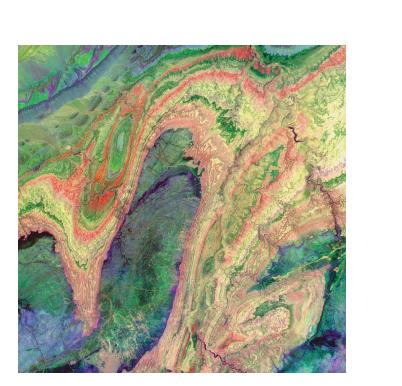


Integrating Applications of Structural Geology in Other Disciplines into Structural Geology Courses

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Only a very small percentage of students in most structural geology courses will become structural geologists. Many, however, will someday use structural concepts and techniques to solve problems in other fields. We can help students see the relevance of structural geology to geological problem-solving, as well as better prepare them for future work in geology and geological engineering, by integrating problems that apply structural geology, but that come from other disciplines, into structural geology courses.



At the recent Cutting Edge workshop Teaching Structural Geology in the 21st Century, we began an effort to seek out and stimulate the development of resources for teaching structural geology that illustrate how the techniques and perspectives of structural geology can be used in solving problems in other disciplines, especially ones that are not traditionally linked to structural geology.

Examples and Current Development Efforts of the Working Group

Structural geology has a large number of straightforward applications to solving problems in other disciplines. Some specific examples are listed below:

Mineral exploration, exploitation

- * What tectonic/structural environments are structurally favorable for mineral deposit formation?
- * What types of dilatant openings can form to host ore? * How can we recognize ore deposits that have been disrupted by deformation?
- * How do structures control the distribution of alteration assemblages locally and regionally?
- * How to characterize the strength and failure potential of mined slopes and openings?

Petroleum exploration, exploitation

- * What tectonic/structural environments are structurally favorable for hydrocarbon deposit formation?
- * What structural traps are possible in petroleum systems? * How can 4-way closure be determined in the subsurface?
- * How can subsurface structure be inferred from surface structure?
- * How can we predict the occurrence and structural character of fractured reservoirs?
- * How do the presence and geometry of various structures (fractures, stylolites, etc.) affect hydrocarbon (fluid) production? * How does rock fabric effect drilling efficiency?

- Engineering, environmental and hydrogeology * How can we determine and characterize the effect of fractures on fluid flow in the subsurface?
- * How can we determine and characterize the effect of fractures and anisotropy on rock strength?
- * What structural studies are important in characterizing nuclear and other waste sites, and construction sites? * How do structures control the dispersion of chemicals in the surface and subsurface environment?

* How do structures control the occurrence and distribution of water resources?

- Geologic hazard assessment (volcanic, seismic, mass wasting) * What are tectonic/structural controls on volcanic and seismic hazards?
- * What structural data are important in hazard assessment? * How can we predict the effects of structure on slope stability?
- * What are the effects of structure (and related fluid pressure) on the occurrence of induced seismicity and slope failure?

Petrology (igneous/metamorphic)

* How can deformation and strain gradients control metamorphic reactions?

* What structural controls affect the emplacement of igneous bodies?

Climate studies

* How can we assess the effects of climate on structure (such as the growth of mountain belts and strain rates of fault slip)? * How can we assess the effects of structure on climate (such as orographic effects)?

Geoarchaeology

* What are the effects of structure on paleo-societies, and on the distribution and character of archeological sites?

Planetary geology

* What can we learn about the structure of terrestrial planets and its application to the study of earth history?

- * How does structure control the architecture and stratigraphic nature of growth packages (fault and/or fold growth
- * How can structure affect the distribution of sedimentary facies, such as string sands which may form in
- structurally-controlled bathymetric lows? * What rheological and kinematic characteristics can be inferred from study of soft-sediment structures (folds, faults,

cleavages, etc.)?

Tectonic studies * How can focal mechanism studies used to infer plate motions and interactions?

* What is the relation of faults and folds to uplift and denudation, and the development of tectonic geomorphology

Glaciology and analog studies

* How can we use studies of ice deformation to infer the rheological behavior of rocks undergoing deformation * How does bedrock structure affect the development of glaciers and ice sheets?

We hope that this list will inspire you to choose examples involving other disciplines when you look for ways to illustrate structural concepts.

Our working group was inspired by these ideas, and members of the working group are currently developing the following activities for use in structural geology courses. As soon as activities are developed, we will post them in the Teaching Structural Geology Resources Collection.

- writing assignment asking structural geology students to develop an essay on how structural geology applies to their field of interest and/or areas of geology that they have studied to date (Barbara Tewksbury,
- an exercise on the interaction between newly-developed joints and geomorphology (*Brian Dade, Dartmouth*
- an advanced exercise applied to petroleum exploration that uses stereonet methods to illustrate borehole data and forward fold modeling (Eric Nelson, Colorado School of Mines) • a modeling exercise to study the phenomenon of crustal rebound and isostasy (Kirsten Menking, Vassar
- a case study on the role of bedrock weaknesses and climate on slope stability in the Virginia Blue Ridge (Zeshan Ismat, Franklin and Marshall College)
- an exercise on evaluating the groundwater potential of fractured bedrock aquifers (*Peter Muller, SUNY* • an exercise using DEM (digital elevation models) to characterize fracture patterns for groundwater flow
- patterns (Dick Enright, Bridgewater State College) • an exercise illustrating the role of structural geology in archaeological site evaluation (*John Dembosky, SUNY*
- a modeling exercise to examine the role of rheology in the flow of glacial ice (*Kirsten Menking, Vassar College*) • a case study of the role of climate in the evolution of structures (*Barbara Tewksbury, Hamilton College*)
- an exercise using remote sensing to study structural controls of karst development (*Dick Enright, Bridgewater*
- State College) • an exercise on determining of the 3D geometry of a contaminant plume (Otto Muller, Alfred University)
- an exercise illustrating the influence of strain history on mineral paragenesis in ore deposits and usefulness in mineral exploration (Jim Welsh, Gustavus Adolphus College)
- a case study of the role of structural geology in evaluation of Yucca Mountain (*John Dembosky, SUNY Geneseo*)
- examples of uses of stereonets in disciplines other than structural geology (Barbara Tewksbury, Hamilton

