Facilitating a geoscience student's ethical development

© 2015 by Vincent S. Cronin, Baylor University, Waco, Texas
(Vince_Cronin@CroninProjects.org) and the International Association for Promoting Geoethics

Abstract

It is the responsibility of each generation of mature geoscientists to help subsequent generations develop as ethical geoscientists. Society depends on professional geoscientists to provide reliable information and unbiased expert advice about some of the most vexing challenges involving our interactions with the natural world. If the results of geoscience are not reliable -- if our results are driven by financial, political or social agendas rather than solely by good science -- the professional work of geoscientists will not be sought or valued by society. Ethics is central to science. Professional geologists have a commitment to advancing scientific knowledge and serving society, and must develop and propagate a shared sense of geoethics to help guide our work.

While mature geoscientists have a responsibility to act ethically and help in the development of novice geoscientists, the final responsibility for our ethical development rests with each of us alone. Geoscientists must accept, adopt, and internalize the imperative to act in an ethical manner every day of their academic and professional careers. The process of facilitating the ethical development of undergraduate geoscience students needs to be tailored to individual institutions, and ranges from an *interior* strategy of infusing ethics education throughout an undergraduate curriculum to an *exterior* strategy that primarily uses online resources and short-course/workshop opportunities organized by professional societies to provide ethical content. Well-articulated case studies with an ethical dimension are particularly effective for ethics instruction. Major geoscience organizations should support and participate in the development of resources for in-class and online learning about geoethics.

Introduction

It is possible for people who are not professionals to give no formal thought to personal ethics, and yet still lead a good life. Under routine circumstances, they simply move from one task to the next, making small decisions along the way until the day is done. Occasionally, circumstances cause a more consequential decision to be made, and they do what seems best at the time without much prior thought or subsequent examination. And while entire departments of philosophy professors might object by reiterating Socrates' dictum that the unexamined life is not worth living, my sense is that many lives are led simply without intentional reference to any particular ethical theory or system. The motivation is simply the need to feed, clothe, shelter, and care for yourself and help do the same for the ones you love, while humbly seeking happiness and fulfillment within that small local community.

The situation is different for professional geoscientists. To be called a *professional* means, obviously enough, that you are part of a profession, which is a very special type of job. Professions require specialized knowledge and extensive advanced academic training to develop the skills and requisite background knowledge to undertake certain tasks and responsibilities on behalf of society. Professions are generally recognized formally by the legal system and are often self-governed, at least in part, by professional societies. The most visible examples of professions include medicine, law, and engineering. An important and perhaps essential feature of professions is that their principle purpose is service to the public [e.g., *Andrews*, 2014].

As geoscientists, we are part of a large professional community of scientists that has its own customs and standards as it seeks to fulfill its local and global responsibilities. Today the global community faces major problems in which geoscience will supply essential insights: climate change, water supply, waste management, energy resources, acquisition and reclamation of mineral/chemical resources, and soil conservation to name a few [e.g., *Geological Society of London*, 2014]. Each of these challenges involves issues of government, public economics and private wealth, labor, national sovereignty and political will. As geoscientists are deployed to help manage these vital problems in a sustainable manner, it will be necessary to develop a coherent and shared sense of geoethics within the geoscience community. Perhaps the term "geoscience community" means nothing more than "the set of all geoscientists," but a true community functions more effectively to achieve mutually beneficial outcomes. Geoethics is a fundamental tie that can bind the geoscience community together.

We have more than two millennia of source material to draw upon in studying ethics. If our goal is to facilitate a geoscience student's ethical development, we need to take care not to bury them in literature or arcane jargon. Achieving that goal while the student is an undergraduate is much more like planting a few seeds or saplings that will grow in time, rather than trying to transplant a mature forest. The prerequisite for learning about geoethics is not a full and functional grasp of the history and contemporary understanding of moral philosophy. We require only that a geoscience student be willing to do the work of learning every day, and to put that newly acquired knowledge into practice every day of their professional life.

The core challenge in facilitating student learning about applied ethics in geoscience is to help each student accept, adopt and internalize the need to act as an ethical geoscientist all the time. The struggle is not with others who act in unethical ways, although we have a responsibility to oppose unethical behavior as part of our professional community. Rather, the more important struggle is within ourselves. Striving for professional integrity is a struggle that is not won once and for all time, but continues every day throughout an entire career. How do we help each novice geoscientist to fully understand the central importance of that struggle? How do we encourage each to engage in that struggle, using intellectual tools developed over two millennia of moral philosophy?

The purpose of this essay is to touch on some if the ideas and issues associated with applied-ethics education, and to provide a few thoughts on geoethics education for geoscience students. This is part of an active international conversation, and perhaps an evolving understanding, of how to help geoscience students to become ethical geoscientists.

Background

Basic ideas and definitions about general ethics

Humans are capable of thoughts and actions that are of such amazing grace, beauty and complexity that they scarcely seem possible. We can develop bonds of love and trust with one another that can withstand the most searing trials, and our courage in the face of existential threats can be breathtaking. Humans are also capable of thoughts and actions that debase themselves and harm others, rendering them virtually unworthy of coexistence with the rest of humanity. This range exists as a potential in all of us. Our intellect allows us the choice to condition our thoughts, words and actions to reflect the most positive, most constructive characteristics of our society.

A very basic definition of *ethics* is that it involves the discrimination of "good" and "bad" behavior. In law, the perceived ability to understand the difference between "right" and "wrong" is fundamental to the determination of whether a defendant is competent to stand trial for their actions. Stephen Carter's definition of *integrity* involves "[1] *discerning* what is right and what is wrong, [2] *acting* on what you have discerned, even at personal cost, and [3] *saying openly* that you are acting on your understanding of right from wrong" [*Carter*, 1996; *Benjamin*, 1990]. One might say that our *character* is the summation of all the ethical choices we make about how we interact with each other, and how we treat ourselves.

Development of our character is a responsibility that we all bear as individuals. There is no escaping that we are responsible for ourselves. And yet there is a significant role to be played by the constellation of people around us. We learn from each other. We are influenced by each other. We are responsible to each other. To some extent, we are responsible for each other.

Humans are social animals. Within the tribes that we inhabit, there are mores, customs, and standards of behavior and belief [*Greene*, 2013]. The meaning of the word *moral* reflects the manners or customs of the community, an understood standard of behavior that is expected of any member of the tribe. As moral philosopher Bernard Gert noted, "Every feature of the moral system must be one that is known to and could be chosen by any rational person" [*Gert*, 2005]. Behaviors that are outside of the moral envelope of a group mark a person as an unreliable member of the tribe, or perhaps not a member at all. Throughout much of human history, being ostracized from your native tribe has led to dire consequences for you and your family. Survival was most easily assured through alignment with the moral expectations of your group.

Bernard Gert recognized a universal sense of morality among humans, in contrast to the notion that every group is defined by its own morality that might or might not have significant overlap with other groups [*Gert*, 2005]. "No one discusses the question, 'Should you lie in order to cause problems for a person you do not like?' because everyone agrees on the answer" [*Gert*, 2005, p. 4]. In a series of accessible, well reasoned books, Gert articulated a moral approach whose goals are to reduce the harm or evil, and to increase the amount of good in the world [*Gert*, 2004, 2005]. He recognized five principal evils to be avoided (death, pain, disability, loss of freedom, loss of pleasure) and four fundamental goods to be sought or protected (pleasure, freedom, ability, consciousness). His moral rules -- required for people to inflict less harm on each other -- can be summarized by two dicta: *do no harm* (do not kill, do not cause pain, do not disable, do not deprive of freedom, do not deprive of pleasure) and *do not violate trust* (do not deceive, keep your promises, do not cheat, obey the law, do your duty). Gert admitted exceptions to his moral rules, and suggested a two-step procedure to evaluate whether an exception is justified: collect all of the relevant facts "to provide a complete morally relevant description of the action," and consider what would happen if other people knew that they could also violate that rule under similar circumstances.

