Keene State College
Geology Program
Self-Study Report 2000

Department Chair:
Peter A. Nielsen, Professor of Geology

Approved degree programs:
Bachelor of Science in Geology
Minor in Geology

Related degree program:
Bachelor of Science in Environmental Studies, Science Option, Geology Specialization

Starting date of program: 1971
(courses in Earth Science were taught beginning in 1961)

Previous reviews: 1990-1991
(the Environmental Studies program was reviewed in 1995-1996)

Person responsible for preparation of this report:
Timothy T. Allen, Associate Professor of Geology & Environmental Studies

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Peter A. Nielsen, Department Chair

Gordon J. Leversee, Dean of Sciences

Submitted October 31, 2000

Keene State College • Verification of Faculty/Staff Review

Each full-time faculty member or staff member on duty in the Geology Program has been asked to sign the statement presented below:

By my signature below, I am verifying that I have had the opportunity to review the program's self-study that is being presented to the College's Program Review Subcommittee.

Signature	Date	Additional Response in Appendix
____________________	__________	Yes______ No______
____________________	__________	Yes______ No______
____________________	__________	Yes______ No______
____________________	__________	Yes______ No______
____________________	__________	Yes______ No______
____________________	__________	Yes______ No______

Forms

The following data will be utilized by the program to assist in the description and direction of its program. Data should be tabulated and presented in summary form.

Faculty Information:

Rank Distribution

Professor __1__Associate__2__Assistant _____Instructor _____

Tenure Track _____Tenured __3__Non-tenured _____

Highest Degree

Ph.D. / Ed.D. / Equiv. __3__M.S. / M.A. / Equiv. _____B.S. / B.A. / Equiv. _____

Length of Service at KSC (years)

0-5 _____6-10 __1__11-15 __2__16 or more _____

Specialization (List Areas)

Allen: Hydrogeology, Geochemistry, Petrology & Strucure
Bill: Stratigraphy, Paleontology, Geomorphology
Nielsen: Mineralogy, Petrology, Structural Geology

Part-time Faculty and Adjunct Faculty:

Course load (credits per year)

0-3 __X__4-6 __X__7-9 __X__10-12 __X__13 or more ____

Highest Degree

Ph.D. / Ed.D. / Equiv. _____ M.S. / M.A. / Equiv. __X__B.S. / B.A / Equiv.__X__

Specialization (List Areas)

Introductory Earth Science & Physical Geology, Earth Science Education

Length of Service at KSC (years)

0-5 __X__6-10 __X__11-15 _____16 or more _____

Student Information:

Majors __11__

Options (list)________________

Specializations (list)________________

Minors __7 (ENST-Geology)__

Undergraduate __all__Graduate _0__

Independent Studies __2__

Other (General Education, Interdisciplinary, Service to other Programs) _~340_

Age

17-23 __8__24-29 __3__30-39 _____40 - _____

Gender

Female __6__Male __5__

Table of Contents

Program Description

Program Evaluation & Assessment

References Cited and other Sources of Information

List of Tables

List of Figures

List of Appendices

Notes

Program Description

History of the Program

Dr. Francis L. Haley was hired by Keene State College (KSC) in 1961 to teach Earth Science courses as part of a General Science program. Under President Zorn and Dean David Sarner, planning for an Earth Science Major was begun. Dr. Frederic G. Layman was hired in 1968, and the design of the Earth Science Major was completed between 1968 and 1970 by a committee consisting of Drs. Haley, Layman, and Giovannangeli. A review team visited campus in March of 1970 and concluded that library, laboratory and teaching resources were adequate to begin an Earth Science major. The Earth Science Major was officially recognized in the Fall of 1971. The name of the major was changed from Earth Science to Geology in 1984 to reflect a change in the emphasis of the program from preparation of teachers to preparation of professional geologists, consistent with KSC's evolution from a Normal School to a Liberal Arts and Sciences College.

Dr. Haley retired in 1987. Prior to his retirement, significant discussions concerning the continuation of the Geology program took place. Drs. Haley and Layman, with the strong support of the rest of the College faculty, successfully argued that the major should be retained. Dr. Steven D. Bill was hired in Fall 1987 to succeed Dr. Haley. Dr. Layman then retired in 1988 and Dr. Peter A. Nielsen was hired in Fall 1988 as his successor.

The Geology program was one of the first to undergo Academic Program Review, in the Fall of 1990. The Academic Overview Committee's Geology Program Review Subcommittee Report in the Spring of 1991 (Appendix I) recommended expansion of the program by:

1. adding a new faculty line;
2. using full-time faculty to teach more sections of introductory-level courses;
3. consolidation of certain courses in the major; and
4. reallocation of space within the Science Center.

The administration acted upon these recommendations by hiring Dr. Timothy T. Allen in the Fall of 1992 as a Faculty-in-Residence, and then appointing him in the Fall of 1993 to a newly created third tenure-track line in Geology (with the understanding that he would also have a 1/4 time commitment to the Environmental Studies (ENST) program). Dr. Allen brought expertise in the area of hydrogeology, among others, that has helped the program better address changes in the geoscience professions. Part of Dr. Allen's role has also been to provide more resident faculty coverage for sections of the 100-level courses. In other changes, courses in Optical Crystallography and in Petrography were consolidated into a single course entitled Optical Petrography following the recommendations of the external reviewers. A room in the basement of Huntress Hall was made available for Geology use, and the opening of Rhodes Hall in 1998 finally freed up space in the Science Center for some additional laboratories dedicated to Geology (205 Complex).

Enrollment in the program has been stable; this is discussed further in the section on Students.

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Program Content & Organization

Overview

Geology is the study of the Earth and its environs. It is primarily concerned with deciphering the processes which have operated on and within the Earth in the past, shaping and forming the Earth as we know it today. Geologists study the Earth's past history, as well as present-day processes acting on the Earth, in order to better understand what the future might hold for us. The Earth really is a dynamic, "happening" place, with continual and complex interaction among the Earth's many systems, including those of the geosphere, hydrosphere, and atmosphere, as well as the biosphere and the external solar system. The relationships of these Earth processes to humankind is at the core of many contemporary issues. A full understanding of the Earth system and its processes requires an interdisciplinary approach based on detailed field observations and including the collection, interpretation, and application of quantitative geochemical and geophysical data.

Goals & Objectives

The goal of the Geology program is to teach students about the methods of scientific inquiry and about the Earth, its materials, processes and systems, and thus about appropriate stewardship of the Earth and its resources. We wish to develop in students an appreciation for the uniqueness of our home planet and foster their wonder of the natural world.

Specific objectives include:

1. Supporting the College's General Education program, and other professional fields directly involved with the Earth (including but not limited to Education and ENST).
2. Preparing enthusiastic geoscientists for rewarding careers in industry, government, and teaching, and for continued study.
3. Providing opportunities for professional growth, for both students and faculty, especially through research. In particular, we would like to involve all our students in level-appropriate, student-centered, inquiry-based, active participatory learning experiences (e.g. Culotta, 1994; Markovics, 1990) that engage them in authentic scientific process (e.g. Goodwin & Hoagland, 1999; McConnaughay et al., 1999; McGinn & Roth, 1999).

Relationship to College Mission

As part of its mission, KSC promotes strong relationships among students and faculty that emphasize creative and critical thinking, scholarship and research, and a passion for learning, with a commitment to service. Our efforts in Geology are entirely consistent with this mission. The nature of our program, particularly our emphasis on field work, certainly promotes strong relationships among students and faculty. As a broadly-based science, we naturally emphasize creative and critical thinking, particularly with long-term and global-scale perspectives. Our faculty engage students in scientific inquiry (i.e. scholarship and research), which inspires a passion for learning. Our concern for stewardship of the environment fosters a commitment to service.

Relationship to General Education

Our goal (above) is really to promote the general education of students broadly in the methods of science, specifically as applied to the study of our home planet. Thus we address, in part, the following Goals for General Education at KSC (Senate Document 99/00-23):

* general knowledge of the natural world;
* knowledge and skills necessary to engage as an informed and involved citizen in a democratic society;
* an ability to communicate effectively with others both orally and in writing (to the extent that writing and presentations might be part of our courses, and an important part of the scientific process);
* an ability to read critically and effectively;
* an ability to reason quantitatively;
* an ability to think critically and creatively;
* fundamental research skills (to the extent that research is expected in our courses).

Many students choose Geology courses as a means of meeting their Physical Science General Education requirement. These students account for about 75% of our student credit hours generated (over 90% of our student credit hours generated are in 100- and 200-level courses; see section on Students); obviously this is a significant part of our work. In addition, we support other major programs in Biology, Chemistry, Chemistry-Physics, Education, ENST, and Geography with required (particularly for teacher certification options) or elective courses, and as an appropriate and valuable minor for these fields. In particular, Geology is available as a Specialization within the ENST major. Geology students are also required to take courses in Biology, Chemistry, Physics, Mathematics, and Geography—so the support relationships are reciprocal.

Relationship to External Factors

On Wednesday, May 31, 2000, the New Hampshire General Court passed legislation relative to the licensure of professional geologists (House Bill 1510, Wendelboe & Hinman, 2000). Governor Shaheen signed the bill on June 21, 2000. This legislation recognizes that the professional practice of Geology is critical to protecting the health, safety, and welfare of the public and the environment in the State.

Clearly the science of Geology has always and will continue to play important roles in the identification, evaluation and protection of energy, mineral, and water resources; in the assessment and mitigation of natural hazards; in the assessment and remediation of human impacts on the environment, and in the mitigation of potential future impacts. These are all important, even necessary, contributions to our society. “Civilization exists by geological consent, subject to change without notice” (Anonymous). In addition, the science of Geology also plays a fundamental role in helping to meet our human desire to understand our origins and our place in nature.

Keene State College, Dartmouth College, and the University of New Hampshire are the only institutions of higher education in the state of New Hampshire offering degree programs in Geology.

Design of Program

Overview

The Geology Department offers a 100-level course for the General Education audience every semester. Several 200-level courses, most offered at least annually, serve as the introduction to the Geology major, support other major programs, and/or are also available to the General Education audience. 300- and 400-level courses that meet requirements in the Geology major and the Geology Specialization in the ENST major, and are electives in some other major programs, are generally offered on an alternate-year basis. 300-level courses require 200-level courses as pre-requisites and are intended for juniors and seniors (and the occasional sophomore who has met the pre-requisites). 400-level courses are advanced courses intended for juniors and seniors, requiring 300-level GEOL courses, or additional courses outside of Geology, as pre-requisites.

Course descriptions and recent syllabi are provided in Appendix II. Discussion of each faculty member’s individual teaching approach is presented in the section on Faculty.

Geology Major

The Geology Department offers a major program leading to the degree Bachelor of Science in Geology (Appendix III-a). Students graduating from this program receive a well-rounded interdisciplinary science education built on the foundation of a traditional geology curriculum (Physical & Historical Geology, Mineralogy, Petrology, Structural Geology, Stratigraphy, and Paleontology—courses taught by the department’s senior faculty, Drs. Nielsen and Bill).

Our graduates may pursue advanced degrees in earth or environmental sciences; or seek employment with environmental, hydrogeologic and engineering consulting firms, energy and mineral resource companies, or state and federal agencies. Those choosing the teacher education option are prepared for certification as Earth Science teachers in secondary schools. Geology students are equally well prepared for other careers in which a liberal arts and sciences education is beneficial, such as in elementary education, business, law, or medicine.

Within the Geology curriculum, we emphasize the integration of detailed field observations (albeit mostly qualitative in nature) with "big picture" tectonic and earth-system syntheses. We also seek to provide progressive course-based research experiences preparing our majors for independent and student-faculty cooperative research (e.g. Niemitz, 1995, Goodwin & Hoagland, 1999).

Geology Specialization in ENST

The ENST Program offers a major program leading to the degree Bachelor of Science in Environmental Studies. Students must choose either the Environmental Science Option, or the Environmental Policy Option, and within those options they must also choose a Specialization. With the support of the Geology Department, Environmental Geology is offered as a Specialization within the Environmental Science Option of the ENST major (Appendix III-b). The Geology Specialization, among other requirements, requires students to choose two advanced courses in "Environmental Geology," one in "Structural Geology," and one in "Mapping."

Geology Minor

The Geology Minor (Appendix III-c) is available to any interested students. It is most commonly obtained by students majoring in ENST, Chemistry, Biology, or Geography.

Contribution to General Education

The College's current General Education program (Appendix III-d) requires all students seeking a Bachelor's degree to take at least one Physical Science (Astronomy, Chemistry, Geology, Meteorology, or Physics) course.

Geology courses available for General Education (i.e. those without pre-requisites) include:

* GEOL 100 Perspectives of Earth
* GEOL 201 Physical Geology
* GEOL 206 Oceanography
* GEOL 210 The Hydrologic Cycle
* GEOL 298 Independent Study

GEOL 201 Physical Geology is a 4-credit course with an integrated laboratory component. Currently, students in GEOL 100 Perspectives of Earth may enroll in the optional 1-credit GEOL 101 Perspectives of Earth Laboratory. Either GEOL 201, or GEOL 100 with GEOL 101, meets the requirement of Education majors that their Physical Science General Education course have a laboratory component.

