Uses of a Global Mineral Resource Assessment

The Contributions of Geologic Information to Economic, Social, and Environmental Sustainability

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Environmental issues received increasing attention during the last three decades of the 20th century, a situation that no doubt will continue as we move into the 21st century. Societies all over the world began to realize that the ability of the Earth's systems to supply natural resources and services is finite, but that demands on those systems are multiplying rapidly (Arrow and others, 1995). The viability of current lifestyles and consumption patterns began to be questioned. Many different societies and professions embraced the paradigm of sustainable development as a philosophical construct within which to frame fundamental questions about the use and preservation of natural capital. The paradigm is based upon the ethical premise that current growth should not be achieved at the expense of future generations (Brundtland, 1987).

Sustainability deals with the **inter**generational and **intra**generational implications of finding an appropriate balance among the needs of economic, environmental, and social systems. Although no single definition of sustainable development is acceptable to all parties, the general concept of sustainability has become so widespread in recent years that politicians and decisionmakers have embraced it as an underlying way of thinking about their programs and policies. Sustainability often is described in terms of principles, criteria, and indicators, where criteria represent statements of what is meant by principles of sustainability and indicators are measures of the degree to which the criteria are being reached (Granholm and others, 1996). Because indicators require measures and measures must be supported by data, it follows that a focus on sustainable development inevitably will lead to an increase in the demand for reliable, unbiased information.

Science is "the organized systematic enterprise that gathers knowledge about the world and condenses the knowledge into testable laws and principles" (Wilson, 1998, p. 53). Given that science expands our understanding of the world, it is reasonable to expect that policymakers and the public will look to scientists for information about the status and functioning of the Earth's systems. The current interest in issues of sustainability thus will help raise the visibility of both the social and natural sciences, including geology. To the degree that scientists are willing and able to address the urgent needs of society and then communicate their knowledge to the public and decisionmakers, the status of the sciences will be improved as well (Lubchenco, 1998).

In this presentation, I will discuss one facet of the complex interaction between experts and the public: how to increase the likelihood that the scientific expertise of geologists and the data that they can provide are utilized in the development and review of policies related to sustainable development.

The field of geology developed largely in response to societal needs for natural resources, particularly energy and mineral resources, and also in part because of geogenic impacts on the human-made environment. Energy and mineral resources remain integral components of economic and social systems, providing essential inputs to virtually every economic sector and acting as the driving force for some local, regional, and national economies. At the same time, resource extraction, processing, use, and disposal can have serious environmental consequences that have the potential to threaten environmental security and degrade present and future quality of life (Shields, 1998). In addition, surface and near-surface earth (geological) processes determine both the character of the landscape and the state of the physical and built environment (Hughes, 1995; Berger and Iams, 1996). Clearly, geologic information will be relevant to many aspects of sustainable development.

Geologists traditionally have focused on the scientific and technical aspects of their field, but if they are to be perceived as relevant to the sustainability debate, they will have to demonstrate that geologic information will help societies achieve the goal of sustainable socioeconomic and biophysical systems. Being conversant with the concept of sustainability will be necessary but not sufficient. Geologists will need to understand the policymaking process and enhance their communications skills so that they are able to present geologic information (1) in a format that is understandable and (2) at a point in the policy or management cycle that is useful to decisionmakers. Another important step in getting geologic input utilized will be to reach a mutual understanding between the data user and data provider about the ultimate purpose for the data. The geologist, in the role of data provider, has to be aware of needs of the data user and vice versa. The data user has to be aware of the limitations of the data provided. These needs suggest that the range

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of information that geologists will supply should go well beyond what has traditionally been the case.

As Lubchenco (1995) pointed out, the best policy is based on the best science. Science, however, is a dynamic, ongoing process that continually is discovering new information. Thus, the interaction between science and policy must also be ongoing and dynamic. Lubchenco listed eight types of useful scientific communication: (1) what is known, (2) the certainty with which it is known, (3) what is not known, (4) what is suspected, (5) the limits of science, (6) probable outcomes of different policy options, (7) key areas where new information is needed, and (8) recommended mechanisms for obtaining high-priority information. Essentially, Lubchenco recommended a proactive role for scientists, one in which they not only provide information, but also frame the issues, set research priorities, synthesize complex information, and, perhaps most importantly, communicate how science works. This expanded role is an appropriate one for geologists.

Policymaking is a cyclical process that may be seen as progressing through a series of six stages: (1) identification of objectives and interests, (2) definition of policy, (3) codification of policy in laws and acts, (4) establishment of a regulatory framework, (5) monitoring, and (6) review and adaptation. The type of input geologists provide will depend upon where a society is in this policy cycle and also on the decision context, be it in the mineral sector, an issue related to land use and development, nature conservation, or interactions between the environment and society (that is, anthropogenic versus geogenic impacts).

Clearly there is a need for input from geology as a country's mineral policy is being defined. The consensus building process necessary to the achievement of a relevant and widely accepted mineral policy will depend in part upon information about the impacts and consequences of choosing one policy option over another. Decisionmakers will need information about the depletion of mineral resources and the environmental effects of mining. For earth scientists, the challenge will be to develop (1) a better scientific basis for discussion of adequacy of mineral resources; (2) better data on factors involved in mineral supply that should be in public policy analysis and decisionmaking; (3) better ways to communicate to policymakers and the public the dynamic nature of mineral supply, thus putting the prospect of "running out" in the proper context; and (4) methods to incorporate recycling and reuse into the concept of sustainability (National Research Council, Committee on Earth Resources, 1996).

There also is an enormous need for science input in the development of laws and regulations regarding the environmental impacts of mining. There is a high cost to society when the government enforces laws and subsequent regulations that make no sense to people (Wilson and Anderson, 1997). Here, geologists can provide information to policymakers and the public about (1) the environmental consequences of mining, including the costs of environmental compliance and the effects of using best practices in the environmental management of mining; (2) improved environmental management and restoration ecology associated with mining and mineral processing; and (3) how mining affects the environment and how environmental degradation can be minimized (National Research Council, Committee on Earth Resources, 1996).

Finally, the input of science in the review and adaptation phase cannot be underestimated. Environmental regulation will not adapt quickly to scientific advances unless scientists themselves remain involved in the policy cycle. However, given the engagement of scientists and a societal willingness to respond to new information and changing preferences, adaptive management is possible (Lee, 1993).

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