AEG Presentation, 2022

Why do I think geoethics is fundamental to engineering geoscience?

by Vince Cronin

**SLIDE 1** I understand that I am the only thing standing between you and lunch, so thank you for being here.

I am grateful for the opportunity to serve the **AEG** and **GSA's *Environmental and Engineering Geology Division*** as the Richard H. Jahns lecturer for this coming year.

**SLIDE 2** The first Jahns Lecturer, back in 1989, was my friend and mentor, Dr. Jim Slosson. Jim had been the State Geologist of California from 1973 to 75, and then presided over a company of consulting engineering geologists. AEG member Paul McClay introduced me to Jim in 1979, when I was a newly minted Bachelor of Geology from Pomona College. At the time, I had ***no idea*** how to find **the trailhead to my career**.

**SLIDE 3** Soon, I was working a few days a week for Jim as an apprentice engineering geologist. I continued to work with Jim on various projects for almost three decades as I made my way through graduate schools and into a career in geoscience research and education.

**SLIDE 4** I've worked on several presentations for this year's Jahns lecture series. The list of topics I hope to present in my Jahns lectures this year is available through a website I've created for the purpose, and its URL is shown at the bottom of the next few slides. I have it printed on a card I would be glad to give you after the talk.

**SLIDE 5** One of the presentations I'm offering is **"How can an engineering geologist find an active fault?"**

I'm not a seismologist, and seismologists are generally not field mappers. Geoscientists have not mapped all active, seismogenic faults that might pose a hazard to people and the built environment. So how can an engineering geologist use high-quality open-source data to identify the surface trace of faults that might still be able to generate a damaging earthquake? This is appropriate to a general or undergraduate audience, and many graduate students could benefit from the overview.

**SLIDE 6** Another of the presentations I'm offering is **"The search for the Dog Valley Fault."**

The Dog Valley Fault generated a magnitude 6 earthquake just north of Lake Tahoe in 1966, and its ground-surface trace has not been firmly established. This talk describes an application of methods covered in the previous talk, aided by work done recently by Kate Hobart in her Masters thesis research. Each of these two talks stand on its own as an explanation of methods that geologists can use to find active faults.

This hillshade image was made from a 1-meter DEM derived from LiDAR data, and is used to help us find structural lineaments parallel to the fault strike. *<<show compound lineaments>>*

**SLIDE 7** Recurrence of a large earthquake on the Dog Valley Fault might lead to failure of earth-fill structures like Stampede Dam near Truckee. Failure of this dam and the Boca Dam just downstream could cause many casualties and massive damage along the Truckee River as the flood passes through downtown Reno.

**SLIDE 8** I can also describe **A path from "rocks for jocks" to a career in engineering geology.**

We tend to attract students into geology departments through our introductory courses. Some think of geology as camping for a living, but a better hook is to stress the benefits that geologists provide to society. Serious students (or students with serious parents) consider job prospects as they search for a major in college. They want to find a path that leads to a viable career. None of the students shown in this photo from a lecture in my introductory geology course had declared a geology major at the beginning of the semester. Several of these students graduated with BS degrees in geology, interested in pursuing a career that matters to society.

**SLIDE 9** Beyond college, development of a novice engineering geologist usually involves a sort of classic apprenticeship to gain practical knowledge from experienced geologists. And the engineering geology community plays an important role in developing the next generation of applied geoscientists through professional societies like AEG and GSA.

**SLIDE 10** I can also talk about my sense that "**Geoethics is at the heart of engineering geoscience"**

The ethical dimensions of geoscience were not explicitly considered in my college coursework, beyond matters related to the responsible conduct of science. There is more to this job than just knowledge, skill, and technique. This talk will introduce the idea of geoethics as forming an essential foundation for our work in the public interest as engineering geologists.

**SLIDE 11** The last of my presentations that I will mention might be the most important: "**How can engineering geology help society meet the challenge of a changing climate?"**

Engineering geology forms an important part of the practical interface between humans and our Earth's environment. Mitigating the effects of a warming climate will require the sustained efforts of the engineering and engineering geoscience communities throughout the coming decades. In parallel with the need to reduce the human-controlled drivers of global warming, we need to provide reliable information to society so that the adverse effects of a changing climate can be avoided or mitigated. Ignoring the problems will not solve them, but preparing to address the problems will lead to opportunities for engineering geologists to provide great service to society.

**SLIDE 12** So you are hereby deputized to help me seek out audiences for Jahns lectures in your neck of the woods and surrounding areas. I am particularly interested in reaching novice geologists and geology students who might be looking for their own trailhead into a useful career, applying geoscience in the public interest. I am asking for your help in this work.

**SLIDE 13** I learned a lot from Jim and his associates that was not covered in my undergraduate education. How to survive logging a borehole and a trench. How to recognize landslides, faults, daylighted beds, potential debris-flow hazards, and what steps should be taken to mitigate the effects of these hazards.

**SLIDE 14** But the most profound and lasting lessons involved our ethical obligations as professionals in service to society. And so I would like to mention two cases I helped Jim with early in my career that had a profound influence on my understanding of how professional ethics is fundamental to our work.