Students may take additional Geology courses to fulfill further General Education Science distribution requirements. Possible courses, beyond those listed above, include courses with only GEOL 201 as a pre-requisite:

* GEOL 202 Historical Geology
* GEOL 309 Geomorphology
* GEOL 315 Environmental Geology
* GEOL 440 Evolution of Earth and Life (with additional BIO pre-requisites)
* GEOL 460 Hydrogeology (with additional pre-requisites in MATH and PHYS).

Accreditation & Assessment

We have not identified any mandates or standards for Geology programs promulgated by government or accreditation agencies. The legislation mentioned above defines the professional practice of Geology and establishes minimum requirements for licensure of Professional Geologists in New Hampshire (e.g. at least 30 semester hours of courses in Geology from an accredited College or University, among other requirements), but does not otherwise set standards for academic programs. The NH Department of Education does, however, enforce specific standards for the certification of Earth Science teachers, and the National Council for Accreditation of Teacher Education (NCATE) has standards for the accreditation of teacher education programs, including those for Earth Science teachers; see discussion in the section on Program Evaluation & Assessment: Outcomes.

While there may not be accreditation standards for Geology programs, there are recommendations and guidelines offered by professional organizations in the field. Additional insight can be gained by comparing our program with those at similar institutions. Further discussion is presented in the section on Program Evaluation & Assessment: Outcomes.

Program Revisions

Our academic planning and curriculum development processes are informal; progress comes largely from individual faculty initiative. For the most part, changes over the last ten years represent response to specific curricular suggestions from our previous program review, and adjustments associated with the bringing on of a new faculty member with new areas of expertise and interest (itself a response to the previous program review). We:

* Consolidated 400-level elective courses in Optical Crystallography and in Petrography into a single course entitled Optical Petrography.
* Introduced a new 400-level elective course in Hydrogeology (which also meets requirements for the Geology Specialization in ENST).
* Added a field-based laboratory component to the course in Environmental Geology (Allen, 1997a), which is now offered at a 300- instead of 400-level.
* Added a similar laboratory component to the 400-level Hydrogeology course (Allen, 1998)—this new lab will first be offered in Spring of 2001.
* Introduced an interdisciplinary team-taught 400-level elective course on the Evolution of Earth and Life, which is also cross-listed in Biology.
* Introduced a new 200-level General Education course on The Hydrologic Cycle, which will first be offered in Spring of 2001.

Significant changes were also made to the ENST major program in 1995. Most relevant here was the specification of certain courses (or groups of courses) in the Environmental Geology Specialization (Appendix III-b). These changes significantly improved the ENST major by eliminating a number of bottlenecks, and made the ENST major even more attractive to students, with a possible inverse impact on the Geology major. (In the past, our sense was that some students would turn to Geology as an alternative to the lengthy and difficult ENST program. Enrollment trends are discussed further in the section on Students.)

Learning Outcomes Assessment

A detailed list of Desired Learning Outcomes is presented in Appendix IV. In general terms, we want our students to understand the workings of the natural world and the processes of science, and we want them to be able to read, observe and think critically, reason quantitatively, undertake research, and communicate effectively—in other words, to engage in the scientific process and discourse.

Within individual courses, learning outcomes are assessed with course-based examinations and the evaluation of other student work. For those Geology courses that are pre-requisites to further geology courses, there is some informal assessment of learning outcomes from the previous courses in the later courses. In addition, the participation expected of students while on course-based field trips generally requires the students to draw upon the total of their learning. Many of our students take part in the student-club organized extended field trips following the spring semester each year, and this also provides an informal means of assessment for those that participate. However, for the major program as a whole, there is no formal capstone experience that would provide a means in common to all of assessing the total learning of our majors.

The ENST Program does include a capstone seminar, although it does not necessarily serve as a vehicle for assessment of ENST student learning in Geology.

In the Geology Department, and across KSC in general, we are really only just beginning to develop a tradition of independent research involvement among our students. In 1996, KSC's President established a fund to award modest grants to students in support of their independent research and creative projects. Several Geology students have been awarded grants from this fund (Appendix V). Other students have been involved in externally supported research projects (Appendix V). Some efforts by Geology and ENST students have resulted in undergraduate student authorship or co-authorship on posters or presentations at regional scientific meetings (Drobat & Nielsen, 1995; Howe et al., 1995; Harkay & Reinhold, 1998; O'Rourke et al., 1998; Nielsen et al., 1998a). As the tradition of independent research continues to develop, students (and faculty) learn from the projects and students that have gone before. The new laboratory component of the Hydrogeology course is a direct by-product of such student-faculty cooperative research (O'Rourke et al., 1998; Allen, 1998). While the number of undergraduates involved in research might not increase significantly, there is still opportunity for the quality of that involvement to improve.

Our graduates have, by and large, ultimately been successful in finding meaningful, relevant employment (Appendix VI). Several have pursued graduate study (Appendix VI).

Advising Practices

Geology faculty advise students majoring both in Geology as well as in ENST. Advising is informal and largely left to the student's discretion. Certainly, we see these students in our courses often enough; meetings of the student Geology club (GEODES) provide another venue for communication with students. The principal issue in our advising is the every-other-year offering frequency of most upper-level courses, which essentially dictates the academic plans of Geology majors, and sometimes limits the choices available to ENST-Geology students.

Other Considerations

Given the nature of our subject matter, the program does not explicitly address gender or multi-cultural issues. Certainly many cultures are influenced by the natural resources and environment (i.e. the geology) of the place where the culture developed, and we do take a global perspective in many of our courses. We could do more to encourage our students to consider study of a foreign language, both for graduate school and for the possibility of international work in geology. We have had students participate in international exchange or undertake internationally-based research projects (Appendix V), but these activities are at the discretion of the student and are not an formal part of our program.

Our General Education courses are often offered in the evenings, and during the summers. These sections are typically taught by adjunct instructors. Our major program is geared towards full-time day students. Nontraditional students attracted to the major have adjusted their schedules to take our offerings. Field work creates special problems in scheduling that are not easily resolved.

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Faculty

Demographics

The full-time resident faculty, their year of appointment, current rank, areas of specialization, and year of degree are listed in Table 1, below.

All are white males, ages ranging from the 35-40 age bracket to the 50-55 age bracket. All are tenured, and all hold the Ph.D. degree in Geology. Length of service at KSC ranges from 8 to 13 years.

Adjunct Instructors are employed to teach additional sections of our general education course offerings, to meet student demand beyond what the resident faculty are able to offer. Currently, adjuncts account for 37% of our total student credit hours generated in Geology (see further discussion below). They are drawn from a pool of local secondary school science teachers and graduate students, which includes graduates of our own program. Recently, upper-level undergraduate majors have been employed to teach general education laboratory sections under the supervision of one of the resident faculty. We have not used adjunct instructors to teach more advanced courses in part because of a dearth of available and willing qualified professionals, and given the breadth of our resident faculty there has been no need.

Professional Qualifications

While summarized here, full details of the qualifications, specializations, and scholarly and faculty development activities of the full-time faculty are provided in the Curricula Vitae, included in Appendix VII. The faculty is well balanced with respect to the range of specializations needed for breadth of courses offered in the program.

Faculty development efforts have been largely individual. We do work together to conduct field trips, such as for the GEODES student club, and attend field conferences, such as New England Intercollegiate Geological Conference (NEIGC).

Timothy T. Allen

Timothy Allen has broad training and experience in metamorphic and igneous petrology, structural geology, isotope geochemistry, heat flow and exploration geophysics, and hydrogeology. He has research interests in both “hard-rock” geology (the interrelationships between structural development, metamorphism and magmatism during mountain-building in the New England Appalachians)

Table 1: Full-Time Resident Faculty

Faculty Member	Year of Appointment	Current Rank	Areas of Specialization	Year of Degree
Timothy T. Allen	1992	Associate Professor	Hydrogeology, Geochemistry, Petrology & Structure	1992
Steven D. Bill	1987	Associate Professor	Stratigraphy, Paleontology, Geomorphology	1982
Peter A. Nielsen	1988	Professor	Mineralogy, Petrology, Structure	1977

and in sub-surface hydrology (ground-water recharge processes and rates). In both areas, he is interested in applications of geochemistry (particularly of light stable isotopes) and geophysics. He is heavily involved with the New Hampshire Geological Society (NHGS, as a Director, newsletter editor, and web-master), the NEIGC (as web-master, and field trip leader: Allen, 1996a, 1996b, 1997b), and the Mount Washington Observatory (as an "EduTrip" co-leader, and on the Billings Fund Committee). Governor Shaheen and the NH Executive Council recently appointed Dr. Allen to a four-year term on the newly established Board of Professional Geologists (Wendelboe & Hinman, 2000).

Dr. Allen just completed a sabbatical leave for the Spring of 2000 during which he helped establish the KSC Laboratory for Stable Isotope Biogeochemistry (Gebauer & Allen, 2000), wrote a proposal (now pending) to the National Science Foundation's (NSF) Course, Curriculum and Laboratory Improvement (CCLI) program seeking to acquire an X-Ray Fluorescence (XRF) Spectrometer (Allen et al., 2000), and made further progress on interpreting geochronologic results he and collaborators had previously obtained from rocks he collected in the Karakorum Mountains of northern Pakistan. Over the summer of 2000, Dr. Allen began a project funded by the US Geological Survey's (USGS) EDMAP program (Allen, 1999), working with students on detailed geologic and structural mapping of plutonic and metamorphic rocks in the vicinity of Lake Sunapee in west-central New Hampshire (Allen, 1997b).

Dr. Allen has taught a wide variety of courses, regularly including:

* ENST 100 Introduction to Environmental Studies
* GEOL 100 Perspectives of Earth
* GEOL 101 Perspectives of Earth Lab
* GEOL 315 Environmental Geology
* GEOL 412 Geochemistry
* GEOL 460 Hydrogeology

and has also had the occasional opportunity to teach:

* ENST 210 Energy and the Environment
* ENST 495 Senior Seminar
* GEOL 201 Physical Geology
* GEOL 303 Structural Geology

as well as seminars on the Geology of the Northern Appalachians and on the Geology of Wyoming. He has developed, but not yet taught, a new course, GEOL 210 The Hydrologic Cycle.

Steven D. Bill

Steven Bill's background is in paleo-environmental analysis and stratigraphy including micro-paleontology and stable isotope geochemistry. He has particular interests in the geology of the central Appalachians, including Pennsylvania, western Maryland, and West Virginia, and in field geology, science education, and teacher training. He regularly attends the Field Conference of Pennsylvania Geologists, and when there isn't a conflict, the NEIGC and/or the New York State Geological Association Conference. He also attends meetings of the NHGS.

Dr. Bill will be taking a sabbatical leave for the Fall of 2000 to do field work at the Pine Creek Gorge in Pennsylvania, developing a field guide to the geology of a recreational trail there, with some support from the Pennsylvania Geological Survey. He co-led Physical Science Institutes for in-service teachers, funded by Eisenhower Grants, in 1993, 1994, and 1995; and participated in an NSF-funded short course on the paleobiology of dinosaurs in 1995.

Dr. Bill regularly teaches courses consistent with his background and areas of expertise:

* GEOL 201 Physical Geology
* GEOL 202 Historical Geology
* GEOL 206 Oceanography

* GEOL 306 Stratigraphy
* GEOL 305 Paleontology
* GEOL 309 Geomorphology
* GEOL 310 Glacial Geology

as well as seminars on the Geology of the Central Appalachians.

Peter A. Nielsen

Peter Nielsen has a classical training in mineralogy and metamorphic petrology, with experience in the Precambrian terranes of the Adirondacks of New York and the Northwest Territories, Canada. More recently, he has been investigating the nature of brittle fracturing and associated hydrothermal fluid flow responsible for deposits of gem-quality fluorite in southwestern New Hampshire (Nielsen & Drobat, 1995; Howe et al., 1995). He took a sabbatical leave in the Spring of 1999 to carry out additional research on these deposits. He was able to make arrangements to spend the spring in Wolverhampton (UK), making use of analytical facilities and collaborating with faculty at the university there. In addition to involvement with the Keene Mineral Club, Dr. Nielsen also attends the NEIGC and other geological meetings whenever he can.

Dr. Nielsen also has an interest in developing interdisciplinary integrated science courses for General Education students (Nielsen et al., 1998a, 1998b), and has team-taught with a Biologist an upper-level course on the Evolution of Earth and Life. As a result, his research interests are taking a significant turn towards consideration of the origins of life on Earth. He attended a Gordon Research Conference on this topic this past summer.

Dr. Nielsen regularly teaches courses consistent with his background and areas of expertise and interest:

* GEOL 100 Perspectives of Earth
* GEOL 201 Physical Geology
* GEOL 301 Mineralogy
* GEOL 302 Petrology
* GEOL 303 Structural Geology
* GEOL 401 Optical Petrography
* GEOL 440 Evolution of Earth & Life

as well as seminars on the Geology of the Adirondacks and of the maritime provinces of Canada. He has also taught IDSM 199 Integrated Science.

Workload

Teaching assignments are determined by historical precedent, areas of faculty expertise, and mutual agreement of the faculty.

