

# Ten Common Principles of Geoscience Departments - Part I

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The success of departments of geoscience is influenced both directly and indirectly by a broad range of factors. Programmatic survival in the face of the complexities of the modern university demands thoughtfulness on the part of all faculty. Never has the need for broadly based public understanding of our Earth and its dynamic systems been as critical as the present. Yet, never has the training of geoscientists occurred at such a low rate. Our goal, therefore, must be to ensure that geoscience education holds a central, and highly visible, role in the academic training of the leaders of tomorrow. In order to work towards achieving this goal, the following list of common principles are put forward. This conceptual framework for strategic thought is broken into two sets of five principles focused on academic and administrative missions. Herein are described the five academic principles, a future editorial will outline the remaining five principles centered on departmental administration and intra-university communication.

**1 – Skill training and construction of the knowledge base.** A critical mission of every degree-granting geoscience department is the training of future geoscientists. As such, it is essential that students receive a complete education in the core material of their chosen discipline. Students must learn the names and chemical formulae of minerals. They must be able to recognize the difference between left-lateral and right-lateral motion. Brachiopods and trilobites, eclogites and tholeiites comprise the standard body of knowledge required of undergraduate geologists. Similarly, the allied fields of environmental geology, hydrology, and physical geography each have their own body of factual knowledge. The first principle of all geoscience departments must be the teaching of the standard knowledge base and foundational skills of the discipline.

**2 – Thoughtfulness and critical analysis.** Science is an extremely creative human enterprise. A guiding principle of all geoscience departments should be the fostering of creative thought. In order to achieve student thoughtfulness the department must encourage students to go beyond the acquisition of rote knowledge. Facts are undeniably the raw materials of science; creative thought, however, is the process by which science grows. Integration of intellectually challenging projects and real-world exercises stretches our students' imagination and creativity. Students must not merely know the facts of science, they must also be able to think scientifically. Hypothesis testing, falsification, and interpretation in the face of incomplete or contradictory data are critical steps in intellectual growth.

**3 – Participatory educational experiences.** Scientific advances are the products of synergistic relationships. The common public misperception of a lone scientist toiling in the solitude of a laboratory could not be further from the realities of our modern professional organizations, research consortia, and multi-disciplinary collaboration. Students training in science must be actively engaged in the process of doing science. Geoscience departments, therefore, should encourage collaborative analysis and team building by their students. The combination of our students' collective experiences and abilities lead to a richer understanding of the Earth's complexity. A guiding principle of participatory education should be the opportunity for undergraduates to be engaged in meaningful scientific exploration as part of a research team.

**4 – Earth systems and societal-environmental interaction.** A fourth common principle of geoscience departments should be the integration of the concepts of Earth systems throughout the curriculum. The multi-disciplinary aspects of the geosciences sometimes result in a form of intellectual isolationism. At the undergraduate level, students struggle to develop connections between the broad range of materials they are asked to learn. As such, the concept of Earth systems provides a scientifically and pedagogically sound process by which students can begin to grasp both the complexities and the interrelationships of the Earth. The extensive, and ever increasing, level of interaction between human society and the environment demands that environmental education be part of every geologist's training. Understanding the complexities of these interactions is important in order to support and sustain the political and economic significance of geoscience education. As such, the long-term growth of our discipline demands that departments of geoscience make integrated systems science education a core component of their academic program.

**5 – Comprehensive general education.** Why must science be a part of general education? What benefits do students receive from their exposure to introductory science courses? Far too often general education programs suggest, or even explicitly state, that science is to be taught so students achieve an understanding of and appreciation for the scientific method. While this philosophical rationale is considered laudatory by some, I suggest that the formal "scientific method" is one of the least significant topics covered in introductory courses. Rather, there are two essential concepts our students must understand. First, science must be shown to be relevant to their lives. This appreciation should be one that goes beyond the beautiful destructiveness of volcanoes, earthquakes, and landslides. As such, students need to be exposed to the societal relevance of both the environmental and traditional solid Earth geosciences. The development of a general theoretical model of large-scale geological processes is less than fifty years old. Likewise, widespread appreciation of the interrelationships between our industrial society and the Earth date from approximately the same time. The volume of knowledge encompassed by the geosciences is growing exponentially. Thus, students need to understand both the youthfulness and significance of the advances in academic and applied knowledge. Second, students must come to appreciate the magnitudes of geologic processes and geologic time. The scale and scope of the Earth and its history builds a perspective upon which they can evaluate their lives. Along with notions of magnitude come related concepts of rate and flux. Students can only achieve a meaningful appreciation of complex systems if they understand the nature of physicochemical fluxes.

Together, these foundational concepts provide students with a solid introduction to the geosciences as well as provide sound justification for the geosciences holding a central position in the general education curriculum. Our departments must focus on this fifth principle, not only for the production of credit hours but also because our introductory sections provide the fertile ground from which we will recruit the next generation of geoscientists.

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Editor