**SLIDE 15** The first involved a site about 110 km northwest of Los Angeles. Gerry Shuirman, Tom Slosson and I worked on this case under Jim's direction.

**SLIDE 16** Interstate Highway 5 was built at the bottom of the valley of Grapevine Creek where it flows through the Tehachapi Mountains toward Bakersfield, California. I-5 is one of the most important highways in California, and is the most direct road from Los Angeles to San Francisco.

**SLIDE 17** During a major rainstorm just before dawn on February 5, 1978, ...

**SLIDE 18** ...water and debris from multiple drainages on the hillslope west of the highway flowed into and blocked the drainage culverts under the roadway. Between 35,000 and 55,000 cubic meters of debris flowed onto the only available surface: the southbound or uphill lanes of I-5.

**SLIDE 19** On that dark, stormy night, the debris flows had enough volume and power to pick-up and move fully loaded semi-tractor trailers, and add their loads to the debris. As the cab of this truck swung around in the flow, the driver saw the red tail lights of a car disappear into an open drainage flume between the north- and south-bound lanes.

**SLIDE 20** The tail lights belonged to a red Ford Maverick. The debris flow had picked it up and carried it to this flume, where the paint scratched from the car was still visible on the concrete walls months later.

**SLIDE 21** The car was carried two kilometers onto the alluvial fan at the base of the canyon. The driver was a young mother trying to get home to her husband and children.

It took days for her body to be recovered. *<pause>*

**SLIDE 22** During the subsequent litigation, it was proven that the public agency that had been responsible for designing, building, and maintaining this stretch of Interstate 5 had ***not*** built the drainage system to handle any sediment or debris. The drainage system had been built to accommodate ***only*** clear-water runoff. They had not utilized adequate geological input or highway engineering ***best practice*** in the design of this highway.

Most of the debris that clogged the drains and flowed onto the highway originated ***in*** or ***immediately adjacent to*** the drainage channels along the hillside, accumulating over the course of months to many years.

**SLIDE 23** Even though the State had sovereign immunity, the family received a substantial settlement. Of course, that did not mitigate the fact that an important life was lost.

This remains a dangerous road during storm events. My understanding is that much greater attention is now given to maintenance along this section of I-5, but that relevant structural changes have not been made to the drainage system in the 44 years since this tragedy.

An engineering geologist would recognize the enormous compound landslide on the left or east side of Grapevine Canyon in this photo. The highway design placed culverts at the base of each obvious drainage, but an engineering geologists would have investigated those drainages and noted the debris potential. Working with highway engineers, engineering geologists could have improved the design of this important artery, saving lives and property in the process.

More information about this case is in a paper I wrote with Jim and Tom Slosson and Gerry Shuirman, which is referenced at the Jahns website.

**SLIDE 24** The second case took place in the small town of Pacifica, California, which is a bedroom community for the San Francisco-San Jose corridor.

**SLIDE 25** On Christmas day, 1981, the Velez family consisted of father Bill, mother Barbara, and three children: Michelle, age 14; Billy, age 7; and Melissa, age 4. They lived in a house built just 8 years earlier on Oddstad Boulevard.

**SLIDE 26** In the initial soils and geology report before the new subdivision was built, the developer's consultants wrote the following:

"We have completed an investigation of the soil geologic conditions of the subject site.

The investigation consisted of a soil and foundation study ***and a geologic reconnaissance of the local area...***

Our findings indicate that the site is suitable for the proposed residential use..."

**SLIDE 27** During a major rainstorm on January 4, 1982, soils in a swale behind the houses on Oddstad Blvd became mobilized in a debris flow that slammed into the house next to the Velez home.

**SLIDE 28** The flow moved that house off its foundations and sent it crashing into the Velez house, crushing it, and **killing all three of the children in the family**.

**SLIDE 29** It took 36 hours to find them in the mud and debris.

The debris flow was studied by Roy Shlemon, Robert Wright, and David Montgomery, whose excellent paper from 1987 describes the geology and dynamics of the event. Most of the debris that flowed toward Oddstad Boulevard had originated in or immediately adjacent to the swale in the hillside above the houses, accumulating over the course of perhaps hundreds or thousands of years. The houses were built, in part, on graded fan deposits from ancient debris flows.

**SLIDE 30** I helped Jim Slosson during the subsequent litigation, when the developers and their consultants offered several explanations for this failure.

**SLIDE 31** • The source of the debris was on the other side of the property line, and so they had no authority to investigate off-site conditions.

**SLIDE 32** • Colluvium-filled swales were not commonly recognized as potential hazards — it was beyond standard practice. (This was probably true, as Roy Shlemon and his coauthors suggested.)

**SLIDE 33** • This project was driven by the developer and engineers. Geology was a minor consideration. Unfortunately, the safety of the humans who would inhabit the houses at the base of that ridge also appears to have been a minor consideration.

**SLIDE 34** Years later, Barbara Velez said that she had thought that their home was built in a safe place. She had no idea it had been built right below the geological equivalent of a loaded shotgun.