Course offerings from the last five years are given in Table 2, next page, and a projection of course offerings for the next three years is given in Table 3, following page.

Independent Studies & Student Contact

Dr. Allen typically has one to three students each semester engaged in cooperative student-faculty research or independent study; Dr. Bill and Dr. Nielsen have also each advised students in independent study projects on occasion (see Appendix V).

One particular strength of our program is the high level of personal attention our students receive. Upper-level classes are small, faculty spend a lot of time with students on field trips, we engage in social activities with students through the GEODES student club, and our doors are usually open. Our majors spend a lot of time in the department, working and sometimes just hanging out.

Typically adjunct instructors have been much less available to their students, however. Such is the nature of employing adjuncts.

Faculty Reassigned Time and Overloads

Through the Spring of 1999, Geology was a part of the Physical Sciences “section,” along with Chemistry and Physics. This group had a single “coordinator” (typically drawn from

Table 2: Course offerings for the past 5 years

(exclusive of summer sessions—GEOL 100 & 101 usually offered during both Summer I and Summer II)

	Timothy Allen	Steven Bill	Peter Nielsen	Adjunct Instructors
Fall 1995	ENST Chair ENST 495 GEOL 100 GEOL 101 GEOL 315	GEOL 201 GEOL 206 GEOL 306	GEOL 100 GEOL 201 GEOL 301	GEOL 100 GEOL 101
Spring 1996	Reassigned* ENST Chair GEOL 100 GEOL 412	GEOL 202 GEOL 206 GEOL 305	GEOL 201 GEOL 302 GEOL 440 GEOL 490	GEOL 101
Fall 1996	Reassigned* ENST Chair GEOL 201 GEOL 315	GEOL 201 GEOL 206 GEOL 309	GEOL 100 GEOL 201 GEOL 401	GEOL 100 GEOL 101–Leger[+]
Spring 1997	ENST Chair ENST 210 GEOL 100 GEOL 460	GEOL 202 GEOL 206 GEOL 310 GEOL 490	GEOL 100 GEOL 201 GEOL 303	GEOL 101–Leger[+] GEOL 101–O'Rourke[+]
Fall 1997	ENST Chair ENST 100 (2) GEOL 100 GEOL 315	GEOL 201 GEOL 206 GEOL 306	IDSM 199 GEOL 201 GEOL 301	GEOL 100 GEOL 101–Leger[+] GEOL 101–O'Rourke[+] GEOL 101–Reinhold[+]
Spring 1998	ENST Chair ENST 100 GEOL 412 GEOL 490	GEOL 202 GEOL 206 GEOL 305	GEOL 201 GEOL 302 GEOL 440	GEOL 100–Monahan[++] GEOL 100–Robbins GEOL 101–Leger[+] GEOL 101–O'Rourke[+] GEOL 101–Reinhold[+]
Fall 1998	ENST Chair GEOL 100 (2) GEOL 315	GEOL 201 GEOL 206 GEOL 309	GEOL Coord. IDSM 199 GEOL 100 GEOL 201 GEOL 401	GEOL 100 (2)–Wood[++] GEOL 101–Andretta[+] GEOL 101–Leger[+]
Spring 1999	ENST Chair GEOL 201 GEOL 303 GEOL 460	GEOL 202 GEOL 206 GEOL 310 GEOL 490	On Leave	GEOL 100–Kerwin[++] GEOL 100–MacKay[++] GEOL 101–Kerwin[++] GEOL 101–Andretta[+]
Fall 1999	ENST 495 GEOL 100 (2) GEOL 315	GEOL 201 GEOL 206 GEOL 306	GEOL Chair GEOL 100 GEOL 201 GEOL 301	GEOL 100–MacKay[++] GEOL 101–Leger[+] GEOL 101–MacKay[++]
Spring 2000	On Leave	GEOL 202 GEOL 206 GEOL 305	GEOL Chair GEOL 201 GEOL 302 GEOL 440 GEOL 490	GEOL 100–Leger[+] GEOL 101–Leger[+]

*see discussion under Faculty Reassigned Time and Overloads
[+]students at time of teaching, [++]graduate of our program

Table 3: Projected course offerings for the next 3 years

(exclusive of summer sessions—GEOL 100 & 101 usually offered during both Summer I and Summer II)

	Timothy Allen	Steven Bill	Peter Nielsen	Adjuncts
Fall 2000	GEOL 201 GEOL 315 GEOL 412 GEOL 490	On Leave	GEOL Chair GEOL 100 GEOL 201 GEOL 401	GEOL 100–Bissacio GEOL 100–Leger++ GEOL 100–Mackay++ GEOL 101–Leger++ (3) GEOL 101-Mackay++
Spring 2001	ENST 210 GEOL 210 GEOL 460 GEOL 490	GEOL 202 GEOL 206 GEOL 309	GEOL Chair GEOL 100 GEOL 201 GEOL 303	GEOL 100–Leger++ (2) GEOL 101–Leger++ (3)
Fall 2001	ENST Coord. GEOL 100 GEOL 315	GEOL 201 GEOL 206 GEOL 306	GEOL Chair GEOL 100 GEOL 201 GEOL 301	GEOL 100 GEOL 101
Spring 2002	ENST Coord. GEOL 201 GEOL 412	GEOL 202 GEOL 206 GEOL 305 GEOL 490	GEOL Chair GEOL 201 GEOL 302 GEOL 440	GEOL 100 GEOL 101
Fall 2002	ENST Coord. GEOL 210 GEOL 315	GEOL 201 GEOL 206 GEOL 309	GEOL Chair GEOL 100 GEOL 201 GEOL 401	GEOL 100 GEOL 101
Spring 2003	ENST Coord. GEOL 201 GEOL 460	GEOL 201 GEOL 206 GEOL 310	GEOL Chair GEOL 100 GEOL 201 GEOL 303 GEOL 490	GEOL 100 GEOL 101

++graduate of our program

the Physics faculty) until it was decided in 1998 to try sub-coordinators for each of the disciplines, splitting the available re-assigned time and stipend. Beginning in Fall 1999, the Collective Bargaining Agreement (the Contract) between the University System of New Hampshire Board of Trustees (USNH) and the Keene State College Education Association (KSCEA) replaced the system of "sections" and "coordinators" with one of Departments and Chairs. Under this Contract, Geology is recognized as an independent department. The position of Chair of Geology has 3 credits of re-assigned time (1 course release per year) and a stipend of $800. As Chair of the Geology Department, Dr. Nielsen has continued to teach a full schedule, taking the re-assigned time as overload pay, in order to continue meeting the needs of the program.

In a side agreement to the 1996 Contract, the Chair of the ENST Program Steering Committee was given 6 credits of re-assigned time (2 courses released per year, or 1 per semester) and a stipend of $750. The 1999 Contract redefines this position as a Program Coordinator, still with 6 credits of re-assigned time and the stipend. While serving as the ENST Chair or Coordinator for two consecutive two-year terms from 1995 to 1999, Dr. Allen did take advantage of the re-assigned time, generally in the form of a 1-course release each semester (as part of his 1/4-time commitment to the ENST program). None-the-less, he often still had a full load of three distinct course preparations. Dr. Allen stepped down from this position for the 1999-2001 term because of his sabbatical leave during spring 2000, but will be returning as ENST Coordinator in Fall 2001.

Dr. Allen was also re-assigned to work on campus technology issues in 1996, particularly related to an NSF funded project in the Technology, Design and Safety program, with a 1-course release in each of two semesters. During this period, there was a concomitant reduction in the offerings of GEOL 100 (and/or an increase in the use of adjunct instructors) to accommodate Dr. Allen's course release.

The offering of the 1-credit GEOL 490 seminars relating to the GEODES spring field trips has been done on an overload basis.

Acceptability of Workload

Since we do not anticipate significant growth in our enrollments, which are stable (see section on Students), and the range of faculty specializations is sufficiently broad to meet our programmatic needs, we do not see strong justification for additional faculty lines in Geology at this time. We do note, however, that:

1. We continue to rely heavily on adjunct instructors for our 100-level general education offerings. Based on an analysis of data supplied by the Office of Institutional Research, during the period from Spring of 1998 through the Fall of 1999 (including summers), adjuncts accounted for 37% of our total student credit hours generated (adjuncts accounted for 64% of student credit hours in 100-level courses). This number may be somewhat inflated because of Dr. Nielsen's sabbatical during that period, but even discounting the Spring 1999 semester, adjuncts accounted for 31% of our total student credit hours generated (54% of student credit hours in 100-level courses). College-wide, adjuncts teach 35% of the student credit hours and 39% of course offerings (52% of 100-level course offerings; *KSC Self-Study for Reaccreditation*, 2000, p. 36). "Numbers of course offerings" and "student credit hours generated" are not necessarily equivalent units. Thus while our use of adjuncts is not out-of-line with the College as a whole, we do recognize it as not wholly desirable.

2. The general nature of teaching loads at KSC (nominally four 3-credit courses but (supposedly) with no more than three distinct preparations per semester) in conjunction with the large number of contact hours (often 16 or more per week) associated with field-based laboratories and course field trips effectively precludes much scholarly work by the Geology faculty (and by students—their course load is nominally five distinct 3-credit courses per semester!). "Faculty are torn between their roles as teachers in a teaching institution and by what they perceive as peer pressure to increase research productivity." (*KSC Self-Study for Reaccreditation*, 2000, p. 44) Of course, sometimes that pressure for increased research productivity comes from within; certainly, junior faculty coming to the college in the past decade, across the disciplines, have brought with them high expectations for themselves in all areas of their work. A review of teaching loads versus research expectations of undergraduate faculty should be forthcoming in the journal *CUR Quarterly* (Wenzel, 2000, e-mail communication).

3. In comparison to Geology programs at comparator institutions, where the average number of full-time Geology faculty is 5 or 6 (see section on Program Evaluation & Assessment: Outcomes and Appendix IX), we are under-staffed. Many of these other programs also employ laboratory, technical, and/or departmental secretarial support personnel, as well as adjunct instructors or visiting faculty.

4. Almost all of our upper-level courses are offered on an every-other year basis. Some of these were enrolled at capacity in the mid-

1990's. Were our student numbers much larger, we would require more faculty (and more space and equipment) in order to be able to offer our core courses more frequently.

Evaluation

Evaluation of faculty is subject to the provisions the Contract, with further guidelines set forth in the *KSC Faculty Handbook*.

The procedure involves the faculty member preparing a self-evaluation report, which together with documenting materials including student course evaluations and peer classroom observations, is submitted for consideration by a Discipline Peer Evaluation Committee (DPEC) which prepares an advisory report. The faculty member's file, the DPEC report, and any response from the faculty member, are forwarded to the Dean of Sciences, who writes a letter of evaluation. If the faculty member is a candidate for promotion and/or tenure, the faculty member's file, DPEC report, and any response from the faculty member are simultaneously but independently considered by an elected, college-wide Faculty Evaluation Advisory Committee, who writes a letter of recommendation addressed to the Vice President of Academic Affairs. Untenured faculty are evaluated by DPEC and Dean annually. Once tenured, faculty may choose to be evaluated by DPEC and Dean every second year if they intend to pursue further promotion. Full professors are evaluated by DPEC and Dean only every five years.

In Geology, DPEC's are composed of the other two Geologists, plus a third faculty member selected from the ranks of the Physicists and Chemists. A fourth faculty member from outside the physical sciences is often included on the DPEC, particularly in evaluation of Timothy Allen because of his responsibilities to the ENST program.

All three of the Geology faculty are tenured. Two hold the rank of Associate Professor, one is a full Professor. Copies of recent evaluations for each faculty member are included in Appendix VII. All three of us are strongly committed to the development and success of our students. Students find our courses rigorous, but ultimately of acceptable and appropriate workload. Of course, there remain plenty of opportunities for faculty development and improvement, too.

Evaluation of adjuncts is not yet subject to contractual guidance. Currently in Geology, an adjunct instructor's student course evaluations are reviewed by the Department Chair, who makes recommendations to the Dean of Sciences regarding the appointments (or re-appointments) of adjuncts. Recently available data on grade distributions by course section suggest that some adjuncts may be more lenient in their grading standards than resident faculty.

Teaching Styles and Effectiveness

Timothy Allen

Following the examples of the best teachers that I've had, I strive to make organized, clear and understandable presentations of the information content of my courses. I rely heavily on graphical images, and draw upon real-life examples as often as possible, connecting the subject matter with the students' own experiences, if I can. Regardless of the content I may be teaching, I promote critical thinking and scientific method (particularly the role of inquiry) as an approach to problem solving both in the questions I ask (a student once commented that I answered his every question with another question in return), but also by personal example, sharing my approach to and experiences of the world. I would like students to appreciate that nature is both beautifully simple and at the same time exceedingly complex—that we understand the world around us on a continuum of time- and length scales. Where applicable, I emphasize quantitative reasoning in developing this understanding of the world. I hope to encourage them to undertake their own explorations, to pursue their own questions. Certainly, I respect my students as young (or old) adults and expect them to assume responsibility for themselves and for their own education. Problem-solving, research, and writing are important components of the work I ask students to engage in. Tests in introductory courses involve a combination of short answer, graphical, matching and multiple choice questions that touch on the entire range of content we've covered. Students find these tests very challenging, but fair. Final exams in upper-level courses are an extension of the problem-solving we've engaged in over the semester. Student response to my teaching has been mostly very positive (see Appendix VII).

