ED13E-0913
Monday, 14 December 2015
Moscone South

Using Significant Geologic Hazards and Disasters to Focus Geoethics Case Studies

Vince Cronin, International Association for Promting Geoethics, and Baylor University
Vince_Cronin@baylor.edu or Vince_Cronin@CroninProjects.org

Abstract

Ethics education since classical times has involved the consideration of stories, parables, myths, fables, allegories and histories. These are the ancient equivalents of case studies. Modern case studies are used in applied-ethics courses in law, engineering, business, and science. When used in a geoscience course, geoethical case studies can enrich a student's understanding of the relationships between issues of geoscience, engineering, sociology, business, public policy and law – all with an ethical dimension. Perhaps more importantly, real cases affected real people. Students develop a strong empathetic connection to the people involved, enhancing students' drive to understand the interconnected layers of the cases. Students might begin to appreciate that geoscientists can help to avoid or alleviate human suffering -- that their careers can have meaning and purpose beyond simply earning a paycheck.

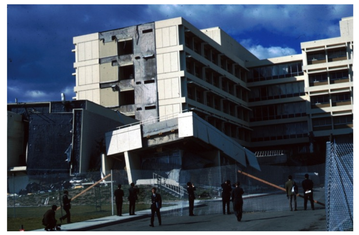
Geologic disasters in which losses could have been predicted, avoided or minimized are quite effective as cases. Coupling a "disaster" case with a comparable "hazard" case is particularly effective. For example, there are many places along the San Andreas Fault in California where [1] significant coseismic displacement has occurred during historical times, [2] structures that are still inhabited were built along or across active traces prior to the Alquist-Priolo Earthquake Fault Zoning Act in 1971, and [3] inhabited structures have been built legally since 1971 within a few tens of feet of active traces. The question students confront is whether society ought to allow habitable structures to be built very near to a major active fault. This topic allows students to work with issues of law, history, seismology, seismic site response, crustal deformation adjacent to active faults, building codes and, ultimately, ethics. Similar progressions can be developed for other major geologic hazards, both natural and man-made, such as floods, landslides, erosion along rivers and coastlines, subsidence caused by fluid/gas withdrawal, induced seismicity, and pollution due to extractive industries. Case study sources are available via http://CroninProjects.org/Vince/GeoEthics/ and SERC has a growing collection of useful case studies (*e.g.,* http://serc.carleton.edu/geoethics/case_studies.html).

There doesn't seem to be a very strong connection in the public mind between science and ethics. The ethical practice of science is of fundamental importance to the entire scientific enterprise. In science, reproduciby observations with their associated uncertainties, and the tested but not-yet-falsified descriptions of relationships between these observations, are the basis of our understanding of truth. And only truth has meaning.

Geoscience educators have the opportunity to reduce these problems in the future through choices we make about content and approach in our geoscience courses. Virtually all of us begin the process of becoming geoscientists in college, and yet in American colleges there is virtually no discussion of the ethical dimension of our work. We should strive to change this silence.

I have students work with case studies that have an ethical component. Here is an example.

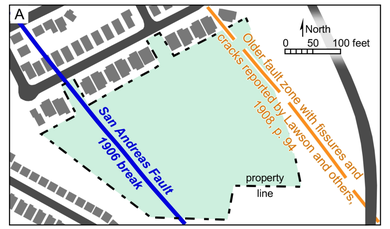
After the disaster of the San Fernando Earthquake in 1971, the State of California began to enact statutes and policies to better protect its people from earthquake-related hazards. It established special study zones around the ground-surface trace of faults that are known to have caused surface rupture within the last ~11,000 years. Development within a special study zone requires a detailed site investigation by a geologist licensed by the State of California, and a plan that ensures that no habitable structures are built across an active fault.



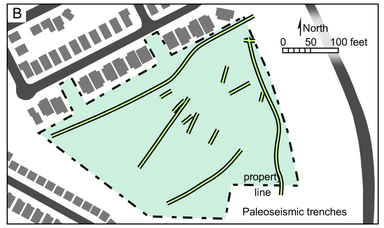
Olive View Memorial Hospital, Sylmar, California. Destroyed with lives lost in the M 6.4 San Fernando earthquake of 1971.

