Geoscience Garden: An outdoor teaching installation at the University of Alberta

Project Goals

Need for a field teaching installation

The disciplines of Earth Science (Geology, Paleontology, Geophysics, etc.) are primarily field-based sciences in which much data collection and interpretation takes place in the field. Students have to learn to translate essentially two-dimensional visual data into inferences about three-dimensional structures. They must integrate observations made at separate locations, and make inferences about the geometry of units underground.

A number of studies (e.g., Orion et al. 1997) have emphasized the importance of field teaching in the Earth Sciences, and the benefits of field teaching for the acquisition of 3-D visualization skills. Notably, 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.

Because of the importance of these techniques, field courses are an essential part of all geology, environmental Earth science, and paleontology programs throughout Canada.

At the University of Alberta, field and map-based work begins in first-year courses: EAS 100 Planet Earth includes a field trip to the North Saskatchewan River Valley, and EAS 105 includes work on geological maps. These introductory courses are followed by an intensive course in 2nd year (EAS 233 Geologic Structures and Maps), in preparation for EAS 234 Geology Field School, a 10-day field course in which students make geologic maps based on observations in Jasper National Park, and interpret the 3-D structure by constructing cross-sections.

These courses are subject to a number of limitations. In 1st-year classes, the range of rocks and structures is severely limited by the University's location (on near-horizontal, relatively young sedimentary rocks). The many students in our 1st and 2nd-year classes who study in programs outside EAS are not able to see most rock-types in their natural geological context.

Students with restricted mobility are similarly limited. Although we have historically obtained support for disabled specialization students to attend field school, non-specialization students (e.g., in Education or Engineering) with mobility disabilities are typically unable to obtain field experience beyond EAS 100.

For 2nd-year students, translating the knowledge from EAS 233 into field observations and measurements in EAS 234 is challenging, especially as EAS 234 is conducted in unfamiliar terrain, often under adverse weather conditions. In addition, students' varying levels of fitness mean that groups become spread out while working, making it more difficult for instructors to give guidance.

An additional need exists in the outreach role of the department, which hosts, in its museums and other activities, numerous visits from school (k-12) groups and members of the public. At present, these visitors experience Earth materials (rocks, minerals, and fossils) in museum displays. These provide an excellent view of exeptional specimens but do not provide insights into the field aspects of Earth Science, and, for the most part, do not allow 'hands on' experience.

Proposed installation

To help overcome these challenges, we propose a 'Geoscience Garden' containing rock slabs and boulders 1–3 m in diameter, in a landscaped area. Specimens will be selected to represent rock-types present in rural western and northern Canada. Specimens will predominantly be obtained from active quarry locations, but sample collection from privately owned land will be considered if appropriate agreements can be reached with landowners. All applicable environmental regulations and impacts will be considered in sample selection.

Once delivered, samples will be placed in planned locations and orientations in a self-contained area within which students can create a simple geological map and discover a geological history. Specimens from selected mineral deposits will be positioned to illustrate the occurrence of different types of mineral resources. Plaques will identify the sources of the samples, and their relevance to communities, in both English and French.

Criteria for measuring the success of the project

A baseline survey of student perceptions of field teaching will take place at the start of the project (August-September 2008). Post-implementation surveys will be carried out in 2009-2011.

The baseline survey will ask students to rate their satisfaction with EAS 233 (Geologic Maps and Cross-Sections) as a preparation for 234 (Field School) and to comment on how EAS 233 prepared them for the field experience. A presentation or poster at Festival of Teaching and Learning in January 2009 will report on the results of this baseline survey, and on progress in installation of the garden.

The post-implementation survey will ask the same questions, followed by additional items specifically about the developing garden. The success of the project will be measured by comparing student responses between the pre and post-implementation surveys.

A third survey instrument will be devised in order to evaluate student perceptions of teaching that uses the installation in EAS 100, Science 100, and other courses. The objective will be to determine to what extent students consider the field component of EAS 100 adds to their understanding of the course material.

Once the installation is completed, outreach visitors to the department's museums will be surveyed to determine whether they visited the garden and what they gained from it.

The success of the project in supporting EAS 233 and 234 will be measured by comparing student responses between the pre and post-implementation surveys, given to students upon completion of EAS 234. The success of the project in supporting EAS 100 and Science 100 will be evaluated by comparing numbers of positive and negative responses from students taking the second survey.