Steven Bill

In my teaching, I emphasize the discipline of geology as a means of understanding the natural world around us. My role is to help students to recognize that their observations of the world can fit into a larger picture; i.e. that the Earth is a complex system that can be better understood through scientific principles. Whenever possible in all courses, I supplement 'the word' with specimens, maps, and other materials to help students visualize this world. Field trips offer the best way to experience our planet, but they are not practical for all situations. To help students visualize the Earth, especially outside of New England, I continue to use and further develop an extensive personal collection of 35 mm slides.

In introductory courses I assume students enter with minimal background and I attempt to set the stage for life long learning about the earth. Rather than surveying a wide range of topics, I prefer to choose a smaller number of topics and examine them thoroughly enough to make them understandable and demonstrate how they interact. I also use geologic principles to develop an understanding of how human affairs relate to the natural world.

Upper level courses also incorporate this thematic approach, but I assume a background consistent with the prerequisites for the course, and an interest in the subject. I try to hone students' ability to make scientific observations as a key element towards developing good scientists capable of interpreting earth processes. Labs and field trips are given special emphasis in these courses, and I push students to work hard. In several upper level courses (specifically, geomorphology and sedimentation/stratigraphy) students participate in class projects that involve field and laboratory quantitative data collection and analysis, and a group written report for the project.

Evaluation of student performance relies on a variety of methods including quizzes, exams, papers, and individual and group projects. Introductory courses typically emphasize evaluation through exams, while group work and writing are emphasized more in upper level courses.

Student evaluations help inform me as to how a particular course went, but I don't feel these evaluations are the whole story. I also gauge student reaction throughout the semester to monitor progress. I try to use exams and assignments that are similar enough to previous semesters to help me assess how consistent student learning is. Some of the most valuable feedback on the effectiveness of my teaching comes from contacts with alumni (both majors and others). Although this information is anecdotal and qualitative, it provides a very valuable sense of how well my efforts have served students in the long run.

Peter Nielsen

I have been a teacher/academic for the past 20 years, starting as a sabbatical replacement (visiting professor) at the University of Alberta and continuing through tenure track appointments at the University of Wisconsin-Parkside and Keene State College. During that time I have evolved from being a teacher whose main interests were geologic research with responsibility for teaching of primarily upper level undergraduate courses to an educator interested in all levels of undergraduate instruction with an interest in smaller scale research problems that can involve students.

I try to challenge the students and to develop their critical thinking skills at the introductory level. For major courses, I present a large amount of data and description, but my main goal is that the student learn to group these data into larger packages which illustrate the important processes and products that geologists deal with (mineralogy, petrology, structure). Assessment of student outcomes includes short answer essay and quantitative questions in traditional lecture and laboratory exams as well as asking students to observe and interpret the primary evidence as presented in rock outcrops on field trips. Student response (both communicated directly and through course evaluations) is generally positive.

I have become less of a lecturer "delivering" information to students and more oriented towards a hands-on teaching/learning environment, particularly in the introductory level and non-major courses. I have also made significant changes in how I handle upper-level major courses. Student involvement in the learning process is stressed and the results over the past several years have been encouraging, both in terms of the amount of factual information that students have retained (because it was learned in context or through inquiry based learning) as well as their understanding of difficult, often abstract concepts.

I participated in an AAC&U Science Institute, a five day workshop focused on the concept of integrated science, and it provided me with the opportunity to develop a model for implementing the concept. Subsequently, I attended a number of PKAL workshops on science education and presented at a workshop at Wheaton College (Nielsen et al., 1998a,b) Much of my scholarly activity is directed toward developing a more effective pedagogy for both introductory level courses and upper-level major courses. I have also become convinced that 'integrated science' may be the best way for non-science majors to have a meaningful general education science experience.

Advising Responsibilities

Geology faculty advise students majoring both in Geology as well as in ENST. Dr. Allen in particular, because of his former role as Coordinator of the ENST program, has advised students from across the spectrum of environmental studies spectrum (e.g. an Environmental Policy student with an Individualized Specialization in Architecture). Advisee assignments, as of September 2000, are given in Table 4. Note that Dr. Bill is on sabbatical for the Fall 2000 semester, so some of his advisees have sought re-assignment.

Table 4: Advisees

Student	Program	Anticipated Graduation Date
Dr. Allen's Advisees:		
Crosbie, Shawn	BS.ENST.SCI	05/02
Crosby, Daniel.	BS.GEOL	05/01
Hurd, Elizabeth	BS.GEOL	05/01
Leone, Jason	BS.ENST.SCI	12/00
Oed, Matthew	BS.GEOL	12/00
Patterson, Scott	BS.ENST.SCI	05/01
Saxon, Destiny	BS.GEOL	05/01
Dr. Bill's Advisees:		
Lindberg, Johanna	BS.GEOL	05/01
Mulvaney, Daniel	BS.ENST.SCI	05/01
Nightingale, Katie	BS.ENST.SCI	05/01
Dr. Nielsen's Advisees:		
Adams, Robert	BS.ENST.SCI	12/99
Burt, Christina	BS.GEOL	12/01
Doubleday, Virginia	BS.ENST.SCI	05/01
King, Joshua D.	BS.GEOL	05/01
Martindale, Kevin	BS.GEOL	05/04
Peterson, Mary	BS.GEOL	05/01
Roy, Matthew	BS.ENST.SCI	05/01
Totman, Paula	BS.GEOL.TC	12/02
McElroy, John	BS GEOL	05/03

Dr. Allen and Dr. Bill have also each participated in the First Semester Advisor program.

Departmental Interactions

At the time of the last review, the Geology program consisted of just two faculty, who had adjacent offices. Since contact between the faculty was frequent due to their proximity, formal faculty meetings were rarely if ever scheduled. Now there are three faculty (with offices not all adjacent) yet formal faculty meetings are still infrequent. As a result, the Department does not have a well-developed "habit of collective deliberation." None-the-less, faculty interaction is collegial, and often involves the conduct of joint class field trips. All three faculty regularly participate in the GEODES spring field trips and sit in on the associated seminar. Although the Geology faculty do no always share common priorities or approaches, DPEC evaluations reflect genuine respect and concern for individual professional and personal growth.

Service to and Involvement in the College

All three of the faculty have been very involved in the life of the college, in such areas as Technology Planning, Academic Program Review, and General Education Curriculum Development (among others). Complete details of our service activities are presented in our respective CV's. We have good relations with our colleagues from across campus, and are well-respected by faculty and administration alike. We have variously engaged in cooperative ventures with faculty from Biology, Geography, Chemistry, Physics, and Mathematics (including DPEC service, faculty searches, team-developed or team-taught courses, research collaborations, etc...). We are particularly involved in the ENST Program.

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Resources and Facilities

Learning Resources

The Mason Library presently contains approximately 1300 volumes in categories QE (Geology), TN (Mineral Resources), GC (Oceanography) and GB (Physical Geography, including Geomorphology and Hydrology) (Judith Hildebrandt, 2000, personal communication). Serials in the main collection include the Geological Society of America's (GSA) complete *Decade of North American Geology* series, the Mineralogical Society of America's *Reviews in Mineralogy*, and the *Treatise on Invertebrate Paleontology* (the latter two standing orders). While the collection is not large, it has been adequate. Some weeding is necessary, as some of the volumes are dated and do not reflect current paradigms in the Earth Sciences. The Library is aggressively developing its collections, for example subscribing to an "approval program," and has budgeted extra dollars to meet collections needs in the Sciences (including Geology).

The Library currently subscribes to approximately 14 journals and several other serials in the earth sciences, as well as the general science journals including *Science* and *Nature,* and other related journals such as *Evolution,* and *Limnology & Oceanography.* Numerous other journals and resources are available through the Library's subscriptions to on-line services. None-the-less, there may be room for re-configuration (or expansion) of our journal subscriptions to better align with the range of our course offerings—for example, the journals *Ground Water* and *Geochimica et Cosmochimica Acta* (except that it is an Elsevier journal costing $1755!) might be more appropriate than (or in addition to), say, *Economic Geology* and the *Bulletin of the American Association of Petroleum Geologists.*

The GeoRef and GEOBASE databases are now fully accessible anywhere on campus (and off-campus via password) through FirstSearch. In addition, the Library has assembled a Geology resource site accessible from its home page.

Other media resources include a variety of videos, video laser disks, CD-ROMs, overhead transparency files, and slide sets (e.g. Shelton's *Geology Illustrated*) in the Geology Department, and videos in the Center for Media and Information Technology (CMIT) collection (including the entire *Earth Revealed* PBS telecourse). The Department maintains overhead and slide projectors for use in each of its classrooms, and a large-screen video monitor mounted on a cart equipped with video-tape and laser-disk players.

The Geology Department's mineral, rock & fossil collections are generally adequate. We continue to augment our collections through field trips and selected purchases. We need to do more in the area of cataloging our collections and keeping them organized. Much of our work areas are overrun with stray material! Our suite of thin-sections could be augmented from our own collections, especially if we could make the time to get our thin-sectioning apparatus operational.

A significant mineral display is on public view in the Library, thanks to loans and gifts of specimens from local collectors and alumni. Other displays are mounted in cases in the Science Center hallway and in our classrooms.

The Geography Department has maintained a federal depository library for USGS topographic maps since 1970. We have a collection of various geologic maps and other materials, but as with our specimen collections, this is not cataloged and is unkempt, largely due to inadequate storage facilities. (We also have a significant collection of books and journals, which might warrant some coordination with the library?)

Equipment & Technology

A complete inventory of our equipment is provided in Appendix VIII. Computing technology is discussed separately below. We have basic equipment for geologic field work and mapping, cutting rock samples and preparing thin sections, sediment size analysis, petrographic and stereoscopic microscopy, and hydrologic measurement. We have recently established an interdisciplinary laboratory for preparing samples for stable isotope analysis. Other analytical equipment, what there is of it, has fallen into disuse or disrepair. Routine maintenance on our balances and microscopes was last done in 1992; other equipment has seen little or no maintenance ever. Particular needs include work on our balances and microscopes, setting up of our thin sectioning equipment, and perhaps an attempt at resurrection of the spectrograph.

Beyond the repair or replacement of some of our existing equipment (such as balances), desirable capabilities that we do *not* have include (in approximate priority order):

1. ability to crush rocks and prepare powders for whole-rock chemical, isotopic, or mineralogical analyses
2. analytical instrumentation for geochemical analysis of rocks, minerals, sediments and soils (e.g. XRF), with associated sample preparation equipment
3. analytical instrumentation for stable isotope ratio measurements to complement our new preparation laboratory
4. equipment for conducting geophysical exploration of the subsurface (Seismic, Magnetics, Gravity, etc...)
5. equipment for study of mineral fluid inclusions in section (heating/cooling stage)
6. automated instrumentation for sediment particle size analysis
7. ability to separate minerals from crushed rocks (or sediments) for individual mineral analyses
8. analytical instrumentation for chemical analysis of waters (e.g. ICP-OES or ICP-MS, and an Ion Chromatograph)—a capability that could be

shared with the Biology and Chemistry Departments and the ENST Program, and these instruments would make a nice complement to a New Science Building!

9. automated instrumentation for mineralogical analysis of rock powders, sediments, and soils (Powder XRD)
10. analytical instrumentation for enhanced microscopic and chemical analysis of minerals (e.g. SEM-EDX)—a capability that could be shared with the Biology Department.

Certainly the entire wish-list above is probably beyond the means of our current department to make full use of, much less support. But, some enhancement of our capabilities is necessary if we wish to involve our students in modern geological scientific investigations.

Towards these ends, addressing items 2 and 1 above, a proposal to acquire a Wave Length Dispersive XRF Spectrometer with spot analysis and element mapping capabilities, along with associated sample preparation equipment (including crushing and pulverizing) is now under review in NSF's CCLI program (Allen et al., 2000).

Addressing item 3, we anticipate developing an interdisciplinary NSF proposal in the next two years or so, to acquire an Isotope Ratio Mass Spectrometer (IRMS) once our preparation lab has proven itself. New, less expensive, mass spectrometers have been developed recently that would be appropriate in our setting (Kirchner and others, 1999, 2000). In the meantime, we intend to analyze the prepared gas samples (i.e. CO_2) with an IRMS at another institution, such as Dartmouth College.

We currently borrow an exploration seismograph—item 4 above—each fall from Dartmouth in order to support a lab in Environmental Geology (Allen, 1997a). Their magnetometer is not available to us in the fall when we would like to use it. Their seismograph is aging, and if we had our own it would more conveniently find use in Physical Geology and other courses. We are cultivating a possible alumni contribution of funds to help purchase one of our own. We anticipate using our supplemental equipment budget (see below) to purchase a magnetometer this year or next.

Relative to item 5 above, We are negotiating with the Geology Department at the University of Vermont to acquire their surplus fluid inclusion heating/cooling stage. This would be used primarily to support student-faculty research but also in the Petrography course, and possibly Petrology and Mineralogy.

