Course-embedded research and scientific communications in undergraduate geology majors courses: Examples from the Mineralogy – Igneous/Metamorphic Petrology sequence at LSU

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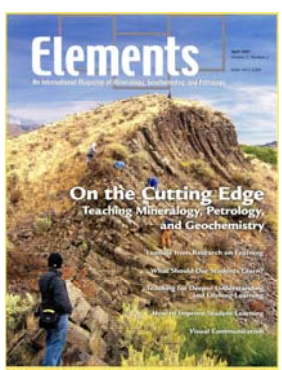
INTRODUCTION

The opportunity for all undergraduate geoscience students to obtain authentic research experiences and to learn effective communication of this research is a powerful means to establish deeper understanding of geoscience topics as well as to engage all students in the culture and practice of research. The purpose of this contribution is to provide an example of an integrated approach that provides a research and communications experience for all geoscience majors within a geoscience curriculum. This undergraduate research and communications experience, realized in the Mineralogy – Igneous/Metamorphic Petrology sequence at LSU, builds on opportunities and resources of the On the Cutting Edge program.

The legacy of "On the Cutting Edge"

Cutting Edge workshops have been and continue to be critical for expanding boundaries of the possible. In addition, Cutting-Edge on-line resources have been particularly useful both for faculty development and student learning.

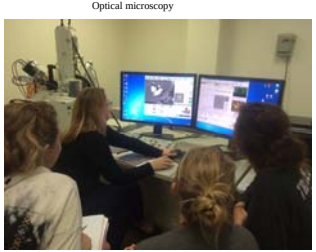


MINERALOGY

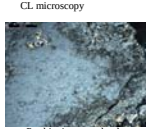
In the required sophomore-level Mineralogy course, crystallographic and physical properties, chemical systematics and 3-D visualization of mineral frameworks are studied. Students are introduced to optical microscopy and optical cathodoluminescence (CL) as tools to discover unique and diagnostic properties of minerals. As a way for these students to explore concepts, to improve spatial mapping from different images, and to put theory into practice, the LSU electron microprobe (EMP) is used to provide a research experience in Mineralogy.

Optical microscopy

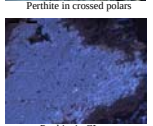
CL microscopy



Backscattered electron imaging on LSU EMP



Perthite in crossed polars



Perthite in CL

In small groups, students collect data on selected minerals for their chemistry, compositional zoning, and alteration, and then calculate stoichiometry. A jig-saw method is used to combine data from different teams to calculate temperatures and pressures. This experience becomes the foundation for research in the junior-level Igneous and Metamorphic Petrology course with a full-fledged course-embedded research project, the Pet Rock Project.

IGNEOUS AND METAMORPHIC PETROLOGY

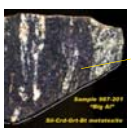
In the full embedded research, the Pet Rock Project, students follow the steps of a practicing petrologist going from megascopic to microscopic descriptions, EMP imaging and quantitative analyses of selected minerals and interpreting data to provide evidence for a coherent story for development of the selected rock. Next, students write a professional petrology-type paper and give a talk to the class.

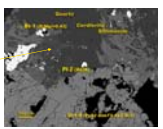
The limited scope of the embedded research project, a single sample from a geologically restricted area, is important because it:

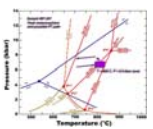
- Provides the entire group of students with a similar research experience i.e. common geologic background and imaging/analytical tools.
- Engenders wide-ranging student-student discussion on many, often open-ended, topics.
- Creates ownership of data by personal acquisition of data and this augments the experience.

Certification of the class as communications intensive enhances the student experience because:

- A clear set of guidelines for writing a geology (petrology) paper was generated (e.g. Henry, 2009b).
- Writing criteria were established and weighted in accordance with their relative importance – roughly half being related to expected components/content and half related to the practice of writing. A similar rubric was established for the oral presentations – about half related to content and half related to presentation skills.
- Guidelines and rubrics are given to students so that there is a clear establishment of expectations.







LESSONS LEARNED

Experience with course-embedded has provided several lessons:

- Have well-formulated rubrics.
- Adjust expectations if equipment fails.
- With larger class size, group projects will likely be necessary. Group projects have their own challenges e.g. dynamics, group scoring, etc.
- Be ready for a transformation in the students.

MEASURABLE OUTCOMES

A measureable outcome of the course embedded research opportunities is the enhanced engagement of undergraduate students in subsequent research, measured by enrollment in research specific undergraduate courses, with geoscience faculty i.e. beginning with 16 in 2002-2004 and expanding to 145 in 2015-2017.

ACKNOWLEDGMENTS

Dave Mogk and the Cutting Edge team are thanked for the inspiration to do better. The ~600 LSU Mineralogy and Igneous-Metamorphic Petrology students who were part of this long-term experiment are thanked for willingness to reach beyond their comfort zones.

RESOURCES

Communication across the Curriculum at LSU (2017): http://www.lsu.edu/academicaffairs/cxc/index.php

Dutrow, B.L. (2007) Visual communication: Do you see what I see? Elements, 3(2), 119-126.

Henry, D. J. (2009a) Rubrics in a Communications-Intensive Geology-Majors Course: Their Roles in Departmental Assessment. Workshop of "Assessing Geoscience Programs: Theory and Practice" "On the Cutting Edge – Geoscience Programs: Developing Pathways to Strong Programs for the Future" series. Carleton College, MN, http://serc.carleton.edu/departments/program_assessment/program.html .

Henry, D.J. (2009) The Pet Rock Project - Developing Professional Communication in a Petrology Course, SERC website, http://serc.carleton.edu/sp/library/communications_curricula/examples/example2.html , Written rubric, http://serc.carleton.edu/files/sp/library/communications_curricula/examples/geol_3041_writing_assignment.doc ; Oral rubric: http://serc.carleton.edu/files/sp/library/communications_curricula/examples/geol_3041_oral_presentation.pdf