The Geoscience Garden: building an outdoor simulated mapping environment for geoscience education

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Summary

The Geoscience Garden, under construction in areas of University of Alberta Campus, consists of large (1 - 5 m) boulders and rock slabs arranged in a landscaped layout that represents the geology of western and northern Canada. The garden provides a simulated field environment in which Earth Science students can develop field observation skills, interpret features of the Earth's crust in three dimensions, and discover Earth history. It will display specimens of mineral deposits in geological context, and illustrate their importance to rural and northern communities. The project adds a unique capability for teaching basic field skills to students in a local environment, and will prepare them for field courses at more senior levels. Initial responses to the Garden have been very positive; students returning from field school report significantly greater satisfaction with their ability to collect basic field data.

Introduction

The disciplines of Earth Science (Geology, Paleontology, Geophysics, etc.) are fundamentally field-based sciences in which much primary data collection and interpretation takes place outdoors. In learning to collect and use these data, geologists must translate essentially two-dimensional visual data into inferences about three-dimensional structures. They must integrate observations made at separate locations, and make deductions about the geometry of units underground. Typically, students learn these techniques from a combination of laboratory-based demonstrations and field schools at off-campus locations. This is especially true for universities that lack bedrock outcrop on campus.

However, the first few days of field school present students with many new experiences, including outdoor work in inclement weather conditions, and, for some, demand unaccustomed physical agility in addition to new mental skills. On-campus opportunities to learn field skills are therefore extremely valuable for teachers of geology as a preparation for the more demanding environment encountered at many field schools.

Why a geoscience garden?

A number of studies (e.g., Orion et al. 1997) have emphasized the importance of field teaching in the Earth Sciences, and its benefits for the acquisition of 3-D visualization skills. Notably, two studies by Dillon et al. (2000) in Canada and Calderone et al. (2003) in the US have shown the benefits of simulated outcrops for student learning. At the University of Alberta, the range of available rocks and structures for teaching is restricted by the university's location on near-horizontal, relatively young sedimentary rocks, which extend several hundred kilometres in all directions. This makes simulated outcrops particularly valuable, particularly if they add to the variety of rock types, orientations, and structures that students encounter.

Installation

A 'Geoscience Garden' containing rock slabs and boulders 1–5 m in diameter, is being developed (Fig.1). The specimens are selected to represent rock-types from in rural western and northern Canada. They are placed in planned locations and orientations (Fig. 2) in the campus landscape so as to simulate natural outcrops in an area that has a pre-defined geological history. The layout includes similar samples of particular rock-types, enabling students to correlate outcrops and thereby identify mappable units. To explain the distribution of units and their features, students must deduce the presence of structures such as folds, faults, and unconformities. By collecting observations throughout the garden (Fig. 3), students will be able to create a simple geological map and deduce a geological history. Specimens from selected mineral deposits will be positioned in appropriate areas to illustrate the occurrence of different types of mineral resources. Plaques identify the sources of the samples, and their relevance to communities, in both English and French. We plan also to bury a boulder containing magnetite, as a target for discovery and modelling by geophysics students.

Figure 1: Installation in progress.

In the completed project, we plan to deliver instructional information via the world-wide web to users with hand-held devices (e.g. iPod touch/iPhone, Blackberry, Android phone). These will enable focussed instruction on field tasks. Visitors to the garden will be able to use their own smart-phones to access a subset of the material, aimed at more general learning objectives. We envisage delivering spoken commentary and instruction, images, and 'virtual reality' similar to the Google Earth Street View experience.

In addition to students in introductory classes, we anticipate visitors from schools and community organizations and teacher-education courses. A brochure for community and school visits will be prepared, including exercises to guide K-12 students through a discovery-based learning experience. In addition, we will prepare on-line support materials for delivery to visitors' smartphones or other handheld devices.

Figure 2: Example of installed sample.

Figure 3: Mapping class using the Geoscience Garden

Evaluating effectiveness of the Geoscience Garden

Pre-, syn- and post-installation surveys are in progress, to evaluate the effectiveness of the installation. Two surveys have been executed to date. Results from the pre-installation survey), though generally expressing high satisfaction with the Field School experience, showed a strong desire for prior practical experience with field techniques. Of 30 respondents, 13 made suggestions for increasing the practical content of the on-campus structural course that precedes Field School, showing the need for a facility such as the Geoscience Garden.

A second survey was completed in 2009, by students who took one lab in the developing Geoscience Garden, then with only 5 boulders of limited diversity. Despite this limitation, many respondents commented favourably on the Garden. A much higher proportion (56% compared with 32% in 2008) found the on-campus course 'essential' as a preparation for Field School, and a lower proportion (15% vs. 28%) found it 'moderately useful' to 'not useful'. This contrast extended to all subdisciplines for which the question was asked. Answers to "open" qualitative questions showed that respondents felt better prepared in basic field skills such as measuring the orientations of geologic features, though they still felt they had weaknesses in making geologic maps and cross sections; in this regard, several students made suggestions for expanding the Garden by including a greater diversity of rock types, with more geologic structures, and by including rocks spread over a wider area of campus.

Conclusions

The Geoscience Garden will be a major feature of the campus landscape. In addition to contributing to the learning of undergraduates in geoscience programs, we intend that it will provide an esthetically pleasing outdoor environment in which members of the university community and the public will be able to increase awareness of Earth history and their geological heritage.

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