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# The Citizen–Geologist
# *GSA Presidential Address, 1992*


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**E-an Zen**

I'd like to talk about a matter that calls for our collective attention: What the role of GSA and of geologists should be in the future well-being of our world.

For over a century, GSA has enjoyed the respect of the geological community, earned by a superb record of promoting and spreading scholarly information on geology. If the self-image of an institution can be measured by the people it chooses to honor, then our Penrose Medalists may gauge our ideal. Searching among the names of only those medalists no longer with us, I find Charles Schuchert, Norman Bowen, Reginald Daly, William Morris Davis, Arthur Holmes, William W. Rubey, Preston Cloud, and Harry Hess. Discoverers and innovators all, their thoughts have shaped the way we look at Earth and at our science.

With a few notable exceptions, however, these honored men (for they are all men) spoke mainly to other geologists. We have not expected our leading scientists to reach out to the public or to the political leaders. Should GSA play an active role in public outreach, or should it keep to the traditional focus of propagating scholarly knowledge? These questions deserve serious debate.

Science is too important to be left to the scientists. Geology directly impinges on human welfare and so cannot be an ivory-tower science. Conservation of the environment, discovery and recovery of Earth's resources, avoidance of natural hazards, disposal of wastes, forecasting of global change, decisions on land use, equity for the future—these and other issues need geological knowledge both for technical resolution and for guiding public policy. Public policy needs public support; we ignore the public at our own peril.

That peril is something we geologists know only too well. We feel frustrated that we are under-represented in science, in education, and in the shaping of public policy; that earth science is often regarded as a second-class subject in schools; that when the news media describe our natural world they often omit geological information; and that in a budget crunch, departments of geology and state geological surveys are among the first casualties. These situations cry out for us to improve the visibility of geology and to widen its public role. Public outreach is a responsibility from which we may not shirk.

We can help improve people's appreciation of geology by building a record of timely, useful, and visible contributions to their welfare. We can also set an example for interdisciplinary cooperation in matters that affect society's well being. Physicists in the United States enjoy their political credibility partly because they rose to meet the demands of the Second World War, symbolized by the Manhattan Project. To save our planet may well be the next, global, Manhattan Project or, using Albert Gore's (1992) more positive metaphor, a globally shared Marshall Plan. Such an undertaking will involve many disciplines and different kinds of institutions, but geology should have a central role. Will we be ready with wise and specific plans to steer decision makers toward good choices? Let's prepare ourselves for that happy prospect.

Clearly, better science education is a key to any long-term effort to inform people about our natural world, and GSA is actively promoting earth-science literacy. Scientific literacy is part of a public agenda because it can enhance ballot-box competency. We must relate scientific knowledge to society's sense of value—what is right, what is wrong, what is important—so that people can meld scientific knowledge with their own lives. How do we begin?

Let's first consider the public image of a scientist. This is not a frivolous consideration; public perception of a scientist reflects and affects how the public reacts to science. A scientist is often depicted as an egocentric white male, a brilliant weirdo in a white lab coat, deficient in common sense, working like a fiend, driven equally by curiosity and by greed. This caricature permeates science fiction, comic strips, TV, and even serious newspapers. I suspect that this image feeds partly on misunderstandings and partly on revulsion against research that offends some people's moral sense. We have not fully faced this issue, and we aggravate the problem every time we duck people's questions about science or scientists. As a start, we need to show people that scientists are normal human beings having the same basic human concerns and impulses.

Another element affecting the image of a scientist has to do with scientific ethics. Issues involving ethics are rightly newsworthy, and cases of scientific misconduct do catch public attention. People now realize that scientists, being human, are not only fallible but temptable, and that research organizations sometimes fail to police themselves.

Ethics does indeed permeate science. Every step we take, from observation to publication, involves ethical decisions. When may I throw out anomalous data? How do I interpret ambiguous information? Should I admit an error in judgment? Who should be my coauthors? Is my research topic intrinsically immoral? These decisions shape the quality of the results. Because science is a public enterprise and because ethical factors underlie the relation between the taxpayer and the scientist, we need to develop serious dialogue with our fellow citizens, and cultivate shared values as well as shared interests, based on our common stake in the future.

Environmental ethics is an area where geology has a natural role. I am thinking specifically of our responsibility to protect the long-term ability of Earth to sustain life in its myriad wondrous forms in the face of a growing human population enticed by the prospect of resource-hungry technology. To ask how much life Earth can support acknowledges that we are concerned with Earth as a habitat for all, and not just for *Homo sapiens*. The decision makers have to know that the needs of the other life forms, the entire ecosystem, require adequate attention if humankind is to thrive. They need to be reminded that decisions on land use wipe out future options; option itself is a nonrenewable resource (Zen, 1983).

