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A Case for Geology

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Geology suffers from two enduring stereotypes.

The first stereotype is that geology is "about rocks and minerals," period. It is true that the materials, the configurations of matter, studied in geology are largely rocks and minerals, but the study of geology goes much further than this simple intention. It has a lot more to say about the world in which we live than just a study of earth materials.

The second stereotype concerns the reasons one should study geology. Many persons, including not a few professional geologists, regard geology's role in society as limited to the finding and producing of raw materials to feed the economic system. This is a vitally important role for geology to play, and it is one which provides employment for many geologists, but the purposes of geology transcend its economic utility. If the purpose of teaching geology were only to include the study of a larger array of natural objects (rocks and minerals and such) or to provide vocational training for those engaged in resource-gathering, the case for the subject would be much weaker. Geology, however, provides insights and intellectual experiences unique to this field of science. Why should we *study* the earth? Why should we *teach* about the Earth?

First, the earth presents phenomena of the physical universe on a scale that we actually encounter as humans. Soil sticks to our boots and we can pick up a rock and turn it in our hand. Our walks may take us along a stream or over a hill where we feel the exertion of climbing the slope or the chilly wetness of the flowing water. The scenes we view from a car, train or plane are those of the face of the earth. Houses are made from rock, concrete from rock and sand, monuments from rocks, and the foundations of these are sunk into rock. Unlike the cosmos, the earth is touchable, and we can get around the backside of earthly features to experience and view them from different perspectives and without the aid of complex instruments. At the other extreme of scale, the realm of atoms and quarks is so small as to be totally abstract and can be conceptualized realistically only in mathematical terms. To humans and human senses, the earth is real.

Second, the earth is home to humans and all other life forms familiar to us. Life appears to have originated on this planet from earth materials billions of years ago with geologic as well as biologic processes shaping its evolution to the present. One cannot divorce the history of the earth from the history of life any more than one can separate the cyclic exchange of materials among living organisms from components of the earth. The connections between the earth and living organisms apply equally to humans and human culture. Our bodies are made of atoms apparently created in long-dead stars, atoms that have resided as

part of the earth for billions of years. Even as we live, the atoms in our bodies are being replaced by others which continue to cycle between the earth and living systems. Geologic processes affecting these complex cycles of the elements affect all of life.

Civilizations and the economic systems upon which they operate have created new and ever-larger systems of exchange between humans and the earth. Every material thing we have, from the clothes on our backs to our most sophisticated technological devices, are earth materials derived through agriculture, forestry, fishing or mining. Unwanted materials are returned to the earth in an ever-enlarging stream of wastes. Until very recently, little thought was paid to these new, human-made cycles except in the area of resource exploitation. As wastes reenter the geologic cycles and processes, pollution is too frequently the result. To understand and to remedy problems of pollution, a knowledge of the earth must be incorporated into all human decision-making just as it must be incorporated specifically into resource extraction.

A third reason to study geology is that this planet is a dynamic one. Meteorologic/hydrologic processes of the earth are such a pervasive part of the human environment that they need no further elaboration. But less obvious are the dynamic processes acting within the earth to shape the long-term environment as well as produce the less-frequent, dramatic events such as earthquakes and exploding volcanoes. These processes have a duality about them much as a coin with two quite different sides. Geologic hazards, such as earthquakes, which can (and probably did in the past) destroy civilizations form one side of this coin. On the other side, the same processes which produce the hazards also produce beneficial materials or conditions which we call resources. Volcanism in Hawaii occasionally destroys property and, thus, can be considered a hazard, but without volcanism there would be no Hawaii in the first place.