Gert's moral insights join with older ethical theories or systems as a worthy attempt to structure our understanding of how to live a moral life. Other major systems that are commonly described in any brief summary of applied ethics include various forms of the utilitarian (or consequential) approach originally described by John Stuart Mill, virtue ethics described by Aristotle, the natural law ethics of Thomas Aquinas, deontological ethics of Kant, duty ethics and the theory of justice described by John Rawls, and human rights ethics exemplified by the work of John Locke and A.I. Melden, to name a few [*Martin and Schinzinger*, 2005; *Starr*, 1991; *Shafer-Landau*, 2012, 2015; *MacIntyre*, 1998].

Anthony Weston is a moral philosopher who has attempted to provide an accessible "21st century toolbox" filled with useful ideas about how to navigate our world [*Weston*, 2013]. He offers two clues to the nature of ethics: first, "ethics asks us to pay attention to something beyond ourselves"; and second, "we work from the inside of [ethics]". He asks us to recognize that we are part of an ethical continuum that began long before our time here and that will continue long after we are gone. We stand in the middle of this ethical continuum, and have an effect on it just as it affects us. He suggests "that to think or act ethically is to take care for the basic needs and legitimate expectations of others as well as our own." To him, a moral person might simply follow the customs and traditions of the community, but an *ethical* person is engaged in questioning and challenging those moral values, "systemizing and criticizing and possibly even revising our moral values, as well as more consciously embracing them" [*Weston*, 2013].

Robert Barger encourages us to frame our understanding of how ethical decisions are made by considering how such judgments are affected (or perhaps determined) by an ideology or worldview [*Barger*, 2008]. Barger conceives of metaethics as an attempt to understand the source or foundation of ethical judgments and their justification, and "how a particular worldview...underlies and determines the formulation of such ethical judgments."

Hugh Gauch, Jr., also considers worldviews in his treatise on the scientific method, stating "A worldview is a person's beliefs about the basic makeup of the world and life" [*Gauch*, 2012]. Some people have a worldview that makes it impossible for them to conceive of an Earth that is older than a few thousand years, or that life on Earth evolved over time. An ideology effectively blocks their ability to understand facts that are inconsistent with their views, or to fully value opinions that differ from theirs. To Gauch, the key question with respect to worldviews is "How much does worldview pluralism affect science's claims and fortunes?" The worldview of a skeptical purist does not place credence in the presupposition that the physical world is real, orderly and generally comprehensible by humans. Gauch concluded that, with the exception of skeptical purists, a unified expression of science is equally comprehensible and useful to all cultures and worldviews.

I am going to use the word *geoethics* in this essay in a rather informal manner to mean, approximately, "ethics applied to the geosciences." Geoethics is also sometimes used in a more macroethical sense to capture the global responsibilities and values that are related to our stewardship of Earth, including the need to adjust our actions and economies so that we can achieve a more just and sustainable future.

Ethics asks us to pay attention to something beyond ourselves, to act with beneficence and avoid causing needless harm, to be worthy of trust. Science seeks an understanding of the physical world that is consistent with our most careful observations, and geoscience focuses our attention on understanding our planetary home. Professionals are experts in command of hard-won technical knowledge, and whose work is useful and beneficial to society. Our shared goal is to help each geoscience student to become an ethical professional geoscientist.

Young adults, old adolescents

I focus on undergraduates in this essay because a substantial number of novice geoscientists enter the workforce after earning a bachelor's degree. Much of what I write in this essay also applies to the ethical education of graduate students, but instruction about geoethics is too important to wait until graduate school.

The average college student in the United States who has attended school continuously since childhood is between the ages of 18 and ~23 years -- right in the middle of a time of almost unimaginable change physically, emotionally, socially and intellectually. The typical undergraduate student is still in the process of becoming functionally independent of the family that was the foundation of their childhood world. They are old enough to vote, marry, and volunteer for military service, but they might be described as older adolescents as accurately as young adults. They have worked their way through an educational system that has promoted certain virtues and a sense of "right" and "wrong" behavior, whether or not that message has also been promoted in their homes, churches, teams, media and other associations. First-year college students are not ethical blank slates; however, neither are they mature, informed ethical agents. Recent studies in neuroscience indicate that our brains do not fully mature until around age 25 [e.g., *Aamodt and Wang*, 2012], so the undergraduate college years are enormously important to the ethical development of any person who is fortunate enough to attend college.

My experience is that it is easy to engage undergraduate students in discussions about ethical issues because they have an innate interest in these matters. What they lack is life experience and a full set of intellectual tools that are useful in the process of ethical reasoning. On average, their formal knowledge of ethics is largely limited to general descriptions of a small set of virtues along with a handful of aphorisms. A few geoscience students have taken a course involving ethics in the university's philosophy department, where theory and dense reasoning might take precedence over practical applicability. Recently, students at my university have been required to take an online ethics tutorial prior to registration for courses. That experience seems to have focused on the need to avoid plagiarism and other forms of cheating.

The ethical value that undergraduate students seem to talk about most often is fairness -- a fundamental sensitivity they have had since earliest childhood. In conversations I have had with my undergraduate students about their ethical concerns, they typically focus on the ethical issues they perceived within their immediate world as a college student in a geoscience department: cheating, teachers they thought were unfair, teachers who are too busy on research to spend time with them, and various injustices they had endured. They tend to focus on ethical failures rather than examples of positive ethical behavior. Their concerns tend not (yet) to be global in scope, but rather they are just trying to survive their courses in chemistry and calculus. They are focused on microethical concerns affecting their local world, but are far less attuned to macroethical concerns that affect the geosciences and its relationship to society as a whole [*Herkert*, 2005].

In working with adolescents and young adults, we should understand that many of them have a strong tendency to be quick to judge, label, criticize, and shun a person for words or actions they consider to be inconsiderate, unjust, untrue or unfair. These tendencies are not unique to the young, of course. But is a single lapse of judgment sufficient to characterize a person's character as intrinsically poor? I would argue that it does not, or else we would all be in trouble. We cannot begin to learn deeply about ethics until we abandon the practice of branding other people as unethical simply because they have made a mistake. As David Brooks reminds us, we are all flawed and should face our inadequacies openly, with honesty and humility [*Brooks*, 2015]. We are each "crooked timbers," to borrow a phrase from *Kant* [1784]. We need to approach our studies of ethics with kindness, charity, empathy, and humility. Our own flawed character should lead us to know, or maybe just hope, that forgiveness and redemption are requisite parts of healing and growth.

The undergraduate years can be essential to the ethical development of a novice geoscientist. While undergraduate geoscience students are not ethical blank slates, they are effectively blank slates with respect to the ethical conduct of science in general and geoethics in particular. My sense is that these students are generally unaware of the existence of geoethics, and have not given much or any thought to the role that ethics plays in science. Geoscience faculty members have a responsibility to help students develop their functional knowledge of applied ethics. The most direct ways to do so are to teach through the personal example of being an ethical professional, and to include geoethics as an intentional and integral part of the geoscience curriculum.

Why do we need to spend time teaching geoethics within a geoscience curriculum?

An undergraduate geoscience curriculum is already crowded with material that well-educated geologists or geophysicists need to master. Time is not elastic, so if something is added to the undergraduate curriculum, something else must be eliminated. Hence, there is often concern if not outright hostility about the idea of including non-science material in the undergraduate geoscience curriculum. The same concerns and hostility have accompanied the inclusion of ethics in engineering curricula [e.g., *Herkert*, 1999; *Sigma Xi*, 1993]. Bernard Lo described a commonly held opinion in the science community, "Only unethical persons have ethical problems. Ethics is a matter of common sense and experience. Therefore, studying ethics isn't useful" [*Sigma Xi*, 1993]. Many university faculty members in STEM fields observe that they have no formal training in applied ethics, so it would be improper and perhaps even unethical for them to teach applied ethics. (The faculty of many philosophy departments would agree.)