Perhaps the issue of wetlands can illustrate some of my points. In 1988 George Bush proposed an environmental policy that included "no net loss" of wetlands. Today, an executive redefinition of wetlands reduces that protection. This legal juggling might put the integrity of significant wetland areas at risk (Alper, 1992; Nicholas, 1992). Is the mere preservation of the total area of wetlands enough to ensure their long-term robustness? Can wetlands be created or repaired fast enough to compensate for losses, yet sturdily enough to fully perform their natural functions (National Research Council, 1992)? How does one create new wetlands, and in whose backyard? Yours or mine?

As geologists, we can help discover the natural processes that sustain a wetland, as well as clarify how human activities might modify these processes. That's our normal job. But we also need to tell lawmakers and voters why wetlands are important, why they must be protected, and how their protection goes beyond satisfying legal definitions and filling administrative pigeonholes.

A different subject that demands attention is the public appreciation of where earth science fits into the school curriculum for kindergarten through twelfth grade. Does earth science qualify as a lab science? This question directly affects the ability of earth science to attract students. Confusion is rampant, in part because we geologists are schizophrenic on this matter. Earth science encompasses the lab sciences, meaning chiefly chemistry and physics, because first, we need these tools to calibrate and project natural relations, and second, we need the constraints of these disciplines to help us distinguish what's plausible from what's fantastical. However, earth science is more than just applied chemistry and physics, because geology is at its core. Geology is also a historical science that draws inferences from unique events, a process that gives our science its important concepts of time, sequence, and correlation.

Let me put it another way. Laboratory studies are usually so designed that the initial and boundary conditions, as well as the variables, are carefully controlled, so that one could gain detailed understanding of idealized systems. Earth science must practice this kind of discipline, but it also must deal with the real world. This real world is not simple and neat. It is nonlinear, it is contingent, it is time-dependent, and it usually consists of a complex and messy overlay of events. Thus, when we apply to Earth precise understandings gained from simplified systems, we have to extrapolate to situations where we cannot run away from nature's untidiness. The two approaches are as woof and warp in weaving: neither can serve alone. We need to discuss the matter, one on one, with educators at both K through 12 and university levels, so that they will incorporate these understandings in their policy decisions.

Granted that science is vital to society; must we aim at literacy for all? Isn't that rather wasteful? After all, only a few percent of students can be expected to need science; the rest seem to get along quite well without it. Morris Shamos, a past president of the National Science Teachers Association, raised this question by asking, "Is it necessary that the mayor of New York be versed in plate tectonics to run city hall?" (Shamos, 1988).

Plate tectonics or not, science does enter into the running of city hall. That was also Pete Palmer's point in his article "What should my neighbor know?" (Palmer, 1990). Those who will be making policy choices in 15 or 20 years are today's students, and one of them may be the next city manager, the next CEO of a major industry, the next environmental activist, the next judge, the next legislator, or the next president or prime minister. Certainly, most citizens will have to respond to technology- and science-based issues at several levels of government: for example, pumping groundwater for irrigation, disposal of nuclear waste, or allocation of public land between preservation and use. Successful resolutions of these technical issues depend on the concurrence of the affected people. My answer to Mr. Shamos's challenge is that we are obliged to cast our nets widely and to expose as many people as possible to basic knowledge because we don't know who will need this knowledge.

If we want the world to pay greater attention to geology, and if we want decision makers to allocate more resources for geology, then we need to demonstrate the importance of geology in public affairs, and we must accept our public obligation to be good citizen-geologists. This means that we need to include nonscientists among the immediate beneficiaries of the knowledge we garner and disseminate, and we must make sure that, dealing with them, we use language that's free of jargon or hidden connotations. Our contribution should not exclude professional judgment, clearly labeled, of course, for if we withhold our professional judgment, we would still affect policy formulation, albeit in a negative way.

We are geologists by choice, but we are inhabitants of this fragile planet perforce. As geologists, we are supposed to know the importance of looking at Earth as a total system, and to know how to be its good stewards. We should be prepared to speak to our conviction. I, for one, would say this to the world: If we want sustainable global development, then we must learn to be good guests and walk lightly upon Earth. We must contain both the explosion of world population and the explosion of our consumption of resources. Both explosions devastate our Earth, both consume our future options, and both destroy hopes of sustainable development.

Consider this. In terms of consumption of key energy resources and emission of greenhouse gases, the United States contributes a good deal more than India, China, Indonesia, and Brazil combined, although the total population of those countries is about ten times that of ours (Table 1). In terms of lifetime load on the environment, every additional North American is equal to about 15 additional people in those countries. It seems to me that we cannot continue to enjoy our riches if the rest of the world has to queue up for their daily bread. All nations must share the responsibility of ensuring the equity of future societies because we live under the same blue sky. Indeed, unless we can contain the twin explosions of population and consumption, all other measures of conservation and natural hazard avoidance will be no better than putting Band-Aids over mortal wounds, or taking aspirin for cancer.