This assignment is an example of the kind of activity that can be developed to allow students to practice skills in structural geology and also explore the relevance of structural geology to another discipline.

This activity can be downloaded from our Activities and Assignments Collection at http://serc.carleton.edu/NAGTWorkshops/structure04/activities/3699.html

Development of an On-line Resource Collection

Do you have good examples to contribute??

We encourage you to contribute specific ideas to our growing collection of examples that illustrate applications of structural geology to other disciplines.

To submit an example, use our on-line submission form shown at right (information on tear-off sheet below).

You may also view what is currently in the collection at http://serc.carleton.edu/NAGTWorkshops/structure/TSG_Resources.html

On our web submision form we ask you to:

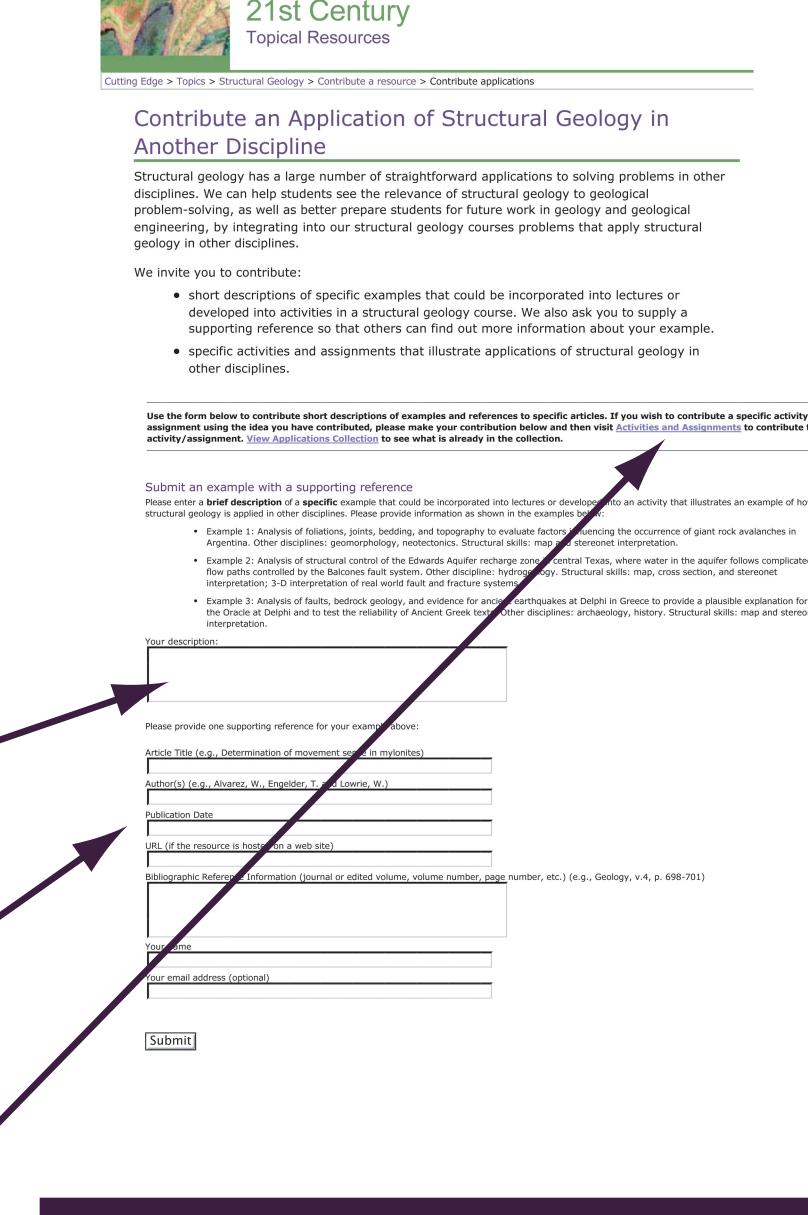
Provide a brief description of a *specific example*, rather than a generic case. We have provided three descriptions as guides for writing your brief description.

List a *single supporting reference* to provide the interested browser with an entrée into relevant background material.

If you already have an activity developed for the topic, submit the brief description and supporting reference, and then submit the activity to our Activities and Assignments Resource Collection.

We hope that you will help us build this collection!

Please tear off one of the sheets at right and take it with you. Go to our web site, and contribute your good ideas.



Want to join our working group? Send an e-mail to Barbara Tewksbury at Hamilton College (btewksbu@hamilton.edu)