I would argue, however, that ethics is actually a central imperative in science because the scientific enterprise is concerned with discovering reliable information about the materials, properties, processes, and history of the physical world. Rather than "reliable information," I am tempted to use the controversial word "truth" here in the sense suggested by Albert Einstein: "Truth is what stands the test of experience" [*Einstein*, 1950]. Truth to a scientist is not an ultimate and immutable explanation, but rather is a provisional approximation within some measure of uncertainty [e.g., *Rutherford and Ahlgren*, 1991; *Gauch*, 2012]. The idea of "truth" is central to ethics, as expressed through virtues such as "honesty," "trust," "reliability," and "understanding" [e.g., *Ahern*, 2011; *Gert*, 2004].

One of the recommendations that emerged from a forum sponsored by Sigma Xi entitled "Ethics, Values, and the Promise of Science" [*Sigma Xi*, 1993] involves ethics education:

> "Appropriate ethical behavior needs to be communicated to and practiced at all levels of academic, governmental, industrial and other research organizations associated with science and engineering. Ethics should be taught as an integral component of formal scientific education, in cooperation with technical professionals and scholars in the humanities."

This sentiment is echoed by Stephanie Bird, who wrote that "it has become apparent" that the practice of simply *hoping* students will learn about responsible research conduct and ethical behavior by observing exemplary behavior in the lab "is inadequate and serves neither the needs of the research community nor those of society as a whole" [*Bird*, 2014].

Unfortunately, there has been a history of significant ethical lapses among scientists in general and geoscientists in particular. This history provides the motivation for sustained efforts concerning geoethics. A short and incomplete list of ethical problems follows: fabrication or falsification of data; conflicts of interest; failure to maintain confidentiality; practicing without a license in certain jurisdictions; inappropriate client advocacy; creation of biased or inaccurate reports that are favorable to clients' interests; selective data acquisition, analysis or disclosure; insufficient scope of work to recognize or effectively address problems; regulatory violations; failure to disclose regulatory violations; misrepresentation of professional qualifications; unethical treatment of geoscience students; trespassing or conducting investigations without permission on private property; damaging key geological outcrops; sampling without requisite permission; plagiarism and self-plagiarism; insufficient or missing attribution of sources; practicing beyond competency; accepting/offering bribes or gifts to influence decisions; submission of biased reviews that are tainted by self-interest; inadequate protection of human safety; and retaliation against whistle-blowers [e.g., *ASBOG*, 2015; *Goodstein*, 2010; *Oreskes and Conway*, 2010; *Swazey et al.*, 1993; *Andrews*, 2014].

The geoscience community demonstrates that it believes ethical practice to be important in several ways. Most professional and academic geoscience societies have some form of a code of ethics for their members, strongly indicating that the geoscience community as a whole feels that there is an essential need to define standards of ethical practice. Lists of links to the ethics codes of various professional societies are available in several locations on the web, several of which are provided at the end of this essay. Canada requires successful completion of a Professional Practice Exam that emphasizes professional ethics to become a licensed geoscientist [e.g., *Andrews*, 2014]. The *Association of State Boards of Geology* (ASBOG) affirms the importance of geoscience ethics, and includes questions about applied ethics on its licensing exam [*ASBOG*, 2015]. Many states require licensed geoscientists to participate in ethics short courses or workshops on a regular basis in order to retain their licenses. One of the central purposes of the *American Institute for Professional Geology* (AIPG) is to encourage the ethical practice of geology, including the recognition of geoscientists as professionals. AIPG "certifies geologists based on their competence, integrity, and ethics" and has strongly supported efforts to license the practice of geology in every state in the US [http://www.aipg.org]. The American Geosciences Institute (AGI) is a federation of member societies representing approximately 250,000 geoscientists across the globe, and has compiled *Guidelines for Ethical Professional Conduct* through consultation with its members [http://www.americangeosciences.org/community/agi-guidelines-ethical-professional-conduct]. The *International Association for Promoting Geoethics* has arisen in recent years in response to the need to develop, promulgate, and strongly encourage the ethical practice of geoscience worldwide [http://www.iapg.geoethics.org].

Personal responsibility and education

We educate ourselves. The purpose of our schools as they are conventionally structured is to collect materials and expertise in a convenient place, to bundle ideas in convenient sets and categories, to facilitate understanding of existing ideas and the generation of new ideas, and to bring together diverse people who want to learn. The role of a teacher is to facilitate learning. With all of the resources that society has marshaled to help me to learn, at substantial cost, the enduring truth is that I have to concentrate and work diligently to accomplish that learning. Without my commitment and effort, all of those resources are wasted on me. My learning is my responsibility.

Learning about anything requires a commitment by the student to do the work necessary to learn, to make the connections, and to internalize the hard-won knowledge by consolidating short-term memory into functional long-term memory [e.g., *Khan*, 2012]. This is as true of learning about geoethics as in gaining a functional knowledge of calculus or reflection seismology. In order to retain our expanding knowledge of geoethics, we must use it every day in different ways, making connections between how we live our personal and academic or professional lives. We choose to learn, accept, adopt and practice living with integrity as a personal commitment.

On the inside of the ceremonial gates of Pomona College are the words of former college president James Blaisdell: "They only are loyal to this college who departing bear their added riches in trust for all mankind." The opportunity to engage in higher education carries with it responsibilities toward others, recognizing that only a small part of Earth's population will have the opportunity of a college education. Given that opportunity, we *ought* to -- it is *ethical* to -- take full advantage by working hard to master the core knowledge in our chosen field of study. For geoscientists, the ethical responsibility for mastering our core material relates to our responsibilities to be good scientists, to be stewards of Earth, and to serve society. Society depends on geoscientists for reliable information about our many geologic challenges. We hold our added riches in trust for all of humanity, across the globe and forward in time.

My development as an ethical person is *my* responsibility. Fulfilling that responsibility takes intentional effort, exerted daily. Fulfilling that responsibility requires me to listen to and learn from the diverse voices throughout history and across cultures -- voices of people who have graced us with their insights about how we might choose to live our lives. My development as an ethical geoscientist is essential if I am to fulfill the three great responsibilities I have as a geoscientist: contributing to and sharing scientific knowledge, service to society, and stewardship of planet Earth.

Our shared responsibility to develop the character of following generations

It is the responsibility of each generation to help subsequent generations develop as ethical people. Within the geosciences, that responsibility to help novice geoscientists develop is shared by all mature geoscientists, but special responsibility rests with geoscience teachers and advisors, and those who hire novice geoscientists after graduation. The personal ethical norms for an entire career can be established early in a geoscientist's training and apprenticeship. In engaging in the development of applied ethics, we are part of a continuum that began long before our time and that depends critically upon us for its propagation into the future.

Strategies

Do not reinvent the wheel

We can learn from efforts in other professions to define their ethical concepts and standards as we continue the process of developing the field of geoethics. A vast literature exists about the nature and ethics of science. Thankfully, there are useful summaries and syntheses of this sea of knowledge that we can utilize. Hugh Gauch, Jr., has written an excellent, accessible book on the scientific method that includes his thoughts on the nature of truth and the scope of scientific ethics [*Gauch*, 2012]. It provides a nice introduction to the broad field of the responsible conduct of scientific research, which is the focus of many books and websites [e.g., *Macrina*, 2014; *D'Angelo*, 2012; *Goodstein*, 2010; the National Center for Professional & Research Ethics website]. The pamphlets *On being a scientist -- a guide to responsible conduct in research* by the National Academies [2009] and *Honor in science* [*Jackson*, 2000] are of an appropriate scope and scale to be required reading for any undergraduate science major.