If geology is to play a major role in the effort to use Earth wisely, then we need to act on that conviction. GSA is already in there. Our SAGE program and our Institute for Environmental Education, as well as our various outreach committees, are working productively on many important challenges. Our joint sponsorship with the U.S. Geological Survey of the Congressional Science Fellows program has been a success, and our participation in the American Geological Institute's Government Affairs Program is off to a good start. Nevertheless, we must do more, especially toward building equity for the future. To do so, we need to collaborate with our colleagues in other lands. Perhaps together we can help figure out how to set aside some of our remaining natural endowment for the future world, in ways that meet each nation's own needs and perceptions. Going beyond that thought, perhaps we should consider whether we need an international earth-science–centered think tank; a group to define and recommend specific long-range actions, rather analogous to Resources for the Future. The Committee for the Wise Use of the Earth, chaired by Bill Fyfe, is pondering what GSA and geologists can do to assure sustainable global development. They'd welcome your ideas.

As important in the long haul, we need to work with people as individuals. We need to reach out to students and to their parents; we need to work with teachers. We ought to get involved in public service, and we should convey our views to our elected representatives. Although a single person is unlikely to make a large mark, if we all make an effort, we just might make a difference. This will be a great challenge to us individually as well as collectively as members of GSA. This will be a great adventure, where we need to thing big and think ahead. Our involvement will demand a high standard of work as well as a high level of sensitivity to public perception. This call cannot wait for someone else, because singly and collectively *we* are that someone else.

In closing, I thank Sam Adams, Norman Newell, Pete Palmer, Craig Schiffries, Catherine Skinner, Reds Wolman, and especially Alta Walker for commenting on various drafts of this talk. I appreciate having the privilege to take a turn at standing watch for GSA. It has been a challenging and stimulating year. I gratefully acknowledge the wonderful help and support from the entire headquarters staff. I've had fun.



TABLE 1. COMPARISON OF RESOURCE CONSUMPTION AND GREENHOUSE GAS GENERATION

| | | Four populous developing nations | | | | |
|---|---|---|---|---|---|---|
| | United States | China | India | Indonesia | Brazil | Combined |
| Population, 1990 (x $10^6$) | 249 | 1139 | 853 | 184 | 150 | 2326 |
| Commercial energy consumption, 1989 (joules) | | | | | | |
| Total | 73,370 x $10^{15}$ | 26,156 x $10^{15}$ | 7528 x $10^{15}$ | 1453 x $10^{15}$ | 3445 x $10^{15}$ | 38,582 x $10^{15}$ |
| Per capita | 295 x $10^9$ | 23 x $10^9$ | 9 x $10^9$ | 8 x $10^9$ | 28 x $10^9$ | 17 x $10^9$ |
| Metals consumption, 1990 (tons, x $10^3$) | | | | | | |
| Aluminum | 4352 | 650 | 420 | n.d. | n.d. | n.d. |
| Copper | 2143 | 512 | n.d. | n.d. | n.d. | n.d. |
| Crude steel | 102,351 | 69,504 | 20,036 | n.d. | n.d. | n.d. |
| Greenhouse gas emission, 1989 (tons) | | | | | | |
| Industrial $CO_2$ | | | | | | |
| Total | 4869 x $10^6$ | 2389 x $10^6$ | 652 x $10^6$ | 138 x $10^6$ | 207 x $10^6$ | 3386 x $10^6$ |
| Per capita | 19.7 | 2.2 | 0.8 | 0.8 | 1.4 | 1.5 |
| Anthropogenic methane | | | | | | |
| Total | 37 x $10^6$ | 40 x $10^6$ | 36 x $10^6$ | 6.5 x $10^6$ | 8.8 x $10^6$ | 91.3 x $10^6$ |
| Per capita | 0.15 | 0.04 | 0.04 | 0.04 | 0.06 | 0.04 |
| CFC | | | | | | |
| Total | 130,000 | 12,000 | 4000 | 1000 | 6000 | 23,000 |
| Per Capita | 523 x $10^{-6}$ | 11 x $10^{-6}$ | 5 x $10^{-6}$ | 5 x $10^{-6}$ | 40 x $10^{-6}$ | 9.9 x $10^{-6}$ |

*Note:* Data from World Resources Institute (1992, from Tables 16-1, 21-2, 21-5, 24-1, and 24-2); n.d. indicates no data from the institute.

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