Items 6-10 are part of the long-term plan (for example, associated with the Science Center building project), or are pipe-dreams...

Computing

Each of the three full-time faculty have reasonably up-to-date, networked, desk-top computer workstations in their offices (representing significant progress since the previous Geology Program Review!). Adjunct faculty have shared access to a somewhat less up-to-date, networked, desk-top computer workstation in the department's adjunct office space.

The College has recently subscribed to a site-license for basic personal productivity software (Microsoft Office). Other software needs are the responsibility of departments or even individual faculty. For example, Dr. Allen regularly relies on illustration, image processing, scientific graphing, database, programming, and graphic design/page layout software, all of which he has provided for himself out-of-pocket.

Geology students have not had access to computing resources within the department, nor have their courses demanded much access. Our alumni have noted this as a weakness in their preparation (see section on Program Evaluation & Assessment: Outcomes).

Students do have access to the central general-purpose computing clusters in Rhodes Hall, the Library and other locations, and Geology students sometimes also make use of the Geography Department's GIS lab. All Residence Hall rooms are wired for network connections, and dial-up internet connections are subsidized for off-campus students.

A new general-purpose computing cluster has just been established in the Science Center, and in addition two new computers (one PC and one PowerMac) have been allocated to Geology to establish a small departmental cluster. Much work remains to be done on integrating the use of these computers into our curriculum. Assuming that we can afford appropriate software and peripherals, things that we envision the facility will be used for include:

* Preparation of geologic maps and illustrations for geologic reports.
* Data acquisition through image capture, scanning, and interfaces with data-loggers and instruments .
* Processing and analysis of geologic, hydrologic, geochemical and geophysical data.
* Visualization and representation of above types of data.
* Modeling of various Earth systems, for example ground water flow.
* Computer-mediated teaching & learning.

Hydrogeology is probably the most computer-intensive course we currently offer, but we expect that the facility will be used to some extent in virtually all of our upper-level courses. It will also support student research efforts, particularly enhancing the quality of presentations and any resulting publications. As this facility is only now being established, several significant issues remain to be worked out, including software acquisition and maintenance, acquisition of peripheral devices, provision of technical support, and upgrade or replacement planning.

Our classrooms have only recently been wired with active computer network ports, which will facilitate the use of computer-based presentations in classes. Few of us, however, have yet prepared any such presentations, nor do we have any computer display capabilities within the department. We will need to rely on CMIT or other resources in the Science division.

Physical Facilities

Science 201 (564 ft^2): Classroom and laboratory for upper-level Geology courses, accommodates up to 18 students. Open during the day.

Science 201A (396 ft^2): Preparation area, laboratory, storage, and student work area. Open during the day. Utilities include a sink & gas.

Science 203A (329 ft^2): Primarily used for working storage. Usually open during the day.

Science 203 (972 ft^2): Classroom and laboratory for introductory geology classes, accommodates up to about 40 students. Open during the day. Utilities include a sink, and a campus network connection.

Science 205 (261 ft^2): Petrographic laboratory, computer cluster, department conference and reading room, and advanced student work area. Houses the petrographic microscopes, computer equipment, and video monitor cart. Access is by combination lock. Utilities include campus network connections.

Science 205A (108 ft^2): Work area for introductory students, storage and staging area for field labs in Environmental Geology and Hydrogeology. Open during the day. Utilities include a campus network connection.

Science 205B (100 ft^2): The Stable Isotope Biogeochemistry Laboratory. Access is by combination lock, through room 205A. Utilities include a campus network connection and gas service. There is no sink or fume hood.

Science 208 (100 ft^2): Office for Steven Bill.

Science 210 (100 ft^2): Office for Peter Nielsen.

Science 212 (100 ft^2): Office for Timothy Allen.

Science 216 (128 ft^2): Office for use by Adjunct Instructors.

Huntress Basement 17 (350 ft^2): The Rock Room, housing our rock saws, thin sectioning equipment, and other sample preparation equipment. Access is by key. Utilities include water. The room is also a mechanical room for Huntress Hall, where primary steam mains enter the building. This has led to problems do to overheating and inadequate ventilation, and from the blow-off of excess steam, which has showered much of our equipment with rust. There is no fume hood, dust collection, or compressed air.

Hydrogeologic Field Sites: Each is equipped with several shallow (10 to 15 feet) nested piezometer and water-table monitoring well pairs.

* College Fields, includes a 140-foot deep observation well in a semi-confined stratified drift aquifer, and a drainage lysimeter, approximately 1 mile from the Science building.
* Keene Forestry Park, ~2 miles away.
* College Camp, ~2.5 miles away.

Work space for organizing and storing our collections is at a premium. Part of the problem is, of course, the tendency to collect a lot, and the lack of time needed to keep our collections organized and our spaces clean and workable. More appropriate storage furnishings might help, as might appropriate support staff.

Physical facilities that we do *not* have include: a proper laboratory for geochemistry, equipped with fume hoods and other necessary utilities; an appropriate room for analytical instrumentation; or an appropriately equipped room for rock sample preparation. The ability to separate our teaching and laboratory preparation areas from student work/study areas is also desirable. A hydrogeologic well-field on the main campus, close to the Science building, would be more convenient than the College Fields site, which is about a mile away. We eagerly await the Science Center renovation and addition project, still an interminable several years away from even being funded, much less completed!

Support Staff

There are no laboratory or technical support staff available to the program. In recent years we have relied heavily on our advanced students, particularly those serving as adjunct instructors, for the maintenance of our introductory lab mineral and rock teaching collections. Maintenance of departmental equipment and facilities falls to the faculty. As with the management of our collections, routine maintenance is usually deferred, both for time and budgetary (as opposed to space) reasons. As we continue to develop and improve our equipment and facilities, these chores are an increasing burden on the faculty, who already have plenty to do. We note that the other natural science departments (Biology, Chemistry, even Physics) all have laboratory or technical support staff available to them (at some level), as do many of the Geology programs at our comparator institutions (see Appendix IX). Secretarial support is available but very limited (there is one secretary to serve the needs of all the faculty housed within the Science Center); within Geology, the faculty now produce all their own documents at their desktop anyway. Computer technical support (for faculty) is available through the centralized help-desk and CMIT. As we develop a small departmental computing cluster for use by Geology students, technical support arrangements for it will need to be carefully managed.

Budget

The discretionary budget available to the Geology program (for FY2001; representative of our funding level for many years) includes $2500 for equipment, almost $3000 for supplies (or equipment), and $500 for maintenance and repairs. We typically are able to augment these funds somewhat with savings from our photocopy and telephone allotments. Travel for field trips is funded separately. For FY2001 through FY2003, we have been allocated an additional $3500 per year in supplemental equipment funds, for a total equipment budget of $6000 per year. It is expected that we will be able to hold funds over from year to year in order to accumulate sufficient funds to purchase larger equipment items.

The Dean of Sciences usually has additional funds not allocated to the departments (for FY2001: $25K “instructional” and $5K “supplemental equipment”). In the past, through consultation with his council of department Chairs, some of these funds were used to help meet departmental needs above budgets such as purchases of more expensive items of equipment. For FY2001, he has proposed using these funds to supplement operating budgets (as opposed to equipment). In addition, the Dean has $20K (for FY2001) of divisional repair and renovation funds, which could be used to support building infrastructure improvements, including some types of equipment.

In some past instances, departments have pooled funds to purchase shared equipment (for example, the weather station was a combined effort of Physics, ENST, Geology, and Geography; the stream current meter, a combined effort of Geology, Geography, and ENST).

Other sources of funds, available to the Department upon successful application, include:

* Technology funds, such as for departmental computing clusters, managed by the College Information Technology Committee with input from the Academic Technology Committee.
* The Grant Match account, used to meet the matching requirements of external grants, such as the $120,000 that would be required to match our pending NSF-CCLI proposal to acquire an XRF spectrometer (Allen et al., 2000).

In addition, individual faculty have access to a “Professional Enhancement” allowance ($725 for FY2001, although we may also draw this year upon our FY2002 allowance of $775) which may be used for professional travel or things needed for research or teaching. Faculty may also apply for competitive grants from the Faculty Development Pool (up to $2500 for individual projects, or $5000 for collaborative ones; establishment of the Stable Isotope Biogeochemistry Laboratory was greatly facilitated by a interdisciplinary collaborative faculty development grant).

Students, working in collaboration with a faculty sponsor, may apply to the College’s Undergraduate Investigative and Creative Projects Fund for small grants (up to $750) to support their work. Several Geology students have taken advantage of this fund since its inception (Appendix V). Some of the hydrological and mapping equipment now owned by the Department was originally purchased with these funds.

Finally, a sum of several thousand dollars has accumulated over the years in the Geology gift account, thanks to the generosity of a few special friends. We hope to cultivate a significant additional alumni donation to help support the acquisition of an exploration seismograph.

For our basic day-to-day operations, the budget has so far been adequate. However, as we develop our facilities and capabilities in order to involve students in more hands-on activities, we will begin to really test our budgetary limits. For example, we now need to worry about supplies for the Stable Isotope lab, mass spectrometer analytical fees, software for the computer cluster, etc... Certainly our equipment needs far outstrip the available resources. New KSC and USNH initiatives in planning budgets and managing funds, for example the ability to carry funds forward from year to year in order to accumulate enough for more expensive equipment items, should help (some).

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Students

Enrollment Trends

Enrollment in and Student Credit Hours generated by Geology courses has been relatively constant over the last ten years (Figure 1a and 1b), especially in comparison with the rest of the natural sciences (Figure 2a and 2b) which peaked in 1995 and has since declined (markedly so in Chemistry and Physics). Fall semester Geology enrollments have averaged 380 students, generating an average of 1033 student credit hours (data for Spring semesters is not maintained by the College's Office of Institutional Research).

Over the last ten years, according to the *KSC Factbook 1999,* the number of declared Geology majors (including some listed under the now-defunct Earth Science and Earth Science TCO major designations) has averaged a total of about 10 students each year (Figure 3a). It should be noted that these data do not include those students majoring in the ENST-Geology Specialization. Unfortunately, the database maintained by Office of Institutional Research is apparently unable to track students at the level of "Specialization." Further, it is unclear whether the data presented in the *Factbook* includes students with a dual major whose "first" major is not geology. It should also be noted that these data are limited by the proclivity of KSC students to not follow-through on paperwork, such as submitting major declaration forms...

While a total of 10 majors does not constitute a large program, it is of reasonable size. Our upper-level classes are small and personal,

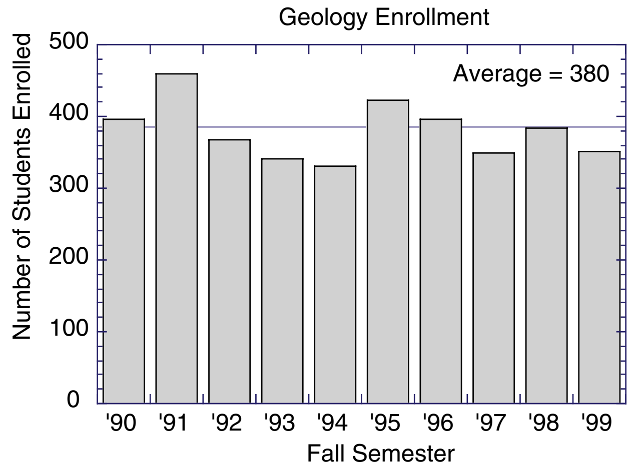

Figure 1a: Number of students enrolled in fall semester Geology courses. Data source: *Keene State College Factbook 1999.*

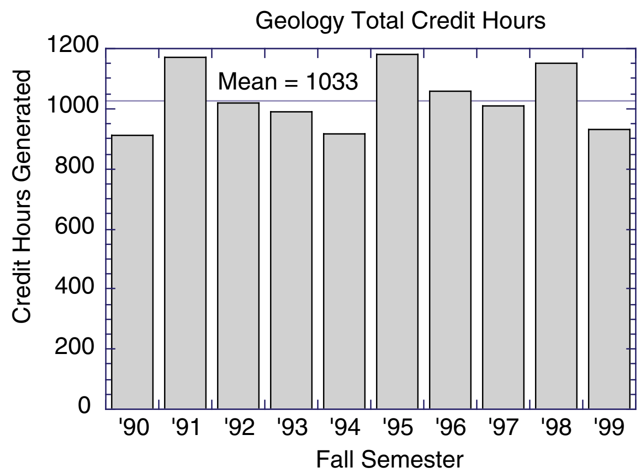

Figure 1b: Student Credit Hours generated by fall semester Geology courses. Data source: *Keene State College Factbook 1999.*

with students getting a lot of individual attention from faculty, something our alumni specifically cite as important to them (see section on Program Evaluation & Assessment: Outcomes). While there is some room to grow enrollment in the major, it really is not much. In the mid-1990's, some of our core upper level courses were subscribed to capacity. Were our student numbers much larger, we would require more faculty in order to offer our core courses more frequently than every-other year.