Geoscientists have good models for applied ethics in several allied fields. Engineers have developed a culture that values applied ethics, and they are perhaps the most closely related discipline to the applied geosciences. A practical example of this consonance is the Professional Practice Exam, given to engineers and geoscientists alike who are seeking licenses to practice in Canada [*Andrews*, 2014]. The field of engineering ethics is more fully developed than geoethics at this time, in part because of the long history of professional engineering societies articulating their views of engineering ethics through codes and guidelines [*Luegenbiehl and Davis*, 1992]. The Accreditation Board of Engineering and Technology (ABET) *Code of Ethics of Engineers* is still a widely referenced resource for engineering in the United States [https://engineering.purdue.edu/MSE/Academics/Undergrad/ethics.pdf]. Its most direct counterpart in the geosciences might be the Code of Ethics of the American Institute for Professional Geologists [*AIPG*, 2003].

Engineers have developed popular texts explaining successes and failures in their field, textbooks that are partly or entirely devoted to engineering ethics, and a variety of educational resources developed in support of courses in engineering ethics taught in many, but not all, engineering programs [e.g., *Petrosky*, 1985; *Andrews*, 2014; *Harris et al.*, 2014; *Martin and Schinzinger*, 2005; *Seebauer and Barry*, 2001; *Shuirman and Slosson*, 1992]. The journal *Science and Engineering Ethics* focuses on engineering but has many articles of more general interest. Given that geoscientists typically spend too much time in front of a computer, the field of applied ethics for computer engineers/scientists also supplies resources and educational models that can inform the development of geoethics [e.g., *Barger*, 2008; *Stichler and Hauptman*, 1998]. John D'Angelo is a chemist and ethicist who wrote a brief, accessible text on ethics and misconduct in scientific research that is largely relevant to the geosciences [*D'Angelo*, 2012]. Environmental ethics also has a rapidly expanding literature that overlaps substantially with geoethics. Two early environmental works that are still essential reading are Rachel Carson's **Silent Spring** and Aldo Leopold's **A Sand County Almanac** [*Carson*, 1962; *Leopold*, 1949].

The textbooks developed for courses in science ethics or engineering ethics tend to have a broadly similar structure. This structure might be adapted effectively for a course on geoethics. The applied-ethics textbooks begin with a summary of general ethics and associated terminology, followed by ideas and terms that relate more directly to the practice of science or engineering. Engineering texts also tend to define and emphasize the special responsibilities that professionals have toward society, often citing the codes of ethics of relevant professional groups. In virtually all of the pedagogical texts I have reviewed, case studies follow the account of general ethics and are used to illustrate the roles that ethics play in engineering or scientific decision making. Case studies also have the significant side benefit of teaching technical knowledge and skills alongside the example of practical applied ethics. Many case studies also illustrate the social impact of decisions made by scientists or engineers.

Content

What questions, ideas, and resources about geoethics should an undergraduate geoscience student be familiar with before graduation with a bachelor's degree? We will be optimistic and assume that the student has access to sufficient internal (within their department) and external (online and elsewhere) resources to gain familiarity with geoethics content.

I ask you to recall and consider seriously that there are limits to the amount of material that a student can process -- a fact that is commonly ignored by university teachers to the detriment of students. If we want students to internalize their growing understanding of geoethics, we will have to provide them with time to read, write, discuss, experiment, and reflect.

The following list is long, and yet it is certainly incomplete. It is offered as a starting point for reflection and discussion. Graduates with bachelors degrees in geoscience should...

- be able to give an informed answer to the question "Why be ethical?" [*GWU*, 1998]
- be honest and trustworthy in all professional and academic interactions [e.g., *Ahern*, 2011]
- be concerned for the welfare of others
- strive daily to live a life of personal, professional/academic, and scientific integrity
- respect "the fundamental rights, dignity, and worth of all people" [*Fisher*, 2003]
- have "an understanding of professional and ethical responsibility" [*ABET*, 2015]
- have "the broad education necessary to understand the impact of [geoscience] in a global, economic, environmental, and societal context" [*ABET*, 2015]
- have "a knowledge of contemporary issues" that might relate to intersections of geoscience and society, or to geoethics [*ABET*, 2015]
- understand the basic vocabulary of moral philosophy (e.g., ethics, morals, values, dilemmas)
- have a basic functional knowledge of the half-dozen or so most prominent theories, systems, or models of general ethics (e.g., utilitarianism, values ethics)
- be able to apply ethical perspectives, theories, models or systems to help clarify or resolve an ethical problem or reach an ethical decision
- have a functional knowledge of the responsible conduct of science [*Gauch*, 2012; *Mogk*, 2014]
- be able to reliably/formally assess the uncertainty of a measurement or computational result involving observational data
- fully and accurately cite the source of data and ideas, sufficiently to allow another person to locate and evaluate the primary source material
- be familiar with the general rules or customs of the science and geoscience communities with respect to authorship, as well as the customs associated with acknowledgments in papers prepared for public viewing
- be able to argue respectfully "from example, analogy, and counter example" [*GWU*, 1998]
- be able to identify stakeholders in a situation that requires ethical judgment [*GWU*, 1998]
- be able to identify and differentiate ethical issues from other types of issues [*GWU*, 1998]
- understand the different types or purposes of various codes of ethics: normative, educational, aspirational or regulatory
- be familiar with the general contents of codes of ethics governing general science and various aspects of geosciences, as published by relevant professional and academic societies. It is

particularly important that they notice the strong similarities in what different segments of the geoscience community consider to be ethical behavior.
- be able to apply "ethical codes to concrete situations" [*GWU*, 1998]
- be able to work toward resolution of ethical issues by "identifying and evaluating alternative courses of action" [*GWU*, 1998]
- place ultimate importance and value on the protection of human life, safety, health, and welfare
- accept and understand the responsibility to act as a steward of Earth, by virtue of a geoscientist's education, experience and perspective
- support the sustainable use and development of Earth's resources, and understand the practical and ethical imperative to maintain a healthy biosphere
- inform the public or public authorities about the risks associated with geological hazards, including hazards that might be induced by human activities.
- remember to consider the metaethics of a situation in which you have primarily focused on the microethics, and vice versa
- understand the role and responsibility of a geoscientist who is acting as an expert in governmental or judicial proceedings
- understand the role and responsibility of a geoscientist who is acting as an expert supplying members of the general public with information about geological events or processes
- understand and be able to articulate the role, rights and responsibilities of a geoscientist to a client, and their limits
- understand and be able to articulate the role, rights and responsibilities of a geoscientist to an employer, and their limits
- work toward resolution of ethical conflicts with courtesy, respect, openness and attentiveness to alternate viewpoints
- understand the likelihood, if not inevitability, of encountering a person in your professional life who does not share your commitment to personal or professional/academic ethics, and who might actually want to do you harm. Graduates should be able to recognize this situation and take responsible steps to protect themselves.

Case studies

Case studies fulfill the same purpose in ethics education for scientists and engineers as their more ancient counterparts of parables, myths, fables, and allegories fulfilled in classical ethics education, although case studies are more firmly tied to actual events. Case studies form an important core of engineering ethics and geoethics pedagogy. Bernard Lo stressed the importance of teaching about applied ethics using cases that involve ethical dimensions, so that students can discuss, think-through, and experiment with authentic ethical dilemmas in the safety of the classroom before they encounter them later in their careers [*Sigma Xi*, 1993].

Perhaps the best feature of case studies is the seamless manner that technical, social and ethical issues are often woven together in a well-articulated case. Sometimes case studies are direct descriptions of actual events based on public records, and sometimes they are synthetic cases that might or might not be based on actual events. Cases can describe instances where the decisions were appropriate and the outcome was positive, but it seems that many describe instances where problems arose and failure (if not outright disaster) ensued. The cases are always simplified to some extent, but not because we want to avoid the messiness of actual ethical situations. We simply do not have access to all of the data that the original participants in a case had to work with, and do not exist in the same physical, professional or psychological context as the original participants at the time they had to make ethical judgments.

When we work with case studies that portray or closely parallel actual events, we must be sensitive to two facts: real cases involve real people whose families are probably still coping with the aftermath of the problem, and we should display appropriate consideration for their privacy and wellbeing; and real cases may involve active litigation. Here is a brief example of a case study.