The Velez parents divorced, completing the destruction of that family.

In a photograph taken from the same vantage point as this one from January 1982, ...

**SLIDE 35** ...here is the site as it appears today. The land where the destroyed houses once stood was purchased by other people, who built new houses on the vacant lots. The house you see on the left here is the new house built at the base of the swale, on a lot established on the Holocene debris-flow fan that should have been identified when the area was mapped in 1969, before the subdivision was built.

**SLIDE 36** The new house has a small corridor next to it for any future debris flows to pass through. The mitigation of the hazard is simple and inexpensive.

**SLIDE 37** A quarter century ago, I presented this case at an AEG symposium on geoethics. After my presentation, an older gentleman pulled me aside and asked me if it was unethical to make a mistake. There was emotion in his voice — perhaps regret or sorrow. His question caught me up short. Whatever I said in that moment, the truth is that I had no good answer. Later, I decided that perhaps I needed to stop pontificating about ethics until I had gained more experience and perspective. Whether I have that perspective yet is a matter of opinion.

**SLIDE 38** Society needs reliable geoscience information so that we can build necessary structures in the geological environment. Architects and engineers depend on reliable geoscience information. And sometimes, despite our best efforts and working to the highest standards of care, bad stuff happens. Mother Nature always bats last.

The first two studies involved forensic investigations and litigation related to disasters in the past. It was apparent to me in both cases that the right thing for the engineers and geologists to have done is to search for and mitigate hazards associated with their projects that could destroy structures and even lives. My final case story this morning raises the question of how we should act as ethical professionals to prevent, avoid, or mitigate future problems?

**SLIDE 39** This last case with an ethical dimension was brought to my attention by Bill Bryant of the California Geological Survey.

The San Francisco-San Jose corridor has some of the most expensive real estate in the world, and so the pressure to develop housing that is convenient to workplaces is intense. In 1906, the San Andreas Fault generated a magnitude 7.8 earthquake resulting in more than 12 feet of right-lateral slip in the area enclosed in the white rectangle, which is detailed in the next image.

**SLIDE 40** After the Alquist-Priolo Earthquake Zoning Law was enacted in 1971, one area along the San Andreas that had not previously been developed was generally considered to be undevelopable, because several strands of the active fault passed through it. A few years ago, a developer acquired this vacant land.

**SLIDE 41** They hired State-licensed geological consultants to trench the property and locate the fault strands The double lines show where trenches were dug, and the traces of the faults they uncovered are shown in blue.

**SLIDE 42** The developer mapped-in commonly used setbacks from active fault traces, shown in yellow...

**SLIDE 43** ...and created a design maximizing the number of houses that could be built in the remaining space, using the average footprint of existing houses in the neighborhood. They planned to use the setback space for roadways and utilities — water, electricity, waste, telecommunications, et cetera. The plan complied with all existing statutes. Would you approve this plan for construction? ***<pause>***

**SLIDE 44** (same as 43)

**SLIDE 45** Well, as a visit to Google Earth will demonstrate, this development ***was*** approved and built. So now you can own a house located literally within the active traces of one of the most dangerous faults in the world. It is reasonable to assert that virtually all geologists know what will happen here at some point in the future when the northern San Andreas Fault uncorks another great earthquake.

**SLIDE 46** But do the people living in those houses, now and in the future, understand and accept the hazard that surrounds them? That's a rhetorical question — of course they don't. They assume that these new houses that have been inspected and permitted by the government are safe places to live and raise their families. What do we, who clearly see and better understand the risks, owe to these people and to society?

I have heard licensed geoscientists say that their work and recommendations are consistent with all relevant governmental laws and regulations, and that their client would not pay for any work beyond that. Privately, they might admit that they would like to practice at a higher level, but it's just a business decision not to.

This places current standard practice at the lowest level allowed by the government.

**SLIDE 47** ***Slosson's Law***, named for Jim Slosson, states that "practice will drop to the lowest level permitted by the administration and enforcement of applicable law."

**SLIDE 48** We can and must do better as a profession of engineering geologists.

**SLIDE 49** We must support the positive evolution of codes, and the enforcement of codes, so they can better protect public safety.

An essential characteristic of our professional work is its service to the public — to society as a whole. We are the scientific liaisons between society and the geological environment.

**SLIDE 50** Geologist Bob Tepel refers to the "primacy clause" in codes of professional ethics, which establishes that a professional has an ethical duty to the public. In our professional work, the health, safety, and wellbeing of the public are paramount.

**SLIDE 51** In this view, business decisions do not outweigh our professional obligation to protect the public. Public safety is a core value in engineering geoscience.

**SLIDE 52** We professional geoscientists must be stewards of Earth's environment.

**SLIDE 53** Our development activities should be of sustainable benefit to society.

**SLIDE 54** And we must avoid or effectively mitigate potential hazardous consequences of projects in which we participate.

**SLIDE 55** For more information about this and other Jahns lectures this year, and to contact me with suggestions, please go to this website.

Remember, I need your help so that the Jahns Lectures this year will reach a broad audience. Thank you for your attention.