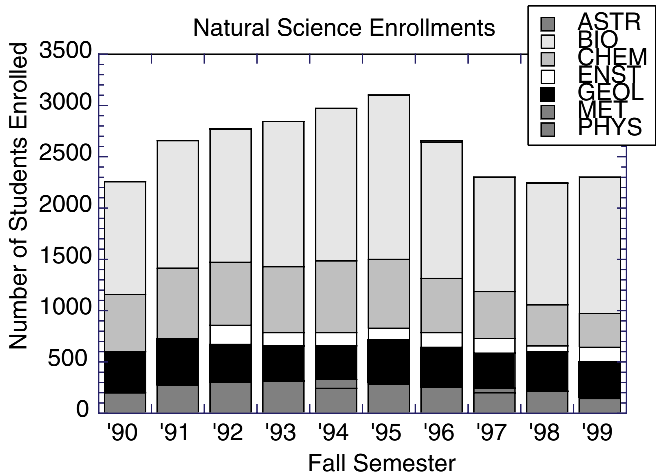

Figure 2a: Number of students enrolled in fall semester natural science courses (including Astronomy, Biology, Chemistry, Environmental Studies, Geology, Meteorology, and Physics). Data source: *Keene State College Factbook 1999.*

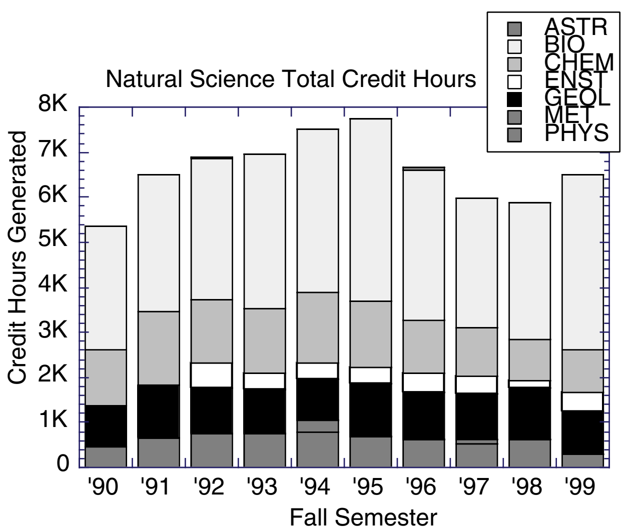

Figure 2b: Student Credit Hours generated by fall semester natural science courses (including Astronomy, Biology, Chemistry, Environmental Studies, Geology, Meteorology, and Physics). Data source: *Keene State College Factbook 1999.*

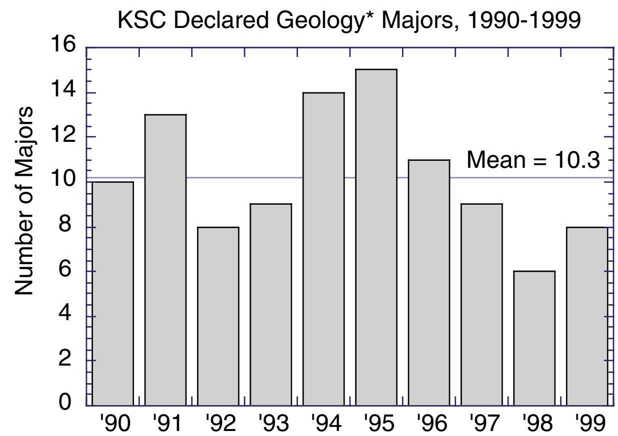

Figure 3a: Number of Declared Geology Majors (including Earth Science and Earth Science TCO), fall semesters. Note that this does not include ENST-Geology Specialization, nor does it appear to include students with a dual major whose first major is not geology. Data source: *Keene State College Factbook 1999.*

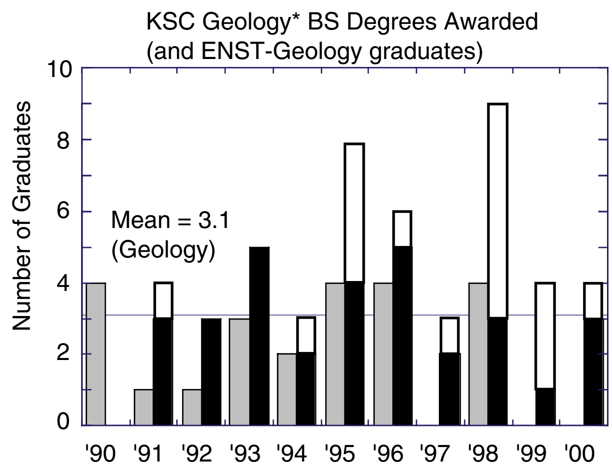

Figure 3b: Number of BS degrees in Geology (including Earth Science and Earth Science TCO). The data for gray bars is from the *Keene State College Factbook 1999*, for the period 1990-1999; data for the black bars is from Appendix VIII (derived from Alumni records), for the period 1991-2000. We believe the latter to be accurate. White boxes on top of the black bars indicate number of *known* ENST-Geology graduates (Appendix VIII).

The decline in the number of Geology majors since 1995 (Figure 3a) might be related to a decline in overall enrollments in the natural sciences during that time (Figure 2a), and/or to changes in the ENST major program in 1995, which significantly improved the ENST major by eliminating a number of bottlenecks, and made the ENST major even more attractive to students, with a possible inverse impact on

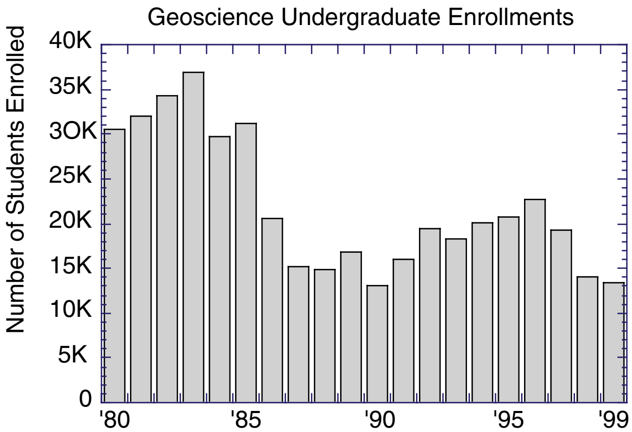

Figure 4a: Geoscience Undergraduate Enrollment nationally, 1980-1999 Data source: AGI, 2000a.

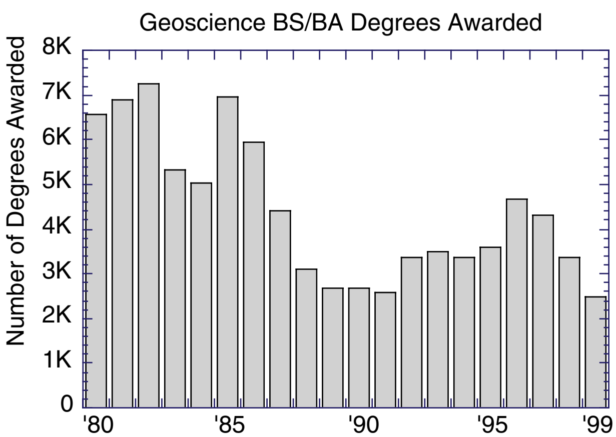

Figure 4b: Geoscience BA/BS Degrees Granted nationally, 1980-1999 Data source: AGI, 2000b.

the Geology major. (In the past, some students would turn to Geology as an alternative to the lengthy and difficult ENST program.)

Regarding the numbers of Geology degrees awarded each year (Figure 3b), there are significant discrepancies between the data presented in the *KSC Factbook 1999* and that presented in Appendix VI (derived from Alumni records and other sources). The reasons for discrepancy are unclear; could it be a problem of dual majors where the "first" major is not geology, or could it due to December versus. May completions? Depending on which data set you believe, we produce an average of 2.3 or 3.1 graduates per year. Some alternate-year cyclicity in the number of graduates might be related to the every-other year scheduling of upper level geology courses.

National cyclic trends in geoscience enrollments (Figure 4a) and in geoscience bachelor's degrees awarded (Figure 4b) are correlated (out of phase) with employment opportunities for geoscientists (AGI, 1999). Boom-and-bust cyclicity has long been associated with the Petroleum and Mining industries. Opportunities in the Environmental sector are largely driven by politics; for example the significant decline over the 1980's may be related to the environmental policies of the Reagan and Bush administrations which may have led to decreasing employment opportunities for geologists in the environmental sector.

Demographics

More than 90 percent of the student credit hours generated by Geology are in introductory (100 & 200-level) courses (Figure 5), particularly GEOL 100 Perspectives of Earth and GEOL 201 Introductory Physical Geology. This reinforces the primacy of serving the college's General Education program in the Geology program's mission.

We have not analyzed the distribution of majors among students taking Geology courses to meet general education requirements. Certainly many Education majors, who are required to take a laboratory course to meet their physical science general education distribution requirement, choose Geology over other physical science options. We otherwise have little reason to suspect that the students in our introductory courses are not representative of the KSC student population as a whole.

The male/female demographics of students enrolled in the Geology program have not in the past reflected those of the KSC student population as a whole. Among those graduates from the past 10 years that we include among alumni of our program (Appendix VI),

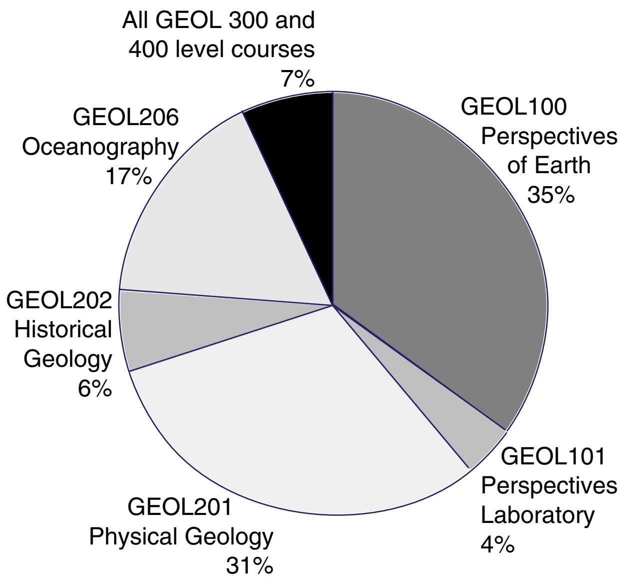

Figure 5: Student Credit Hours generated by course, Fall 1992 to Fall 1999 (including Summer Sessions). Data source: Geology grade report prepared by Office of Institutional Research, spring 2000

only about 34% are female; In 1999, 57% of the KSC student population was female. Our demographics are, however, consistent with national data—35% of Geoscience Bachelor degrees awarded from 1991 to 1999 were to women (AGI, 2000b). Nationally, the proportion of females among undergraduates enrolled in Geoscience programs has risen from 24% to 42% over the last twenty years (AGI, 2000a). This is a promising trend. The September 2000 list of declared students in Geology or ENST-Geology at KSC (Table 5) includes 9 females and 9 males (i.e. 50% female, more representative of KSC students).

There have been very few ethnic minorities in the KSC Geology program; minorities comprise only about 2% of the student population at KSC (*KSC Factbook 1999*). Minorities comprise only about 5% of undergraduate Geoscience enrollments nationally (AGI, 2000a).

Admission Process

There are no special requirements or processes for admission into the Geology program.

Admission to the College is managed by the Admissions Office. Very few entering students ever express an interest in Geology as a potential major, as the field is not one that many students are really aware of coming out of high school. It seems that most students become interested in geology only after they have been exposed to it at the college level. Thus our problem is one of recruitment rather than admission. It is therefore important that we ensure an adequate number of seats in GEOL 201 for first and second year students, and that we make sure to share with the students who enroll in that course everything that is exciting about geology.

Participation in Program

There is a student club for those interested in geology, the GEODES (which stands for: **G**eologists **E**mbarking **O**n **D**angerous **E**xpeditions for **S**cience!). They meet periodically throughout the year—sometimes for free pizza—and run a number of field trips. Since 1989, the main event has been an extended field trip (one to two weeks duration) to relatively distant regions, which takes place every May following graduation. We have gone to the following locales:

* 2001 (planned) coastal Maine (T. Allen)
* May 16-27, 2000 Adirondacks, NY; and Ontario, Canada (P. Nielsen)
* May 19-29, 1999 Maryland, West Virginia, Virginia (S. Bill)
* May 18-31, 1998 Wyoming, South Dakota, Utah & Colorado (T. Allen)
* May 18-25, 1997 Central & Eastern Pennsylvania (S. Bill)
* May 12-17, 1996 Bay of Fundy, Nova Scotia, Canada (P. Nielsen)
* May 14-21, 1995 White Mountains, NH & ME; and Quebec, Canada (T. Allen, P. Nielsen)
* May 15-22, 1994 Maryland, West Virginia, Virginia (S. Bill)
* May 16-23, 1993 Adirondacks & Upstate New York (P. Nielsen, S. Bill)

* May 11-17, 1992 Central & Eastern Pennsylvania (S. Bill)
* May 12-19, 1991 Bay of Fundy, Nova Scotia, Canada (P. Nielsen)
* May 10-19, 1990 Maryland, West Virginia, Virginia (S. Bill)
* May 14-20, 1989 Adirondacks, NY (P. Nielsen)

In addition to these activities, the Club also organizes an annual Holiday party at Dr. Nielsen's home and a summer reunion picnic at Dr. Allen's home; spring semester parties have been held at Dr. Bill's house. These parties often attract program alumni as well as current students.