> 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. The first of these, usually called the Alquist-Priolo Act, established special study zones (SSZ) around the ground-surface trace of faults that are known to have caused surface rupture during the Holocene, within the last ~11,000 years [*Bryant*, 2010; *Bryant and Hart*, 2007; *State of California*, 2007; *CGS*, 2004, 2008]. Development within a SSZ requires a detailed site investigation by a geologist licensed in the State of California, and a plan that would ensure that no habitable structures would be built across an active fault.
>
> A developer wanted to build houses on a small undeveloped area within the SSZ of a fault that experienced ~4 m (13 feet) of right-lateral shear during a single M ~8 earthquake around a century ago. The developer's consulting geoscientist carefully mapped the property, logged trenches across suspected fault traces, and located the main trace of the active fault as well as some minor fault splays. A design was developed that established a ~15 m (50 foot) setback from the mapped main trace, and a ~ 9 m (30 foot) setback from the minor splays [Figure 1A; *Borchardt*, 2010]. 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 [Figure 1B]. 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 reviewed and approved by the appropriate regulatory agencies. The development was built as designed, and now people live in those houses.

A case like this might generate a variety of responses, and a lot of questions. Those questions might lead students to investigate the applicable laws and building codes, the potential danger associated with proximity to a seismogenic fault during an earthquake, the actual experiences of people whose houses are located near a seismogenic fault that generated a recent earthquake that was strong enough to cause damage, and so on. Perhaps the students will consider the question of whether we *should* build certain projects that are consistent with all applicable codes, but yet seem to expose innocent people to significant potential harm. Does the developer have an inviolable right to realize a profit on a real estate investment through the legal construction of a development that meets all relevant code requirements? In the context of ethics, we want students to learn how to set their initial emotional reactions aside to analyze the situation [after *GWU*, 1998].

- Who are the stakeholders in this case?
- What is the social context of this case? For example, how would building this development impact society (a) if no serious damage, injury or death ever occurs due to its proximity to an active fault, and (b) if serious damage, injury or death occurs due to its proximity to an active fault? What level of loss related to an earthquake would it take to negate the positive impact of this development?
- What are the ethical issues involved in this case? [e.g., *Cronin and Sverdrup*, 1998]
- What pertinent evidence do we have, and what evidence that we would like to have is missing. (In a real situation, recognition that you do not have all the facts would lead to additional research.)
- What governmental restrictions (laws, statutes, codes, policies) apply?
- What rights are endangered, if any, (a) if the development is built, and (b) if the permits for the development are denied and the land remains undeveloped?
- What part(s) of relevant professional ethics codes apply to this case?
- What alternative actions could be (or could have been) taken to protect the safety and wellbeing of the public?

Geoscientists have a deep literature of case studies to draw upon. Early in my career as a faculty member, I taught a course called *Case Studies in Engineering Geoscience*, which included a substantial component of applied ethics. The two texts that I used for that course were dominated by case studies: *Forensic Engineering -- Environmental Case Histories for Civil Engineers and Geologists* [*Shuirman and Slosson*, 1992] and *Engineering Ethics* [*Martin and Schinzinger,* 2005]. Civil engineering cases such as dam failures or landslide problems often have a substantial amount of geoscience content and can be readily adapted for use in geoscience courses. Symposia devoted to geoscience ethics occasionally generate volumes that contain case studies [e.g., *Hoose*, 1993]. Recent texts by *Wyss and Peppoloni* [2015], *Peppoloni and Di Capua* [2015], and *Lollino et al.* [2014] continue this tradition of publishing case studies that involve ethical judgments.

The periodical literature is another rich source of useful case studies. The Engineering Geology Division (now the Environmental and Engineering Geology Division) of the Geological Society of America produced for many years a series called *Case Studies in Engineering Geology*, and continues to produce a parallel series called *Reviews in Engineering Geology*. Both series feature a wide variety of case studies. The *Association of Engineering Geologists Bulletin* was also a source of brief case studies, and its current manifestation is called *Environmental and Engineering Geoscience* -- a joint publication of the AEG and the GSA. The International Association for Engineering Geology and the Environment (IAEG) publishes the *Bulletin of Engineering Geology and the Environment*, which also is a source of case studies that could be adapted for a geoethics course. Since June of 1987, David Abbott has written a regular column entitled *Professional Ethics and Practices* for *The Professional Geologist*, a publication of the American Institute of Professional Geologists (AIPG). Many of these columns include brief case descriptions, followed by Abbott's comments that he bases on the AIPG Code of Ethics and his own remarkably deep well of experience and common sense.

Structuring geoethics education: internal and external solutions

If our goal is to have ethical behavior be a characteristic feature of how geoscientists conduct their professional careers, we should infuse ethics throughout everything we do in a geoscience curriculum. And beyond course content, ethical behavior should be the expected norm throughout academic geoscience departments -- in teaching, in research, in administration. Efforts to facilitate the ethical development of undergraduate geoscience students should be tailored to each geoscience department, based on the level of awareness and acceptance of the need to include geoethics training in the curriculum of the department.

The advantage that our friends in engineering have over geoscientists, with respect to applied-ethics education, is that familiarity with relevant aspects of applied ethics is an explicit point in the review criteria specified by their primary accreditation agency [*ABET*, 2015]. Hence, there is a tangible risk to their program if they neglect ethics instruction. The same cannot be said of geosciences.

I would like to frame the following suggestions by imagining two scenarios that bound the range of situations that might be encountered within a geoscience department. In the first scenario, the departmental faculty and relevant administrators are genuinely interested in promoting ethical behavior and in facilitating their students' growth as ethical geoscientists. In this scenario, the approach will be a set of actions taken *internally* while utilizing external resources made available by professional societies, ethics centers, and other groups working to support professional/scientific ethics. In the second scenario, at least one faculty member or administrator in a department is interested in promoting geoethics, while others are disinterested and will not contribute. In this scenario, the approach will be for the few who are interested in geoethics to do what they can while helping students connect with *external* resources developed to facilitate their growth as ethical geoscientists. As reportedly observed by the American humorist, Garrison Keillor, "Sometimes you can only do so much. But you do have to do that much."

Even in departments in which the faculty and administrators are initially open or even enthusiastic about infusing geoethics throughout the curriculum, there might be a problem in achieving persistence over the course of years as departmental faculty and priorities change. What is undeniably persistent, however, is the need for geoethics education.

Internal ethics education. An exemplary way to facilitate student learning and to highlight the central importance of ethical practice is to disseminate the principles of geoethics throughout every course in a department. Tasks as small as collecting data in a reproducible manner, properly defining the uncertainty of quantitative measurements and analytic results, properly attributing the source of data or an idea, taking care of field and laboratory equipment, and being careful to leave outcrops unchanged by your presence are all fundamentally ethical, and the ethical nature of these routine tasks can be highlighted for students by faculty members who understand that ethics content is important. Routinely providing each student who declares a geoscience major or minor with a free copy of *On being a scientist* [*National Academies*, 2009] or *Honor in science* [*Jackson*, 2000] as soon as they declare their degree plans would be a significant statement in favor of ethics by the department. Another positive step would be to follow that opening ante with adding a book like Gauch's *Scientific Method in Brief* [*Gauch*, 2012] as a required text in a low-level required core course for majors, and making it a required text in all subsequent core courses so that the students retain it as a reference.

A benefit of this approach of spreading geoethics across the curriculum is that the faculty will send a clear message to students that ethical behavior is important in all aspects of the geosciences. Another potential benefit is that this effort might, over time, have a sustained positive effect on the ethical climate within the department as a whole.

There are a number of challenges to the long-term success of this approach that would have to be addressed. Time must be allocated to develop resources for each course and implement the plan. The faculty members who teach undergraduate courses will have to agree to make the necessary changes to the way they teach their courses, and to communicate and coordinate their actions with each other. They will need to be willing to listen and learn from each other. Training might be necessary to accomplish this plan, and training requires time and might require funding. As participating faculty members leave and are replaced over time, it might be challenging to sustain this model with new members whose focus will be on research and tenure.

