Embedding Elements of Geoethics in an Introductory Physical Geology Lab Course

Vince Cronin, 2015, Geological Society of America *Abstracts with Programs.* v. 47, no. 7, p.193; https://gsa.confex.com/gsa/2015AM/webprogram/Paper270023.html

<slide 1> Ethical behavior is essential to science. Why, then, is geoethics so poorly represented in the curriculum of most geoscience programs? Do we hope students will develop as ethical geoscientists through osmosis?

<slide 2> There have been ethical problems in the practice of geoscience, both in university and professional settings.

What can be done to develop and encourage a more ethical geoscience workforce? Mature geoscientists of good character will try to conform their actions to the ethical guidelines that have been adopted by respected communities of professional geoscientists, such as the AGI, AIPG, IAPG and others. While questions are often raised about the value of voluntary or aspirational codes of ethics, my view is that they play an important role in establishing community standards of behavior.

<slide 3> A substantial portion of the general public is skeptical about science. This skepticism seems to coexist with an insatiable desire for products and information that are only available as a result of scientific research. Many factors contribute to this skepticism, including politics, ignorance of the nature and practices of science, worldviews, the messy and sometimes contradictory progress of medical science in particular, and the perception that scientists are elitist and arrogant that arises from the observation that some public scientists ***are***, in fact, elitist and arrogant.

<slide 4> I don't think there is a very strong connection in the public mind between science and ethics. In my mind, the ethical practice of science is of fundamental importance to the entire scientific enterprise. In science, reproducible 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.

<slide 5> 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. I would like to help change this silence.

<slide 6> Every semester, I teach or advise 75 to 100 geoscience students. Perhaps 15% of these want to pursue geoscience as a profession. They are typically 18 to 23 years of age, so they are somewhere in the range of late adolescence and early adulthood. Neuroscience tells us that their brains will not attain full adult development until they are around 25 years old. So I am working with them while they are very adaptable, while they are learning a fantastic amount of information, and while they are still forming into the persons they will become.

An introductory lab course in geology is ubiquitous in American colleges that offer geoscience at any level, making it a perfect vehicle for familiarizing students with geoethics.

<slide 7> For the non-major, consideration of geoethics can deepen their understanding of science, and can illumine the relationship of geoscientists to society. Undergraduates exist in a world saturated by marketing, where half-truths and outright falsifications are common. Geoscience, on the other hand, is an enterprise that seeks the most reliable understanding of our planet based upon reproducible observations, responsible assessment of uncertainty, and testable hypotheses. The antidote to misinformation and misconceptions is knowledge. Only reliable knowledge is useful in a society that faces critical environmental challenges

<slide 8> For geoscience majors, an early introduction to geoethics establishes a foundation for continued moral growth through subsequent coursework. We should teach students from the beginning how to participate in geoscience in an ethical manner, and to include estimates of uncertainty in our results.

<slide 9> I want to highlight three of the steps that I have taken in my introductory physical geology course to promote geoethics.

First, I require students to read the AGI *Guidelines for Ethical Professional Conduct*. In class, I highlight the parts of the *Guidelines* that are particularly relevant to the course topic. I refer back to the document whenever the opportunity presents itself. And I inform them about the AIPG and IAPG -- two organizations they can join that have a particular focus on professional ethics.

<slide 10> Second, I emphasize the basics of science: reproducibility of observations, assessment of uncertainty, and testing of hypotheses that seek to relate scientific facts to one another. I think it is the attention to understanding uncertainty that is most surprising to non-science students, who often have the impression that scientists are quite certain about anything they choose to talk about that relates to science.

<slide 11> And third, I have students work with case studies that have an ethical component. Let me give you an example, which I used just last week in my introductory physical geology course, during our exploration of earthquakes.

<slide 12> 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 in the State of California, and a plan that ensures that no habitable structures are built across an active fault.

<slide 13> The site for our case study is in the town of Pacifica, just south of San Francisco and within the San Andreas fault zone.

<slide 14> 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 shear during a single M ~7.8 earthquake in 1906.

The developer's consulting geoscientist **<slide 15>** carefully mapped the property, **<slide 16>** logged trenches across suspected fault traces, and **<slide 17>** located the main trace of the active fault as well as some minor fault splays. A design was developed that **<slide 18>** established a ~15 meter setback from the mapped main trace, and a ~ 9 meter setback from the minor splays. Using the average size of other houses in the area as a guide, the developer created **<slide 19>** 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. The 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.

<slide 20> Students vote on the project as if they were members of a planning commission. Then I have them write a brief justification of their vote. Of the 44 students in class that day, just two voted in favor of the development at this point. After voting, we discuss their ideas about the project before I provide them with a bit more information.

<slide 21> I describe the South Napa earthquake of 2014, which caused $400 million dollars of damage even though it was just a magnitude 6 event.

<slide 22> This house in the Browns Valley subdivision was torn in two by the Napa earthquake. Its owners had it put back together and placed on a new foundation. The utilities buried under the road were badly damaged during the earthquake.

<slide 23> I describe the Nepal earthquake of 2014, which had a magnitude similar to the 1906 San Francisco earthquake.

<slide 24> This earthquake caused more than 3,000 deaths and 10.5 billion dollars in damage. But its effects are enduring.

<slide 25> Finally, I remind them of the 1906 San Francisco earthquake, which caused at least 3,000 deaths, and resulted in more than 10 billion dollars in damage. About 4 meters of right-lateral strike slip occurred in the vicinity of the development in 1906.

<slide 26> Then, I have students cast a second vote on the project and write a brief description of the basis for their vote. The single student who voted in favor of the development in the final pole insisted that the development met all legal requirements, so it was OK.

I asked, "What, if any, ethical issues are evident in this situation?" Most cite an imperative to protect lives, safety and property.

<slide 27> Then I tell them that in real life, the development was approved and built as designed **<slide 28>**, and now people live in those houses **<slide 29>**,.

This case study strongly engaged student interest, and the questions encouraged critical thinking about a real-life situation involving geoscience, public policy, hazards and risk, and geoscientists' professional obligations toward society. My sense is that this was a very successful exercise.

<slide 30> Finally, I want to note that it will be my privilege to be the editor of the upcoming 11^{th} edition of the AGI/NAGT Laboratory Manual in Physical Geology. I hope to include ethical considerations throughout the text in a manner that is intentional yet unobtrusive, and that is consistent with the AGI *Guidelines for Ethical Professional Conduct*.

<slide 31> I want college students in introductory geoscience classes to know that geoscientists are the intellectual interface between humanity and Earth's resources, hazards, and vulnerabilities.

<slide 32> I want them to know that geoscientists have a unique responsibility for the stewardship of our home planet and all of its inhabitants, of all species.

<slide 33> And I want them to understand that we bear our special knowledge of Earth in trust for all of humanity.

<slide 34> Geoethics is a core concept in geoscience. We must become much more intentional in our approach to developing student knowledge of geoethics throughout the entire geoscience curriculum.