Every year, we encourage our students to participate in the NEIGC—three days of field trips in the mid-fall; KSC sometimes has the largest student representation! In addition, we encourage our students to attend the quarterly dinner meetings of the NHGS. In addition, students have attended GSA Northeastern Section meetings when convenient to do so (e.g. Hartford, CT; Burlington, VT).

As discussed in the section on Faculty, the Geology faculty rarely have formal department meetings, and there has been no student representation at those meetings we have had. There is, however, a great deal of informal student-faculty interaction, for example on our field trips and at GEODES gatherings, that helps provide student input to the Department. Sometimes, however, the intense nature of these interactions (e.g. travelling and camping together for 2 weeks in tight quarters) severely tests interpersonal relationships between and among students and faculty!

Honors and Recognition

Students in the Geology program in the past have also looked into organizing a chapter of Sigma Gamma Epsilon, the Geology Honor Society. At the time, it seems that we did not have a sufficient number of qualified students.

Each year a geology student is recognized at the Spring Honors Convocation with the George T. Faust Geology Award. This award was established in 1992 by the Fausts and the family of Sean Mackey '91 in memory of his maternal grandfather, Dr. George T. Faust, a teacher most interested in turning young minds to science. The award is presented to a geology student, selected by the Geology faculty, "who has demonstrated a deep and abiding concern for our planet and one who walks with the wonder and beauty of the universe in his or her heart." Recipients to date are:

* 2000 - Carol Leger
* 1999 - Sean Kennedy
* 1998 - Mark Reinhold
* 1997 - Sharon Monahan
* 1996 - Dana Wood
* 1995 - Patricia Drobat
* 1994 - Scott Mackay
* 1993 - Mark Nimiroski
* 1992 - David Jones

Current Majors

Table 5: Current majors
As of September 2000

Student	Program	Anticipated Graduation Date
Burt, Christina	BS.GEOL	12/01
Crosby, Daniel	BS.GEOL	05/01
Hurd, Elizabeth	BS.GEOL	05/01
King, Joshua	BS.GEOL	05/01
Lindberg, Johanna	BS.GEOL	05/01
Martindale, Kevin	BS.GEOL	05/04
McElroy, John	BS.GEOL	05/03
Oed, Matthew	BS.GEOL	05/01
Peterson, Mary	BS.GEOL	05/02
Saxon, Destiny	BS.GEOL	12/00
Totman, Paula	BS.GEOL.TC	12/02
Adams, Robert	BS.ENST.SCI	12/01
Cleveland, Ashley	BS.ENST.SCI	05/02
Doubleday, Virginia	BS.ENST.SCI	05/01
Mulvaney, Daniel	BS.ENST.SCI	05/01
Nightingale, Katie	BS.ENST.SCI	05/01
Patterson, Scott	BS.ENST.SCI	05/02
Roy, Matthew	BS.ENST.SCI	05/01

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Program Evaluation & Assessment

Outcomes

Professional Organization Guidelines

While there may not be accreditation standards for Geology programs, there are curricular recommendations and guidelines offered by professional organizations in the field. Notably, the American Institute of Professional Geologists (AIPG) Ad Hoc Committee on Curriculum issued a report with recommendations on *Education for Professional Practice* in July 1991 (see Appendices IV and IX), superseding the 1985 *AIPG Guidelines for Undergraduate Programs in Geology*. In addition, Whisonant & Philley (1998) considered the implications to the undergraduate geology curriculum of the testing of geologists for professional licensure, specifically the examinations developed by the National Association of State Boards of Geologists (ASBOG; Warner et al., 1999; Appendix IV).

Our curriculum is not fully in accord with the recommendations of the AIPG (1991). Specifically, we do not have a Field Geology course (although field approaches are incorporated to some extent into most of our other courses), nor do we really have what AIPG would recognize as an appropriate capstone experience (one "involving problem definition, data acquisition, analysis and conceptual integration"). Two courses that we require (Paleontology and Petrology), AIPG now considers elective rather than part of the core.

The ASBOG Fundamentals of Geology Examination focuses on several content domains (Table 6), in order of importance (adapted from Whisonant & Philley, 1998; and Warner et al., 1999).

The ASBOG test is thus reasonably in accord with the AIPG curriculum suggestions. Again, it should be noted that our program does not:

*include a capstone research experience
* require a Field Methods course
* require Hydrogeology

Comparator Institution Comparisons

Further insight can be gained by comparing our program with that at similar institutions. In contract negotiations, USNH and the KSCEA developed a list of 30 comparator institutions, also useful for this purpose. In addition, KSC is a member of the Council of Public Liberal Arts Colleges (CoPLAC), which group provides another basis for comparison. (Besides KSC, one other institution shows up on both lists, Sonoma State University.) Of the 45 institutions on these combined lists (Appendix IX), 20 offer degree programs in Geology and/or Earth Science, through departments of Geology (or equivalent). A number of these departments offer multiple degree programs, for example (in the extreme): BS and BA in Geology, BS in Geology-Environmental Option, BS in Geochemistry (Geology/Chemistry), BS in Geophysics (Geology/Physics), and BS in Earth Science with Teacher Certification. For our purposes, we have focused primarily on BS Geology programs. A summary comparison of these offerings, as discerned from a quick review of department

Table 6: ASBOG Exam Content Domains

Content Domain	% of exam
Research, Field Methods & Communications	37
Structural Geology	12
Hydrogeology	12
Stratigraphy/Historical Geology	11
Petrography/Petrology	8
Geomorphology	4
Engineering Geology	4
Mineralogy	3
Paleontology	2
Geophysics	2
Mining Geology	2
Petroleum Geology	2
Geochemistry	1

web pages, is given in Appendix IX. (Another five comparator institutions offer degree programs in Earth Science through departments of Geography, Environmental Studies, or Natural Sciences; and five more offer only minors in Geology.)

Also presented in the comparison table (Appendix IX) are results from American Geological Institute's (AGI) *1999 Report on the Status of Academic Geoscience Departments*. In addition to many "comprehensive" departments (those offering both undergraduate and graduate degree programs), eighty-five departments offering only undergraduate degree programs responded to the AGI survey.

Several features from the comparison in Appendix IX are of note:

1. Fourteen of the 20 comparator programs require some kind of course in Field Methods, ranging from a 2 credit offering to a full summer field camp (6 credits). Another three programs offer such a course, although it is not explicitly required. Several programs require an additional course in Research Methods. Of undergraduate Geology departments polled by AGI (1999), 81.2% offer such a course.

2. Nine comparator programs require a Senior Seminar. Seven (four of the nine, plus three others) offer a Senior Thesis option. At least one program (Western Carolina) describes their seminar as a capstone.

> These data reinforce the deficiencies noted above in KSC's program—the lack of a field geology course and the lack of a capstone research experience.

3. Paleontology is alive and well: Ten programs (including KSC) require a course in Paleontology, and five more offer such a course as an option. Several programs offer a second course in advanced Paleontology. Fully 100% of undergraduate Geology departments polled by AGI (1999) offer a course in general paleontology.

4. Almost all programs require separate full courses in Mineralogy and Petrology (including KSC).

5. Those programs that offer a course in Glacial Geology (such as KSC) are located in glaciated regions! (surprise, surprise ...)

6. Courses in Hydrogeology and Geochemistry are more popular than those in Economic Geology (or equivalent). Only one comparator program (Cal State Bakersfield) offers a course in Petroleum Geology.

7. Almost all schools require a year of chemistry and a year of Physics. Most also require a full year of Calculus (and at least one requires Differential Equations!). Some programs distinguish between BS and BA degrees in Geology solely on the basis of the level of the Math and Physics courses expected. Only a few programs (such as KSC) require any Biology.

8. Ten programs require (or will accept) a course in Computer Science. Two programs (Fort Lewis and Mary Washington) actually offer a course on Computer Applications in Geology (exclusive of GIS and Remote Sensing) within their departments.

> Relative to these latter two points, many of our students at KSC struggle with one semester of Calculus, and two of College Physics, but observations from some of our alumni suggest that we need to make enhancements in quantitative aspects of (e.g. Macdonald et al., 2000; Keller et al., 2000), and the use of computers in, our program.

9. In assessing learning outcomes, besides programs requiring a Senior Seminar or capstone experience, one program (Austin Peay) notes that it requires all graduating students to take the ACT COMP test *and* submit to an exit interview (orals?) with the faculty. Another program (SUNY Genesco) requires students

to maintain a portfolio of all their writing, which is assessed by the faculty in the students' senior year.

10. Finally, the average (and median) number of full-time Geology faculty among the 20 comparator departments is about 5, ranging from 3 (such as KSC) to a high of 11! (The College of Charleston happens to offer an MS program in Geology). Several programs also note additional adjunct or visiting faculty, as well as laboratory, technical, and/or departmental secretarial support personnel. The AGI (1999) reports the average number of faculty in geology departments offering undergraduate degree programs (only) is 6, based on an analysis of 232 such departments listed in the annual AGI Directory of Geoscience Departments.

Historically, we have not offered a field course or required a capstone research experience due to resource constraints, both Departmental (lack of faculty availability to teach such courses) and for students (summer field camp is an extra expense). Rather, working within the framework of courses that we do offer, we have tried to integrate detailed field observations (albeit mostly qualitative in nature) with "big picture" tectonic and earth-system syntheses.

Certainly, our program is viable in that many of our graduates have been successful in finding appropriate employment or in gaining entrance to graduate school (Appendix VI). None-the-less, based on the analysis above, we could improve by ensuring students receive adequate experience in field methods and providing students with a capstone research experience (while infusing the practice of research throughout our curriculum), as well as enhancing quantitative aspects and the use of computers throughout our program.

NCATE Review

The Earth Science Teacher Certification Option was included in the 1995 NCATE review of KSC's Educations programs. Under our current program, students who wish to obtain certification as Earth Science teachers need to take specific courses that we do not require in the Geology major, but which they may use to meet Geology elective requirements (e.g. ASTR 307 Astronomy). Thus, since eligibility for certification depends on the student having chosen the right mix of electives, rather than having followed a prescribed program listed in the catalog, the Geology major as it currently stands does not fully meet the standards.

Alumni Feedback

In August 2000, we sent a questionnaire (Appendix X) to alumni who graduated over the past 10 years (Appendix VI) with degrees in Earth Science, Geology, or ENST-Geology Specialization (identifying these last was difficult, as the College's database does not track students at the level of Specialization), as well as several ENST graduates with other specializations but who we remembered as having an interest in Geology, and several students with Individualized Majors involving Geology. The total number of surveys sent out was approximately 64. As of October 15, 2000, twenty-six surveys had been completed and returned (response rate 40%); three were returned undeliverable as addressed.

In addition to these surveys, we have relied on other contacts and sources of information to get a more complete sense of our alumni, as shown in Appendix VI. (For example, according to the NHGS's membership records, 12 out of 204 current or former members of the NHGS identify themselves as having received all or part of their education from KSC.) The discussion below, however, is limited to an analysis of the 26 survey responses.

Nineteen of the 26 respondents have received some kind of education or training subsequent to graduating from KSC. Four have received graduate degrees, four are currently enrolled in graduate programs (including 2 of the graduate degree recipients), and two undertook some graduate study:

* PhD Geology, currently enrolled, University of New Hampshire—previous degree: MS Geology, 2000, UNH
* MS Computer Science & Engineering, currently enrolled, Northern Arizona Univ.—previous degree: MS Geology, 1996, Arizona State University
* MS Geology, currently enrolled, University of North Carolina at Wilmington
* MBA, currently enrolled, Assumption College
* MS Vadose Zone Hydrogeology, 1998, Boston University
* MS Hydrogeology, 1998, Wright State University
* 20 graduate credits in Geology, University of Utah
* misc. graduate credits in Geology, University of Rhode Island

Other training reported includes:

* OSHA 40 hour HAZWOPER
* short courses in Contaminant Hydrogeology and other related topics
* Asbestos Certification
* teacher education workshops
* Mountain Leadership, and Wilderness First Responder
* 1000-hour cosmetology program, New England Hair Academy

Of the 26 respondents, 12 classify their current work as related to Geology (+/- environmental studies and/or other field of natural science); another 5 classify their current work as related to environmental studies of other field of natural science, but not Geology. Job titles (and salary ranges) are listed in Table 7 (17 respondents).

Two of the nine respondents whose current work is not related to Geology (or environmental studies or other natural science) report having held geologically-related employment in the past; one is about to start a new geologically-related job. Three describe failed attempts at finding related employment, which provide useful insight about the job market and their courses of study (see below).

Table 7: Alumni Job Titles and Salaries

Job Title	Salary Range
Project Hydrogeologist	not specified
Senior Hydrogeologist	$50K-$75K
Hydrologist	$25K-$50K
Environmental Geologist	$25K-$50K
Field Geologist	not specified
Enviro. Technician (3)	$25K-$50K
Science Teacher (2)	$25K-$50K
Energy Project Assistant	$25K-$50K
Reinsurance Accountant	$25K-$50K
Mech. Engineering Asst.	$25K-$50K
Physical Testing Technician	<$25K
Recreational Therapy Instructor	<$25K
Graduate Student (2)	<$25K

Tasks or skills involved in the Geology or science-related jobs in Table 7 are listed in Table 8 (17 respondents).