The consequences of the dynamic interior of the earth are often much less dramatic than volcanoes. The pulsing of the interior has caused the seas to advance over the continents and then withdraw, giving rise to marine sediments in the interior of continents, some of which have economic value. The slow movements of the continents have moved coal deposits formed in the tropics far to the north and south of the equator. As the continents slowly move and their edges crumple in mountain-building collisions, metallic ores form, atmospheric circulation is altered to form different regional climates, vegetation and animal life respond to the new climatic pattern, and humans find the organic and inorganic milieu suitable or not suitable for establishing civilizations. Your home town is as it is and where it is partly in response to those tectonic processes acting deep within the earth over billions of years. The same processes have had a tremendous influence on the evolution of life as various habitats have been created and/or destroyed allowing some groups to evolve and expand while others became extinct. The joining or isolation of continents and oceans with separate cargoes of evolving organisms may have had great influence on the evolution and distribution of organisms. Perhaps the fact that you are a human reading this and not some other kind of being is partly the result of the complex pattern of tectonic processes which have affected the lines of evolution giving rise to our species.

Fourth, in no other area of study is the immensity of time considered as it is in geology. Time on a geologic scale is a dimension of the universe unappreciated unless one is educated to its existence. We live lives of decades and our familiarity with human history extends over only a few thousand years. Events occurring before times we can personally remember seem "a long time ago" whether we are 10 years or 100 years old. We order time by familiar things that have happened. Everyone even slightly familiar with U.S. history could place in order major events such as the Revolutionary War, the Great Depression, and the founding of the Plymouth Colony, even though most or all of these events are beyond our individual memories. We can keep track of events in terms of how they fit between other ones we readily call to mind or ones that are major turning points in history. To most people, all of geologic time is just "a long time ago," not because of its immensity but because they have no yardstick to make it real for them. Sixty thousand years ago is no different than 60 million or 600 million years if all are perceived as just "a long time ago." A rudimentary knowledge of the geologic time scale, with or without actual numbers of years, gives meaning to the earth's past and this important dimension of the physical universe. But it is not just to provide an understanding of earth history that we should study geologic time. To understand, to fully appreciate where humans and human culture are in the universe, we must have an appreciation of time. To understand the significance of the rapidity of resource consumption, of loss of species and ecosystems, of pollution, of human population growth and the meaning of sustainable technologies, one must have a more sophisticated approach to time than just "it was a long time ago."

Geologic time is immense. It has given life the opportunity to form and evolve on this planet, and it has allowed the seemingly slow processes of geology to build great mountains and then tear them down to begin all over again. Although life has existed on earth for most of its history, human life and modern civilizations have existed for the briefest fraction of this total time. As a civilization in which we view ourselves as the ultimate of creation, we destroy resources at rates one million times, or more, greater than at which they formed. If our species is to have a significant future, we must come to grips with these realities. Understanding and appreciating geologic time has relevance not only in science, but also in religion and philosophy, in sociology, in political science and in psychology. Geologic time is not just for the past but for the future as well.

We should study the earth because it is the stage upon which all of life, all of human existence and all of human culture are played. To understand modern ecosystems, biologic history, the resources upon which all living systems depend, and the place of humans in the scheme of the universe requires an understanding of the processes, materials and history of the earth. Geology provides the relationships and connections among the inorganic, the biologic and the cultural components of our environment. Not to be aware of the earth, its history and how it operates is to fail to understand much of the remainder of our world. We live on an increasingly crowded and polluted planet where merely to survive will require the most enlightened thinking of this and future generations.

To achieve more than mere survival — to bring to fruition the great dreams of humankind — we must understand the basic physical systems under which we operate. We cannot ignore the study of our home, the earth.

Although perhaps subtle to the casual observer, Iowa has a geologic setting, a geologic history and geologic processes — all of which determine much of what goes on in the state. Economic opportunities and limitations, land use and environmental issues have a strong connection with geology. How the state evolves economically and socially may be partly determined by how well today's students understand these geologic connections when they become the leaders of the state.

Coming issues of the *Iowa Science Teachers Journal* will offer suggestions for involving students in learning experiences which will lead them to understand the importance of the study of geology.