**Geological Field Research:**

**An Ideal Course 'Recipe' for Advanced Undergraduate and Beginning Graduate Students**

Yvette Kuiper, Geology and Geological Engineering, Colorado School of Mines

---

**The Recipe**

A Geological Field Research course is an excellent way for students to learn to design and carry out their own (field-based) research. The course is set up in three parts.

In the first part, students write a brief research proposal including hypotheses, tests, and a work plan for the next two weeks. They study appropriate literature and take an introductory field trip to the field area.

In the second part, students prepare a geological map and appropriate cross sections, and write a report presenting rock descriptions, structural analysis, a geological history, and interpretation of results in the context of the hypotheses posed in the proposal. The course can be taught in three weeks as a three-credit course, where each part described above takes one week. It can easily be modified into a longer (but not shorter) course, and/or one that is taught over several weekends and a number of weekday in-class meetings during the semester. It is best if students work in groups of two, not only for safety, but so that they can discuss and learn from each other.

---

**Learning Goals and Outcomes**

Students gain experience in geological mapping and field methods in general, but, perhaps more importantly, they learn how to formulate a testable hypothesis, carry out the research and write a concise and clear report. They also read each other's proposals, and give each other constructive feedback through a mock NSF panel discussion. Furthermore, they learn how to deal with field logistics and to collaborate with their field partners. The effectiveness of the course can be measured through student evaluations that assess course-specific questionnaires at the beginning and the end of the course to monitor students' skills, expectations, goals, and confidence.

---

**Example of mapping and structural analysis (above) carried out by Boston College student Nick Colonis (below), studying normal-sense movement along the Clinton-Newbury Fault in 2014.**

---

**Project Example**

**Eastern Massachusetts Appalachians**

**Student:** Wes Buchanan

**Problem:** The Nashoba terrane in eastern Massachusetts displays a higher metamorphic grade and older cooling ages than its neighboring Merrimack and Avalon terranes. The Nashoba terrane does not show evidence for Alleghanian deformation and metamorphism, while the other two terranes do. How did the Nashoba terrane get exhumed early, but escape Alleghanian deformation and metamorphism? What can we learn from the internal structure of the Nashoba terrane about its possible exhumation history?

**Approach:** Conduct detailed structural mapping and analysis of selected well-exposed areas in the Nashoba terrane to unravel the exhumation and possibly earlier deformation history.

**Outcome:** Asymmetric folds in migmatitic rocks indicate NW-side down, sinistral movement controlled by Paleoproterozoic structures.

**How much did you gain in the following areas as a result of your course results and more?**

- Confidence in discussing scientific concepts with others.
- Comfort in working collaboratively with others.
- Conducting observations in the field.
- Collecting the data needed to answer your research question.
- Confidence in your ability to contribute to science.
- Collecting and analyzing scientific data from a variety of projects.
- Conducting database or internet searches.
- Open questions asked (with very variable answers in 2014).

---

**Benefits**

The Geological Field Research course is ideal for students who will be conducting thesis research involving a significant structural mapping component. Especially students who will be conducting (thesis) research in the area where the course is taught will be well-prepared. Furthermore, the course is an excellent way for the instructor to learn more about the field area. This is in particular useful for faculty trying to start new research projects in an area they are not fully familiar with. Thus, the course serves both students and instructors well, not only because of the learning and teaching experience, but also by possibly enhancing their research. Some of the course projects form the basis of or basis for conference presentations, and possibly more. For example:

- Buchanan, J.W., Kuiper, Y.D., 2013. Preliminary structural analysis of the Nashoba terrane, compiled from the literature by Boston College undergraduate student Keegan Dougherty, and Colorado School of Mines PhD student Wes Buchanan and MSc student Peter Brice, in 2012.

---

**Timeline of depositional, igneous and metamorphic deformation events in the Nashoba terrane, compiled from the literature by Boston College undergraduate student Keegan Dougherty, and Colorado School of Mines PhD student Wes Buchanan and MSc student Peter Brice, in 2012.**

---

**Project Example**

**Colorado Front Range**

**Students:** Patrick Quigley and Tsoilmon Gonghui

**Question:** Do NW-trending Tertiary brittle structures in the Colorado Front Range have a ductile, possibly Paleoproterozoic, component, perhaps related to movement along the Idaho Springs Ralston shear zone? If so, these NW-trending structures, and mineralization along them, may be controlled by Paleoproterozoic structures.

**Test:** Search for ductile deformation along these structures and test whether these structures are truly older shear zones and cannot have been part of the penetrative deformation that is preserved.

**Outcome:** In one outcrop (only...there is evidence for ductile deformation that is not part of the penetrative deformation outside the shear zones and possibly Paleoproterozoic. Thus, the NW-trending faults and mineralization among them may be controlled by earlier ductile (Paleoproterozoic?) structures.