The success of the project for outreach will be evaluated in the third survey, by determining the percentage of outreach visitors who experienced the garden, and from the percentage of respondents who consider that the garden added positively to their experience. 50% of respondents will be considered a success in each case.

Definition of concrete objectives

In the *phase 1*, boulders acquired from landscaping companies will be placed in temporary locations adjacent to the Earth Science Building.

These boulders will be used in the 2008-9 academic year to provide a preliminary field experience to students in EAS 233.

Also in 2008-9, in consultation with university landscaping and planning departments, locations for boulder storage and final installation will be defined for the following phases of installation.

In the *full project (phase 2 and 3)*, the following physical components are envisaged:

- Igneous and metamorphic 'basement': samples representative of the Canadian Shield;
- Sedimentary rocks representative of Western Canada Sedimentary Basin;
- Mineral deposit samples: specimens representative of major mineral deposit types placed in alignment with rock types in which they primarily occur;

Additional fund-raising will be necessary, depending on the sizes of boulders, the success of efforts to recruit donors, and the distances and costs of transportation and installation. Approximately 45 samples will be acquired, over the total period of 3 years, from 2008-2011. The timing of development around the Centennial Centre for Interdisciplinary Science dictates that samples acquired early in this process must be stored and used in a temporary location, prior to final installation and landscaping.

The following physical components will be installed in the last year of installation

- Identifying plaques in both English and French;
- A buried boulder for discovery by students using geophysical techniques;
- Wireless internet will allow video transmission to a classroom, where large class-size makes this an effective means of instruction.

By 2012, The Geoscience Garden will become part of the initial field trip undertaken by students in EAS 100. Students in EAS 105 will also use the garden to learn to make measurements of strike and dip. The installation will become the focus for an introduction to geological mapping in EAS 233. Other EAS classes which may benefit include the following:

- EAS 110 Earth Science Field School;
- EAS 201 Earth Science I;
- EAS 209 Geology of Western Canada and the National and Provincial Parks;
- EAS 210 Engineering Earth Science;
- EAS 222 Stratigraphy and Sedimentation.

Also, in the Human Geography program, students in EAS 192 (Cultures, Landscapes and Geographic Space) will be asked to do a landscape interpretation of the garden, and students in EAS 392 (Research Methods in Human Geography) will collect and interpret data on educational and leisure usage, visitors, and interpretations.

Research

The research component of the project will evaluate user responses to the Geoscience Garden as it is developed. This will be achieved by pre-post evaluation questionnaires, administered to equivalent groups of students, in successive years, who took courses before, during, and after completion of the installation. Outreach users of the facility will also be surveyed. Results of all

questionnaires will be analysed as part of student projects in the Human Geography program. Summary results will be presented to geoscientists and educators both within the University and disseminated by conference presentation and journal publication.

Questionnaires

A pre-installation, baseline survey of student perceptions of field teaching will take place in the fall of 2008. To evaluate the effectiveness of the installation in EAS 233, the baseline survey will ask all students who participated in EAS 234 (Field School) to rate their satisfaction with EAS 233 (Geologic Maps and Cross-sections) as a preparation for EAS 234 and to identify parts of EAS 233 that related best to the field experience. Post-implementation surveys will be carried out in 2009-2011. The post-implementation survey will ask the same questions, followed by additional items specifically about the developing garden. Positive responses will indicate a successful contribution. Survey results will be used in planning both the final installation layout, and the content of EAS 233.

A third survey instrument will be devised in order to evaluate student perceptions of field teaching in EAS 100 and Science 100. The objective will be to determine to what extent students consider the field component of EAS 100 adds to students' understanding of the course material.

Once the installation is completed, outreach visitors to the department's museums will be surveyed with a fourth questionnaire to determine whether they visited the garden and what they gained from it. Positive responses that indicate visitor engagement with the facility will be used to evaluate the success of the outreach program.

All student surveys will be voluntary, and the uses of the collected information will be stated to students. They will be administered by student assistants after the regular (IDQ) course evaluation process. Appropriate ethical statements will be submitted for research on human subjects. (IDQ data will not be used in research evaluation, consistent with University ethical guidelines.)

