of "field" tools that enable them to analyze remote sensing data in much the same way that a geologist in the field would interact with a physical outcrop.



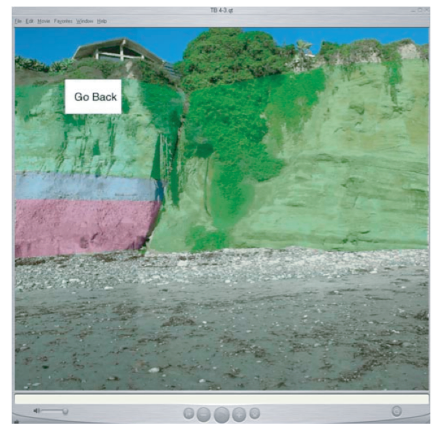
Images from videos prepared by Brown University Planetary Geosciences Group (http://graphics.cs.brown.edu/research/adviser/videos.html)

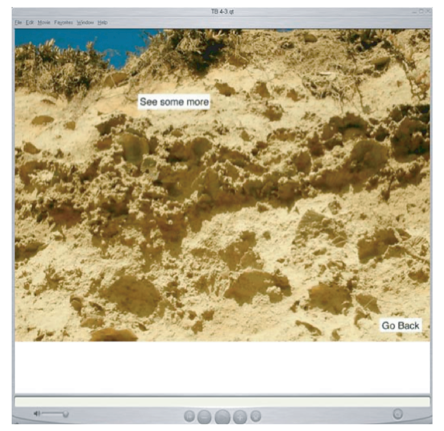
Quicktime VR

(left) A view from a QuicktimeVR environment that gives users a 360° view of a Southern California field site and operates on common desktop computers. Within this environment, users can zoom in on selected points to examine lithology and structure in greater detail (the image on the far right) or call up masks or other augmentations that highlight structural features (the image immediated to the right).

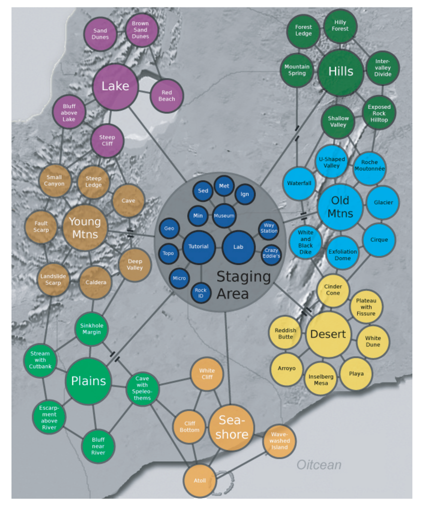
This environment was designed as part of an educational research project comparing student understanding and impression of a field site from physical visits versus interaction with a virtual representation of the site.

Images from Brown 2005





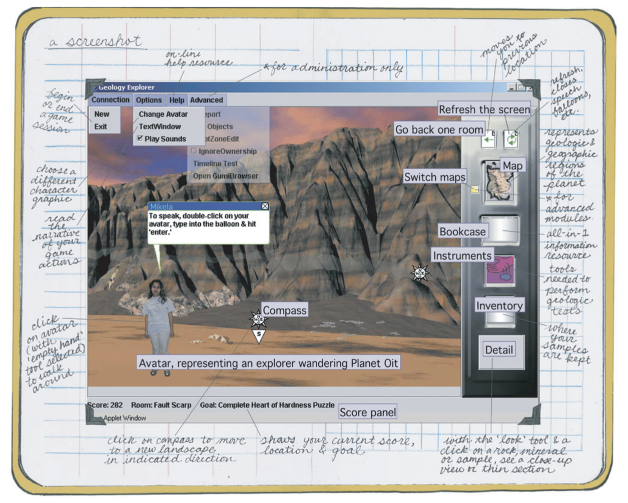
Geology Explorer

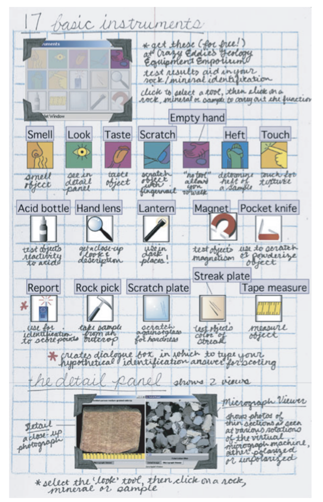


(left) A map of the Geology Explorer virtual world that students use to navigate through the world. Each point in this world is an immersive panorama that allows students to collect and analyze rock samples and map geologic structures.

(Right) Excerpts from an on-line "field notebook" that accompanies GE. The page on the immediate right shows the general structure of an immersive panorama, while the page on the far right explains the field tool kit that users have available to them. The image at the bottom of the page shows a sample with an accompanying thin section that is available at each collection point.

Images from
World Wide Web Instructional Consortium
http://oit.ndsu.edu/menu/





GeoWall Field Site

(left) A scene from a virtual environment used to prepare North Arizona University students for geology field camp. Students navigate to each numbered location, where they describe the rock units beneath each box, mark the location of each box on a 7.5' topographic sheet and color photograph, and mark contact information on the map.

(Right) Students interact with the virtual environment via NAU's Geowall system. The student second from the left is the team driver who interacts with environment via a hand held controller.

Images from
Kelly and Riggs 2006

Instructional design and research questions

Authenticity and data adequacy

- How realistic does the environment appear?
- How similar is what the student does when interacting with the IVFE, to what they would be doing at the actual site?
- What data needs to be imbedded in the IVFE and how should it be imbedded to give the students a somewhat authentic experience?

Augmentation

- What is augmentation?
- How do students perceive different augmentations? (e.g. geologic maps, cross sections, seismic sections, etc.)
- When is augmentation instructionally appropriate?

Adaptability

- How does what students learn from interacting with an IVFE transfer when they visit actual sites?
- Does preparing with augmented IVFEs prematurely "color" students' perceptions of what they are seeing in the field?

Opportunities for research and development

Environment and activity design

A promising approach to designing authentic IVFEs is to make conceptual and behavioral mapping of student and professional field activity part of the development cycle. This type of psychological data would provide IVFE builders with important insight into the interface and data design of these environments.

Integration with geospatial viewers

Another opportunity is to link IVFEs with geospatial viewers such as World Wind and Google Earth. This shows students where sites represented by these environments are, and could also help them to understand the connection between the local geology of the site and regional geology derived from geophysical surveying.

Incorporation into on-line courses

Web delivered IVFEs provide on-line students with an introduction to solving problems in the field, however, there is much to learn about the role of team member collaboration in field work and how this teamwork could be integrated into the generally solitary realm of the on-line learner.

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