The site for our case study is in the town of Pacifica, just south of San Francisco and within the San Andreas Fault Zone. The approximate area of the maps that follow is shown in the white box. The San Andreas Fault Zone is aligned with the yellow arrows.

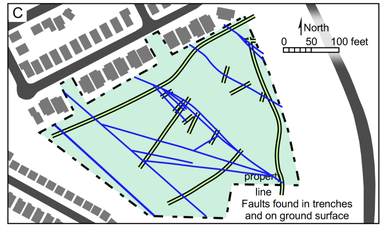
A developer wanted to build houses on a small undeveloped area within the special study zone of the San Andreas fault in an area that experienced ~4 m of right-lateral displacement during the 1906 San Francisco earthquake. Prior to 1971, houses were built directly on the trace of the San Andreas in this area.



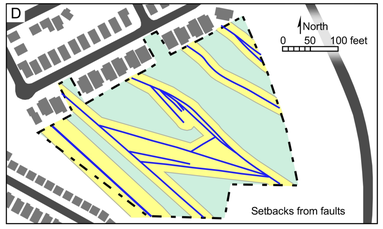
The developer hired geological consultants to review the historical data and to conduct a pre-development site investigation.



The geological consultants excavated trenches across suspected fault traces.

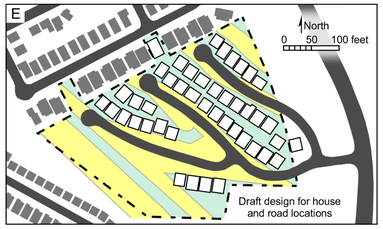


Through trenching and ground-surface mapping, the geological consultants located the main trace of the active fault as well as other minor fault splays.



A design was developed that established a ~15 m setback from the main trace, and a ~9 m setback from the minor splays.

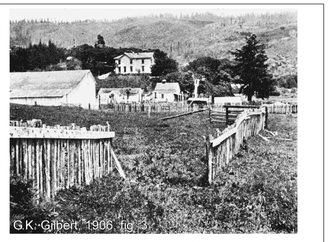
Using the average size of other houses in the area as a guide, the developer created a design that maximized the number of new houses that could be built on the property without intruding on the setback zones around the fault traces. Access roads were all located along the faults, and all of the utility lines (gas, water, sewer, electricity, telecommunications) were buried under the roadways. The design could be implemented profitably, met all legal requirements, and was submitted for review and approval by the appropriate regulatory agencies.



Students were asked to vote on the project as if they were members of a planning commission, and were asked to write a brief justification of their vote. They voted 44-2 against the development. The two positive votes cited the fact that the developer had followed all legal requirements, and so there was no legal reason to reject the proposed development.

Students were subsequently introduced to the South Napa earthquake of 24 August 2014, which caused $400M in damage even though it was just a M6 event. Buried utility lines were extensively damaged.

The Nepal earthquake of 2014 was about the same magnitude as the 1906 San Francisco earthquake, although on a thrust fault rather than on a strike-slip fault. The Nepal earthquake killed ~3,000 people and caused more than $10B in damage.



The students were reminded of the 1906 San Francisco earthquake, which caused at least 3,000 deaths and resulted in more than $10B in losses (2015 dollars). About 4 m of displacement occured in the vicinity of the proposed development in 1906.

The students were asked to cast a second vote on the project and state their reasons. The single student who voted in favor of the development insisted that the development met all legal requirements, and so was OK. Most cited a moral imperative to protect lives, safety, and property that seemed more important to them than the applicable laws or building codes.

Then the students are informed that, in real life, the development was approved and built as designed.

Now, people live in those houses.

This case study strongly engaged student interest, and the questions encouraged critical thinking about an authentic situation involving geoscience, public policy, hazards and risk, informed consent, and geoscientists' professional obligations toward society.

This case study generated a substantial amount of thought and concern among students, and was very successful.

G.K. Gilbert, 1906, The investigation of the San Francisco Earthquake: *The Popular Science Monthly*, v. 69, August; accessed via https://en.wikisource.org/Popular_Science_Monthly/Volume_69/August_1906/The_Investigation_of_the_San_Francisco_Earthquake