Dissemination

The results of these surveys will be analysed as student projects in the Human Geography program. Results will be presented in an illustrated lecture or lectures within the University (at the festival of teaching and learning).

In addition, a presentation to the Education section of the *Geological Society of America* at one of its regular sessions at the GSA annual convention, or comparable conference, in fall 2009 outlining the challenges and progress in installation. At least one additional presentation will be made, closer to the completion of the project in 2012, outlining the successes and/or failures of the project as a teaching and outreach tool.

A paper will be submitted to *Journal of Geoscience Education,* or a similar journal, outlining the project and its results as indicated by the analysis of the survey data.

Instructional development

Activities

The following instructional design activities will be carried out by the applicant:

- Introduction and design of a lab session as part of the redesign of EAS 233
- Modification of the design and expansion of this component in EAS 233 in offerings of the course from 2010 - 2012.
- Assisting instructors in other courses to incorporate Geoscience Garden use into instruction.

These modifications will be aimed at the following learning outcomes

- Improved field skills prior to entry into EAS 234 Field School. Students should be able to confidently and reproducibly measure the strike and dip of an arbitrarily oriented surface.
- Improved student perception of the support of EAS 233 for field activities in EAS 234, as indicated by survey results.
- Familiarization of students in other courses with the field basis of geoscience.

Scope of instructional development work

An outdoor 3 hour lab session will be constructed as part of the redesign of EAS 233 in winter term 2009.

The instructional document will be approximately 3-4 pages in length, and will be incorporated in the laboratory manual for EAS 233.

Students will be provided with compass clinometers (already in department field instrumentation equipment store) and will make measurements from boulder samples that are in place by this date. Student results will be plotted on stereographic projection.

Simple answer sheets will be developed by teaching assistants and instructor.

Additional revisions will be undertaken following completion of student evaluation surveys following the winter 2009 course, and in subsequent years.

Instructional goals

These developments will be aimed at the following learning outcomes

- Improved field skills prior to entry into EAS 234 Field School. Students should be able to confidently and reproducibly measure the strike and dip of an arbitrarily oriented surface.
- Student answers will be expected to be:
    - within 5° of the correct orientation;
    - correctly expressed using the right-hand rule convention.
- Improved student perception of the support of EAS 233 for field activities in EAS 234, as indicated by survey results.
- Familiarization of students in other courses with the field basis of geoscience.

Re-evaluation and revisions in subsequent years will be based on the results of student surveys, and on progress in installing boulders in temporary, and eventually, permanent locations. By the time of completion of the facility (2012) the exercise will involve

- Plotting the location of samples correctly on a map
- Plotting and interpreting the distribution of rock types
- Plotting the orientation of structures (bedding, tectonic structures)
- Describing the geological history of the simulated area

Project management

The following tasks, subtasks and milestones are planned for the duration of the project, which currently extends beyond the period of TLEF funding.

Name	Start_Date	Duration	Milestone
FUNDRAISING AND SUPPORT			
Prepare project plan for TLEF	2008-Jun-27	1 wk	No
Obtain access to STLF funds	2008-Jul-7	1 wk	No
Obtain TLEF funds access	2008-Jul-4	1 wk	No
Meet with Claudia Wood on fundraising	2008-Jun-25	1 day?	No
Fix publicity targets & publicity materials	2008-Jun-26	12 wks	No
Seek funds from alumni and other individuals	2008-Sep-18	52 wks	No
Seek in-kind contributions from suppliers	2008-Sep-18	52 wks	No
Re-apply to TLEF	2009-Jan-1	15 days	No
SAMPLES			
Identify possible sources	2008-Jun-24	54 days	No
General permitting rules?	2008-Jun-24	1 wk	No
Refine transportation costs	2008-Jun-30	2 wks	No
Refine loading and unloading costs	2008-Jun-30	2 wks	No
Contact local lanscape suppliers	2008-Jul-2	8 wks	No
Contact landowners	2008-Aug-15	15 wks	No
Contact quarries	2008-Aug-15	15 wks	No
Additional contacts, landowners and quarries	2009-May-11	12 wks?	No
Site visits landowners	2008-Aug-22	15 wks	No
Site visits quarries	2008-Aug-22	15 wks	No
Deliver samples phase I	2008-Aug-27	12 wks	No
Site visits phase II	2009-May-15	15 wks	No
Deliver samples phase II	2009-May-22	15 wks	No
Site visits phase III	2010-May-15	15 wks	No
Deliver samples phase III	2010-May-21	15 wks	No
LAYOUT AND INSTALLATION			
Meet with admin on siting	2008-Jul-3	2 wks	No
Define timelines for full install with PMO	2008-Aug-15	1 wk	No
Refine earth moving costs	2008-Jul-17	6 wks	No
Refine signage costs	2010-Sep-17	2 wks	No
Identify interim location	2008-Jul-17	1 wk	No
Install samples in interim location	2008-Aug-27	100 wks	No
Revise plan depending on sample types	2010-Sep-3	2 wks	No
Permanent site freed by CCIS operation	2010-Dec-31	0 wks	Yes
Install samples in permanent locations	2010-Dec-31	15 wks	No
Install signage	2011-Apr-15	8 wks	No
TEACHING AND OUTREACH			
Design new components for EAS 233	2011-Apr-15	3 wks	No
Teach EAS 233 2009	2009-Jan-5	12 wks	No