A single course might be devoted entirely or in large part to geoethics, as was my *Case Studies in Engineering Geoscience* course. Ideally, the course would augment other efforts to emphasize geoscience ethics, rather than replace them. It would be best if the course could be developed or taught in collaboration with a willing moral philosopher from the school's philosophy department, and perhaps even a sociologist. Perhaps the course could combine study of general science ethics (i.e., the responsible conduct of research) with geoethics, or an account of the roles of geoscience in society coupled with geoethics. The course could be a required capstone experience. A potential challenge might involve the administrative process of having a new undergraduate geoscience course approved by a university/college course-and-curriculum committee, because the course content would include a substantial amount of material about ethics that is normally taught through a department of philosophy.

Many departments have a weekly colloquium or brown-bag lunch at which speakers are invited to talk about their work. Part of this time can be used to talk about topics with an ethical dimension, or about professional responsibilities, or about issues in which society and geoscience are joined. Whether the opportunity is a weekly colloquium or a class period devoted to ethics, resources are available on the web in support of brief presentations about applied ethics, science ethics, or geoethics. (See the list of some useful web resources at the end of this essay.) The *Northeast Ethics Education Partnership* at Brown University has developed presentations on a number of topics that are available for download. The *Center for the Study of Ethics in the Professions* at Illinois Institute of Technology also has modules on various topics in applied ethics that are available for download, as does the *Ethics CORE* and other groups. The *Teaching Geoethics Across the Geoscience Curriculum* website, supported by NSF and the Science Education Resource Center at Carleton College, is a growing source of useful materials and teaching strategies.

External ethics education. Not all geoscience departments will support the idea of spreading geoethics throughout the undergraduate curriculum. I challenge the geoscience-ethics community to recognize this issue and to collaborate on effectively mitigating the problem.

I became aware of the Khan Academy several years ago while developing a mathematically challenging module for GPS geodesy. Khan Academy (KA) is the inadvertent creation of Salman Khan -- a graduate of MIT and Harvard whose free, high-quality, online educational resources reach many more unique students in a typical week than Harvard University has taught in its entire history since 1636 [*Khan*, 2012]. Khan's short videos about math provide a mechanism for people to explore and learn mathematics on their own, without worrying about tuition or high-pressure high-stakes exams. KA provides a model for how some parts of geoethics education might be accomplished through web-based technology.

Sal Khan has taken learning off the clock, so we are not constrained by class days or times, or by the number of weeks in a semester or quarter. He frees us from complete dependence on what he calls the Prussian model of teaching, in which arbitrary boundaries are placed around knowledge so that linear teaching of discreet chunks of material can be conducted to large audiences of students during fixed times and terms. The Prussian model is fundamentally an industrial-production model for education. In Khan's model, progress is not defined along a straight line from one topic to the logical next, but rather is defined by *mastery* of information and a developing interest in the connections between one bit of information and all the rest. Learning is non-linear, asynchronous, and largely self-directed. The material is organized into coherent, short strands that can be examined within the limitations of a typical person's attention span. If you are learning about one thing and realize that you no longer remember how to do a required step, you simply go back and refresh your memory without apology or penalty. You move back and forth, this way and that, and wherever else your interests take you as you develop a more profound mastery of the material. The KA resource is always there (unlike your teachers), and enhances rather than necessarily replaces traditional coursework [*Khan*, 2012].

There are many types of resources that are currently available online for helping people learn about ethics [e.g., *Ethics Unwrapped* from the University of Texas, the Wikipedia *Portal for Ethics,* the *Stanford Encyclopedia of Philosophy* and the *Internet Encyclopedia of Philosophy*, ethics codes from various organizations, videos and educational modules]. I would like to imagine that the geoscience ethics community could develop its own online ethics resources, in coordination with applied philosophers, sociologists and others with content knowledge, and with necessary assistance from web artists and information-technology/computer-science people. The KA model serves as an encouragement that self-directed learning facilitated by a well-designed online resource is possible and can be effective. And just as KA supports students in traditional math (and other) courses, online geoethics resources can support any internal geoethics educational effort that is undertaken within a geoscience department.

An undergraduate geoscience student or post-graduate working anywhere in the world in the coming decade might be able to go online and work through the basics of general and applied ethics, access provocative and informative case studies, and begin to understand the many codependencies of geoscience and society. With appropriate sponsorship for that online resource, a novice geoscientist in the future could learn about geoethics for free, whenever and wherever they choose, and perhaps demonstrate mastery through some online mechanism whose current manifestation is the digital badge. Perhaps earning or maintaining a digital badge in geoscience ethics will become a requirement for academic degrees, professional license acquisition and renewal, and geoscience jobs in the future.

While web-based opportunities should be developed for self-guided education about geoethics, digital delivery of information is not a fully adequate substitute for more direct human interaction. What web-based curriculum could equal the benefit of watching experienced geoscientists acting ethically in all of their interactions and investigations, every day? There is no technological substitute for an ethical mentor who can talk with a novice and discuss issues and problems as they arise in the real world. There is no escaping the reality that experienced geoscientists teach by example, and thereby demonstrate whether we actually believe that ethical practice is essential. We demonstrate the strength of our commitment through our actions.

If some in the academic community do not want to participate in geoscience ethics education, the broader geoscience community worldwide should step-in to offer students an alternative. Professional and academic geoscience organizations should provide backbone services in support of geoethics education. Ethics education should be a topic represented by sessions at every regional or national meeting of all professional or academic geoscience organizations. Papers about geoethics should be accepted for publication in our professional and academic geoscience journals. Workshops and short courses about geoethics should be held frequently, independently and as a part of local or national geoscience meetings. Education in geoethics is the shared responsibility of the entire geoscience community, just as ethical behavior is (or should be) the expectation *for* the entire geoscience community.

Acknowledgments

My education in geoethics began as an apprentice engineering geologist under Dr. James E. Slosson. Through the workshop "Teaching geoethics across the geoscience curriculum," organized in 2014 by Dave Mogk, Monica Bruckner, Cathy Manduca and the staff of the Science Education Resource Center at Carleton College, I began fruitful and productive interactions with Giuseppe Di Capua, Cindy Palinkas, Catherine Pappas-Maenz, Silvia Peppoloni, Anne Marie Ryan, Peter Geissman, and Susan Kiefer, and became affiliated with the International Association for Promoting Geoethics. I adapted the case study about the housing development along an active fault from a story told by Bill Bryant. Anonymous reviewers offered insightful suggestions that I have adopted, with thanks. Of course, I bear sole responsibility for the shortcomings of this essay.

A few useful websites

American Association for the Advancement of Science, Scientific Integrity, http://www.aaas.org/page/scientific-integrity

American Geosciences Institute, http://www.americangeosciences.org
- AGI Guidelines for Ethical Professional Conduct, http://www.americangeosciences.org/community/agi-guidelines-ethical-professional-conduct
- AGI Member Societies' Codes of Ethics, http://www.americangeosciences.org/policy/policy-positions/ethics

American Institute for Professional Geologists, http://www.aipg.org
- AIPG Code of Ethics, http://www.aipg.org/about/ethics.htm

Center for the Study of Ethics in the Professions, Illinois Institute of Technology, http://ethics.iit.edu
- Codes of Ethics Collection, http://ethics.iit.edu/ecodes/
- Modules in Applied Ethics, http://ethics.iit.edu/projects/modules-applied-ethics

Ethics in Science and Engineering National Clearinghouse, http://www.umass.edu/sts/digitallibrary/

Ethics Unwrapped, University of Texas, McCombs School of Business, http://ethicsunwrapped.utexas.edu

ImpactCS Project, George Washington University, http://www.seas.gwu.edu/%7Eimpactcs//index.html

International Association for Promoting Geoethics, http://www.iapg.geoethics.org
- Codes of ethics and codes of conduct, http://www.iapg.geoethics.org/tools/cec

Internet Encyclopedia of Philosophy -- a peer-reviewed academic resource, http://www.iep.utm.edu/ethics/

Khan Academy, https://www.khanacademy.org

Murdough Center for Engineering Professionalism, Texas Tech University, http://www.depts.ttu.edu/murdoughcenter/

National Association of State Boards of Geology, http://www.asbog.org
- ASBOG Code of Ethics, http://asbog.org/documents/Code of Ethics--2014.pdf

National Center for Professional & Research Ethics, Ethics CORE, https://www.nationalethicscenter.org

National Science Foundation, Responsible Conduct of Research, http://www.nsf.gov/bfa/dias/policy/rcr.jsp

National Society of Professional Engineers, Ethics, http://www.nspe.org/resources/ethics

Northeast Ethics Education Partnership (NEEP), http://brown.edu/research/research-ethics/neep
NEEP training materials can be accessed via http://www.brown.edu/research/research-ethics/northeast-ethics-education-partnership/training-materials/training-materials

Online Ethics Center for Engineering and Research, http://www.onlineethics.org/CMS/about/UserGuide/18848.aspx

Poynter Center for the Study of Ethics and American Institutions, http://poynter.indiana.edu/teaching-research-ethics/workshop-details

Science Education Resource Center, Teaching GeoEthics Across the Geoscience Curriculum, http://serc.carleton.edu/geoethics/index.html
Professional societies mission statements and codes of ethics, http://serc.carleton.edu/geoethics/prof_soc.html

Stanford Encyclopedia of Philosophy, http://plato.stanford.edu

U.S. Department of Health & Human Services, Office of Research Integrity, http://ori.hhs.gov

Wikipedia Portal for Ethics, http://en.wikipedia.org/wiki/Portal:Ethics

References

Aamodt, S., and S. Wang (2011), Welcome to Your Child's Brain: How the Mind Grows from Conception to College: Bloomsbury Press, New York

ABET (2015), Criteria for accrediting applied science programs, 2015-2016, Accreditation Board for Engineering and Technology, http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-applied-science-programs-2015-2016/

Ahearn, J.F. (2011), Honesty, *Am. Sci., March-April,* http://www.americanscientist.org/issues/pub/2011/2/honesty

AIPG (2003), Code of ethics, American Institute of Professional Geologists, http://www.aipg.org/about/ethics.htm

Andrews, G.C. (2014), Canadian Professional Engineering and Geoscience Practice and Ethics [5th edition], Nelson Education, Toronto, Canada

ASBOG (2015), Task analysis survey 2015: A study of the practice of geology in the United States and Canada, National Association of State Boards of Geology, http://www.asbog.org.

Barger, R.N. (2008), Computer Ethics -- A Case-Based Approach: Cambridge University Press, Cambridge

Benjamin, M. (1990), Splitting the Difference -- Compromise and Integrity in Ethics and Politics, University Press of Kansas, Lawrence, Kansas

Bird, S.J. (2014), Social Responsibility and Research Ethics: Not Either/Or but Both, *Professional Ethics Report*, v. 27(2), http://www.aaas.org/news/social-responsibility-and-research-ethics-not-eitheror-both

Borchardt, G. (2010), Establishing appropriate setback widths for active faults: *Env. & Eng. Geosci.*, 16(1), 47-53.

Brooks, D. (2015), The Road to Character, Random House, New York

Bryant, W.A. (2010), History of the Alquist-Priolo Earthquake Fault Zoning Act, California, USA: *Env. & Eng. Geosci.*, 16(1), 7-18, http://s3.documentcloud.org/documents/83738/10-mapping-history-of-alquist-priolo-act.pdf

Bryant, W.A., and E.W. Hart (2007), Fault-rupture hazard zones in California, California Geological Survey, Special Publication 42, 42 p., ftp://ftp.consrv.ca.gov/pub/dmg/pubs/sp/Sp42.pdf

CGS (2004), Recommended criteria for delineating seismic hazard zones in California, California Geological Survey, Special Publication 118, http://www.conservation.ca.gov/cgs/shzp/webdocs/Documents/SP118_Revised.pdf

CGS (2008), Guidelines for evaluating and mitigating seismic hazards in California, California Geological Survey, Special Publication 117A, http://www.conservation.ca.gov/cgs/shzp/webdocs/Documents/SP117.pdf

Carson, R. (1962), Silent Spring, Houghton Mifflin, Boston

Carter, S.L. (1996), Integrity, Harper Perennial, New York

Cronin, V.S., and K.A. Sverdrup (1998), Preliminary assessment of the seismicity of the Malibu Coast Fault Zone, southern California, and related issues of philosophy and practice, *in* A Paradox of Power--Voices of Warning and Reason in the Geosciences, Reviews in Engineering Geology, edited by C.W. Welby and M.E. Gowan, pp. 123-155, Geological Society of America, Boulder, Colorado

D'Angelo, J. (2012), Ethics in Science -- Ethical Misconduct in Scientific Research, CRC Press, Boca Raton, Florida

Einstein, A. (1950), The laws of science and the laws of ethics, *in* Albert Einstein, Out of My Later Years, Estate of Albert Einstein, pp. 114-115, Wings Books, Englewood Cliffs, New Jersey

Fisher, C.B. (2003), Developing a code of ethics for academics -- commentary on 'ethics for all: differences across scientific society codes,' *Science and Engineering Ethics*, 9, 171-179.

Gauch, Hugh G., Jr. (2012), Scientific method in brief, Cambridge University Press, Cambridge

Geological Society of London (2014), Geology for society, Geological Society of London, http://www.geolsoc.org.uk/geology-for-society

GWU (1998), ImpactCS website, George Washington University, http://www.seas.gwu.edu/%7Eimpactcs//index.html

Gert, B. (2004), Common Morality -- Deciding What to Do, Oxford University Press, Oxford

Gert, B. (2005), Morality -- Its Nature and Justification [revised edition], Oxford University Press, Oxford

Goodstein, D. (2010), On Fact and Fraud -- Cautionary Tales from the Front Lines of Science, Princeton University Press, Princeton, N. J.

Greene, J. (2013), Moral Tribes -- Emotion, Reason, and the Gap Between Us and Them, The Penguin Press, New York

Harris, C.E., M.S. Pritchard, M.J. Rabins, R. James and E. Englehardt (2014), Engineering Ethics -- Concepts and Cases [5th edition], Wadsworth, Boston

Herkert, J. (1999), ABET's Engineering Criteria 2000 and Engineering Ethics -- Where Do We Go From Here? Online Ethics Center for Engineering and Research, http://www.onlineethics.org/cms/8944.aspx

Herkert, J.R. (2005), Ways of thinking about and teaching ethical problem solving -- microethics and macroethics in engineering, *Science and Engineering Ethics*, 11(3), 373-385

Hoose, S., editor (1993), Symposium on Ethical Considerations in the Environmental Practice of Engineering Geology and Hydrogeology: Association of Engineering Geologists, 36th Annual Meeting, San Antonio, Texas

Jackson, C.I. (2000), Honor in Science, Sigma Xi, Research Triangle Park, N. C., https://www.sigmaxi.org/docs/default-source/Programs-Documents/Ethics-and-Research/free-pdf.pdf?sfvrsn=2

Kant, I. (1784), Idea for a Universal History from a Cosmopolitan Perspective, *in* Toward Perpetual Peace and Other Writings on Politics, Peace, and History -- Immanuel Kant, edited by P. Kleingold, 2007, Yale University Press, New Haven, Connecticut, http://yalepress.yale.edu/yupbooks/excerpts/kant_perpetual.pdf

Khan, S. (2012), The One World School House -- Education Reimagined, Twelve, New York

Leopold, A. (1949), A Sand County Almanac: Oxford University Press, Oxford

Lollino, G., M. Arattano, M. Giardino, R. Oliveira, and S. Peppoloni, editors (2014), Education, professional ethics and public recognition of engineering geology, Proceeding of the XII International IAEG Congress, Torino, Engineering Geology for Society and Territory, volume 7, Springer, Cham, Switzerland

Luegenbiehl, H.C., and M. Davis (1992), Engineering codes of ethics -- analysis and applications, unpublished paper originally written to be part of the Exxon Modules for Applied Ethics Series, http://ethics.iit.edu/publication/CODE--Exxon Module.pdf or http://hdl.handle.net/10560/2228

MacIntyre, A. (1998), A Short History of Ethics -- A History of Moral Philosophy from the Homeric Age to the Twentieth Century, University of Notre Dame Press, Notre Dame, Indiana

Macrina, F.L. (2014), Scientific Integrity -- Text and Cases in Responsible Conduct of Research [4th edition], ASM Press, Washington, D.C.