EAS 234 Field school 2009	2009-Apr-27	10 days	No
Teach EAS 233 2010	2010-Jan-4	12 wks	No
EAS 234 Field school 2010	2010-Apr-26	10 days	No
Teach EAS 233 2011	2011-Jan-3	12 wks	No
EAS 234 Field school 2011	2011-Apr-25	10 days	No
Design outreach materials			
EVALUATION	2008-Apr-1	216.8 wks	No
Design questionnaire	2008-Apr-1	2 wks	No
Ethics approval	2008-Apr-15	3 wks	No
Set up with AICT	2008-May-6	1 wk	No
Administer questionnaire	2008-Sep-1	2 wks	No
Evaluate questionnaire results	2008-Sep-15	3 wks	No
Questionnaire 2 additonal questions	2008-Oct-6	2 wks	No
Administer questionnaire 2	2009-May-11	2 wks	No
Evaluate questionnaire 2 results	2009-May-25	3 wks	No
Questionnaire 3 additonal questions	2009-Jun-15	2 wks	No
Administer questionnaire 3	2010-May-10	2 wks	No
Evaluate questionnaire 3 results	2010-May-21	2 wks	No
Questionnaire 4 additonal questions	2010-Jun-4	2 wks	No
Administer questionnaire 4	2011-May-9	2 wks	No
Evaluate questionnaire 4 results	2011-May-23	2 wks	No
Design outreach survey	2011-Jun-10	2 wks	No
Ethics approval	2011-Jun-24	30 days	No
Survey outreach participants	2011-Aug-5	180 days	No
Evaluate outreach results	2012-Apr-13	30 days	No
Talk at festival of teaching and learning 2009	2009-Jan-20	1 wk	No
Talk at festival of teaching and learning 2010	2010-Jan-19	1 wk	No
Talk at Geological Society of America or similar	2010-May-21	1 wk	No
Paper in Journal of Geological Education or similar	2011-May-23	12 wks	No
MILESTONES			
Ethics approval, access to funds	2008-Jul-11	0 wks	Yes
Phase I installation complete	2008-Nov-18	0 wks	Yes
Phase I evaluation complete	2009-Jun-12	0 wks	Yes
Pase II installation complete	2009-Sep-3	0 wks	Yes
Phase II evaluation complete	2010-Jun-3	0 wks	Yes
Final installation complete	2011-Apr-14	0 wks	Yes
Full teaching use	2011-Mar-25	0 wks	Yes
Final evaluation	2012-May-24	0 wks	Yes

References

Orion, N., Ben-Chaim, D., and Kali, Y., 1997, Relationship between earth-science education and spatial visualization: Journal of Geoscience Education, v. 45, p. 129-132.

Calderone, G.J., Thompson, J.R., Johnson, W.M., Kadel, S.D., Nelson, P.J., Hall-Wallace, M., and Butler, R.F., 2003, GeoScape; an instructional rock garden for inquiry-based cooperative learning exercises in introductory geology courses: Journal of Geoscience Education, v. 51, p. 171-176.

Dillon, D.L., Hicock, S.R., Secco, R.A., and Tsujita, C.J., 2000, A geologic rock garden as an artificial mapping area for teaching and outreach: Journal of Geoscience Education, v. 48, p. 24-29.