Martin, M.W., and R. Schinzinger (2005), Ethics in Engineering [4th edition], McGraw-Hill Science/Engineering/Math, New York

Mogk, D., 2014, Responsible conduct of research, *Teaching Geoethics Across the Geoscience Curriculum*, Science Education Resource Center, http://serc.carleton.edu/geoethics/rcr_responsible.html

National Academies (2009), On Being a Scientist -- A Guide to Responsible Conduct in Research [3rd edition], National Academies Press, Washington, D.C.

National Center for Professional & Research Ethics (2015), Ethics CORE: National Center for Professional & Research Ethics, University of Illinois at Urbana-Champaign, https://www.nationalethicscenter.org

Oreskes, N., and E.M. Conway (2010), Merchants of Doubt: New York, Bloomsbury Press, New York

Peppoloni, S. and G. Di Capua (2015), Geoethics -- The Role and Responsibility of Geoscientists: Lyell Collection, Geological Society of London, Special Publication 419

Petrosky, H. (1985), To Engineer is Human -- The Role of Failure in Successful Design, St. Martin's Press, New York

Rutherford, F.J., and A. Ahlgren (1991), Science for All Americans -- A Project 2061 Report on Literacy Foals in Science, Mathematics, and Technology: Oxford University Press, Oxford, http://www.project2061.org/publications/sfaa/online/sfaatoc.htm

Seebauer, E.G., and R.L. Barry (2001), Fundamentals of Ethics for Scientists and Engineers: Oxford University Press, Oxford

Shafer-Landau, R. (2012), The Fundamentals of Ethics [2nd edition], Oxford University Press, Oxford

Shafer-Landau, R. (2015), The Ethical Life -- Fundamental Readings in Ethics and Moral Problems [3rd edition]: Oxford University Press, Oxford

Shuirman, G., and J.E. Slosson (1992), Forensic Engineering -- Environmental Case Histories for Civil Engineers and Geologists, Academic Press, San Diego, California

Sigma Xi (1993), A Summary of the 1993 Sigma Xi Forum *Ethics, Values and the Promise of Science*, https://www.sigmaxi.org/docs/default-source/Programs-Documents/Ethics-and-Research/1993ethicsforumsummary.pdf?sfvrsn=4

Starr, W.C. (1991), Ethical theory and the teaching of ethics, *in* Ethics Across the Curriculum -- The Marquette Experience, edited by R.B. Ashmore and W.C. Starr, Marquette University Press, Milwaukee, Wisconsin

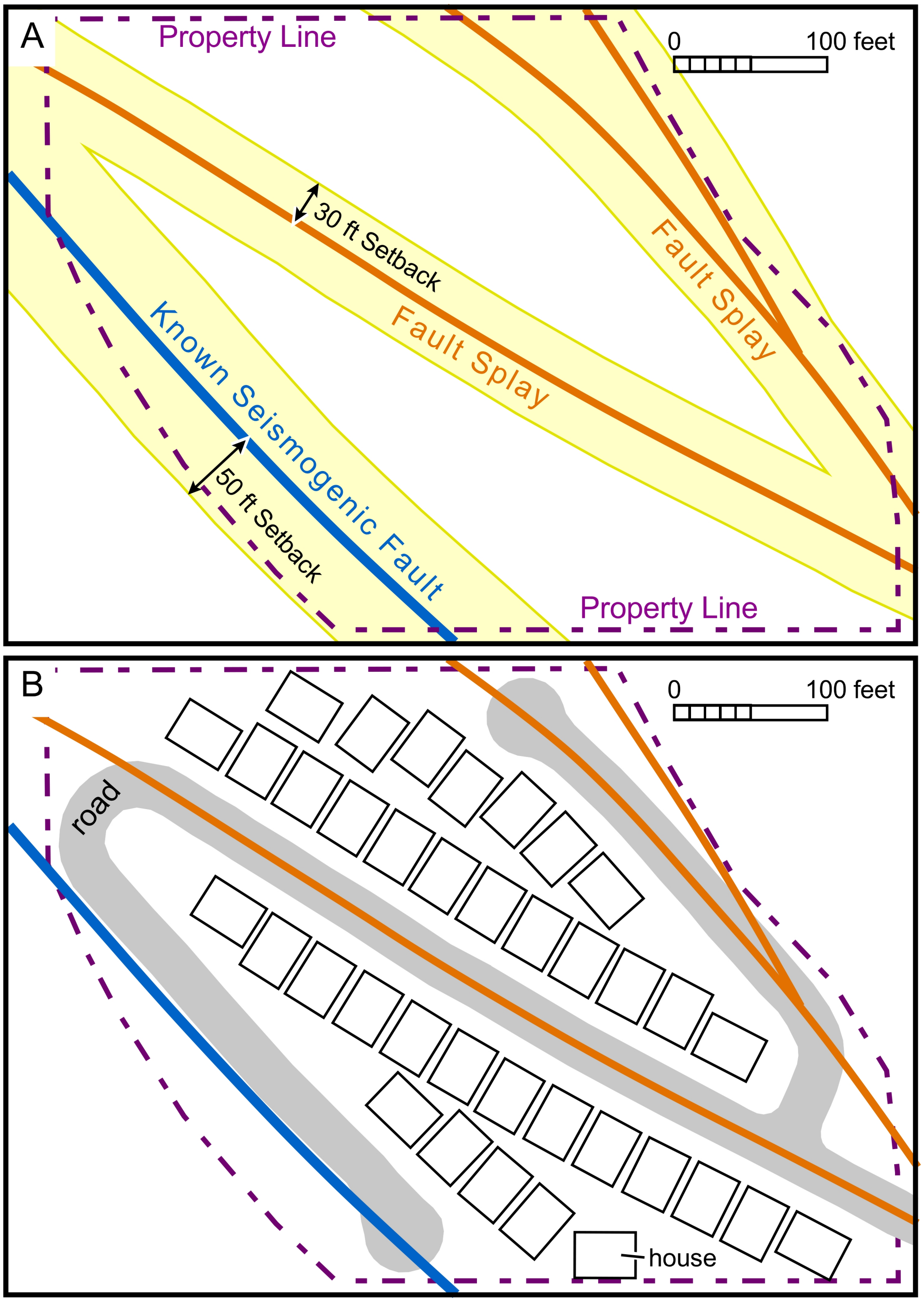
State of California (2007), Seismic Hazards Mapping Act, California Public Resources Code, Division 2, Chapter 7.8, http://www.conservation.ca.gov/cgs/shzp/Pages/shmpact.aspx

Stichler, R.N., and R. Hauptman, editors (1998), Ethics, Information and Technology Readings, McFarland & Company, Jefferson, N. C.

Swazey, J., M. Anderson and K. Louis (1993), Ethical problems in academic research, *Am. Sci., November-December*, 542-553, http://www.americanscientist.org/issues/feature/ethical-problems-in-academic-research/1

Weston, A. (2013), A 21st Century Ethical Toolbox [3rd edition]: Oxford University Press, Oxford

Wyss, M., and S. Peppoloni (2015), Geoethics -- Ethical Challenges and Case Studies in Earth Sciences, Elsevier, Amsterdam


A
Property Line
0
100 feet
30 ft Setback
Fault Splay
Fault Splay
Known Seismogenic Fault
50 ft Setback
Property Line
B
0
100 feet
road
house