Table 8: Important Skills in Alumni Jobs

Task or Skill	# of respondents
writing	13
use of computerized databases	11
sample collection	10
quantitative reasoning	8
fieldwork or mapping	6
computer modeling	6
laboratory analysis	5
graphics and illustration	5
other	7

Employers for these 17 respondents are environmental consulting firms (8); secondary schools (3); universities (2 - the graduate students); the USGS; an insurance company; an industrial company; and an engineering R&D firm.

Table 9: Courses deemed Most Valuable by alumni

Course	# of respondents
Hydrogeology (or Hydrology)	6
Mineralogy	5
Petrology	5
Physical Geology	4
Stratigraphy & Sedimentation	4
Glacial Geology	4
Independent Study	3
Environmental Geology	3
Geomorphology	3
Math (Calculus)	3
Historical Geology	2
Structural Geology	2
Geochemistry	2
Chemistry	2
Physics	2
Remote Sensing	2
ENST Seminar	2
thirteen other courses	1

Courses taken while at KSC that are deemed as most valuable (all 26 respondents) are listed in Table 9 above. Several noted that "all" of their Geology courses are valuable, particularly upper-level courses that involved lab work and report writing. Areas in which respondents (all 26) wish they had better preparation are listed in Table 10.

What these graduates (all 26 respondents) remember the most about their experience with the KSC Geology Program were: their field experiences; the knowledgeable, enthusiastic, and dedicated professors with sincere interest in students; small personal classes, with individual attention; and a sense of camaraderie among students (particularly during late nights in the lab!) and between students and faculty. Those who were involved in Independent Study research projects found them especially valuable and memorable. One noted: "The Geology program offered both gifted and industrious learners an opportunity and a forum to strive, struggle, and eventually prevail in the learning process. Not many of the other departments allow for that."

Table 10: Courses alumni wish they had taken

Course	# of respondents
Hydrogeology/Hydrology	11
computers	5
math	4
Glacial Geology	3
Geochemistry	3
GIS	3
regulatory overview	2
Astronomy	2
Environmental Geology	1
Geomorphology	1
advanced Stratigraphy	1
subsurface exploration	1
surveying	1
environmental engineering	1
Optical Petrography	1
Scientific Writing	1
site assessments	1
Meteorology	1
business & marketing	1
applied Physics	1

Respondents with Geology (or environmental studies or other natural science) -related employment offer the following advice to current and prospective students:

* The more quantitative your course load the better.
* You should be a well rounded student with good writing and math skills, chemistry background, etc...
* Do an independent study, the longer and more involved the better, it opens doors and shows initiative; get an internship or summer job; get work in on time, adsorb as much as possible and take all the courses that you can.
* Take as many geology courses as you can and familiarize yourself with the local geology where you plan to settle down.

* Geology is fun, Geologists are cool and laid back, and understanding lithospheric formation is helpful in looking back historically in both the biological and environmental sciences.
* Get involved in research, it helps prepare you for grad school and looks good on a resume.
* Learn as much as possible, don't avoid Math.
* Take Computer & Math courses.
* Take advantage of every chance for hands on learning and make good connections—those are the things that really count.
* Become well rounded (business, computers, and science).
* Get a good general overview of all aspects of environmental science (energy, geology, water, air quality) and good GRADES and learn simple lab techniques like water testing...
* Do your work in the lab—it's amazing how much it helps to have somebody else's input.
* Get involved with as much as possible. Try to intern before graduating.
* Work in the field during the summer months to see what you want out of the field of Environmental Science, it is far more vast than I expected.
* Pay more attention to Dr. Bill's map courses.
* Spread out your upper level geology courses—it's tough taking 3+ upper level courses in one semester!

Advice from those not now employed in areas related to Geology or environmental studies or other natural science:

* keep up with the work - it will get piled up quickly and then be impossible to catch up.
* Stick with it. Tough it out. Through the courses you will feel a real sense of accomplishment. There are geology related jobs out there - I worked for an international geo-engineering firm for 3.5 years before moving to computer networking.
* Decide your focus early, graduate school or work; learn as much as you can about your field of interest; try for internships or summer jobs that help you toward your goal(s).
* If you want to be given a lot of responsibility in any job, you will most likely need graduate study. Best time to do it is right after undergraduate.
* Make sure your writing skills are good. Take any available internships, even non-paid volunteer, because employers want experience.
* Check the job market first, companies advertising entry-level positions wanted master's and/or experience, specialize.
* I tried to find a job in the environmental field, but people hesitate to hire over 50's when there are many younger applicants.
* Hang in there!

Certainly Hydrogeology, as well as computer, math and writing skills, stand out as very important to our graduates. "Research" (e.g. independent study and hands-on learning) and field experiences are also important.

Summary

Students in the Geology program seem to be representative of the KSC student body as a whole. Some struggle through our courses; others excel. Many do engage in advanced or independent work. Our general education offerings are in high demand, and are almost always oversubscribed. Many students report an increased appreciation for the earth, and for science, as a result of their taking these courses. Program graduates do find employment, many undertaking graduate study at some point, and they remain professionally involved. In all these regards, our program is clearly effective.

How is the overall mission of KSC impacted by the program? While the Geology major is not one of the most heavily subscribed at the College, the program certainly makes a significant contribution to the College's General Education Program and to the interdisciplinary ENST Program. Those contributions are significantly strengthened by the existence of the Geology major program, which remains vital, vigorous, vibrant and viable. In many ways, we feel that our program is a true exemplar of the College's mission, promoting strong relationships among students and faculty that emphasize creative and critical thinking, scholarship and research, and a passion for learning, with a commitment to service.

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Program Strengths & Weaknesses (Challenges & Opportunities)

The strengths of our program include the enthusiasm of our faculty for the subject matter, their deep concern for student development, and the high level of personal attention our students receive. Although we don't offer a field methods course, our graduates do appreciate the field experiences that we are able to offer them. We feel that one particular strength of our offerings is the integration of lecture and laboratory in GEOL 201 Introductory Physical Geology, as discussed in the section on Planning. Overall, our enrollments have been relatively stable. Variations in our number of majors reflects trends across the natural sciences at KSC, and to some extent national trends in geoscience enrollments. The program certainly remains viable, even vibrant, vigorous, and vital.

We face many challenges, however:

1. ensuring students receive adequate experience in field methods;
2. enhancing quantitative aspects throughout our program;
3. integrating the use of computers into our curriculum;
4. infusing the practice of research throughout our program, with a capstone research experience;
5. assessing learning outcomes;
6. acquiring, supporting and maintaining modern analytical and computational equipment and facilities;
7. obtaining adequate laboratory and technical support;
8. keeping our collections organized and useful;
9. developing a stronger "habit of collective faculty deliberation;" and
10. as always, recruiting students.

We have also recently experienced some good fortune, including:

* opening of some space in the Science Center for additional geology labs;
* establishment of a new departmental computing cluster;
* award of an internal grant supporting the establishment of the Stable Isotope Laboratory;
* awards of internal and external grants supporting student-faculty cooperative research projects; and
* new KSC and USNH budget initiatives providing enhanced equipment funds.

We have opportunities now to build on the above successes, as well as opportunities to:

* cultivate a supportive network of alumni;
* enhance the library's collections;
* pursue additional external funding for programs and equipment;
* plan for a new Science building; and
* provide continuing education for NH licensed Professional Geologists.

Our principal constraint is that of limited time and energy. Certainly, inadequacies in our facilities and equipment remain constraining (certainly until a new Science Center is built), and our budget will always be limited. But there is much that we can do with what we have now, it just takes *time* to do it!

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Planning

In planning for the future of the Geology program at KSC, we need to consider trends and future directions in the geosciences and in science education, and consider potential impacts from changes in the academic environment here at KSC, as well as addressing the challenges and opportunities identified in the section on Strengths & Weaknesses.

Trends in Geoscience

Beyond the professional practice of Geology (as considered by AIPG and ASBOG), the GSA, the USGS, and the NSF Geoscience Directorate all offer convergent insights as to the future of geoscientific endeavors: integrated Earth system science.

The NSF Geoscience Directorate describes their objectives for the first decade of the 21st century as (NSF 00-28, 2000):

* Fostering discovery and understanding of the factors that define and influence the Earth's environmental and planetary processes.
* Expanding understanding and predictability of the complex, interactive processes that:
  1. determine variability in the past, present and future states of planet Earth;
  2. control the origin and current status of the forms of life on the planet; and
  3. affect the interdependencies of society and planetary processes.
* Providing the resulting scientific information in forms useful to society.

Their research agenda focuses on enhancing our base of knowledge in four fundamental areas (NSF 00-28, 2000):

planetary structure: To describe the spatial and temporal variations of the structure and composition of all Earth system components, from the inner core to the upper atmosphere, through improvements in observational, theoretical and modeling capabilities.

planetary energetics: To understand the links between physical and chemical processes by focusing on the exchange of energy within and among the components of the Sun-Earth systems.

planetary ecology: To understand the Earth's marine and terrestrial ecosystems and their evolution, and the interactions of the biosphere with Earth system processes.

planetary metabolism: To understand the links and feedbacks among the Earth's physical, chemical, geological, biological, and social systems, how they have evolved, and how they affect the biocomplexity in the environment of the planet.

This research will in turn serve society in three primary ways (NSF 00-28, 2000):

Predicting Hazardous Events: To enable reliable predictions of significant changes to Earth's current state. Earthquakes, severe storms, solar storms, and biological invasions represent threats, but we have the opportunity to mitigate these threats for society. Predictions of extreme planetary events can help save lives and/or lessen property damage.

Assessing Environmental Quality: To provide the basis for assessments of potential natural and anthropogenic changes to the environment such as air and water quality, coastal pollution and erosion, and soil degradation.

Predicting Longer-Term Change and Variability: To furnish information that

> may be used to mitigate losses, alleviate undesirable impacts, and take advantage of opportunities arising from climate variation and change.

The GSA made the second goal of their Strategic Plan: “To catalyze cooperative interactions among earth, life, planetary, and social scientists who investigate natural systems.” (May and Ashley, 1999) To this end they cooperated with the Ecological Society of America and the USGS in a workshop on “Enhancing Integrated Science” (see USGS, 1998). At this workshop, it was noted that:

> Science is increasingly required to take a more comprehensive approach in our understanding of natural systems, thereby seeking to link and integrate disciplines that have been traditionally separated. But interdisciplinary science is not easy to do, nor is it easy to manage. It is an evolution in the conduct of science. Opportunities must be made available where interdisciplinary science may be taught and is practiced. Strong disciplinary science will remain critical, and is necessary to rigorous integrated approaches. (USGS, 1998, Appendix 2)

So what direction are the geosciences headed? As May and Ashley (1999) describe it:

> The Earth-system science movement is sweeping forcefully through academia and government. ... If this movement were just another aberrant wave, we would all recognize it as ephemeral. We know, however, that this is a true “sea change,” not just another wave. We know it as scientists because we know that the world is complex and must be understood eventually in wholes, as well as in parts. Society knows this too; it is intuitive, and often more sensible to the lay person than reductionism.

With a more specific focus on Geology, the USGS’s Geologic Division established seven strategic science goals for the coming decade (Bohlen et al., 1998), reflecting much of the same philosophy as NSF and GSA:

1. Conduct geologic hazard assessments for mitigation planning
2. Provide short-term prediction of geologic disasters and rapidly characterize their effects
3. Advance the understanding of the Nation’s energy and mineral resources in a global geologic, economic, and environmental context
4. Anticipate the environmental impacts of climate variability
5. Establish the geologic framework for ecosystem structure and function
6. Interpret the links between human health and geologic processes
7. Determine the geologic controls on ground-water resources and hazardous waste isolation

and they note the continued fundamental importance of basic geologic mapping in providing data for addressing the scientific needs of our changing world (Bohlen et al., 1998).

Trends in Science Education

The NSF Geoscience Directorate’s plan includes the following education agenda (NSF 00-28, 2000):

> Over the next ten years, environmental stresses in society such as those associated with population growth, pollution, dwindling resources, extreme weather, climate change, land-use changes, and space weather are expected to become even more acute and costly. A balanced strategy to respond to these stresses should include efforts to use the best available scientific data and reduce scientific uncertainty along with responsible mitigation and adaptation. The strategy must include an effective educational component to ensure a competitive workforce for the 21st Century. Thus, the

> geoscience community must be prepared with adequate Earth system science knowledge and information systems, capabilities for prediction and assessment, and an agenda to develop informed and educated leaders to help make decisions. Geoscience education at a broad range of levels will be key to ensure the tools and leadership are in place by 2010. A new, innovative program of Earth system science training and education at all levels should be initiated and developed now to ensure an informed citizenship in 2010.

This plan calls for investments in undergraduate geoscience education through new and emerging instructional technologies and active, hands-on, inquiry-based study (among others). This is consistent with a strong national trend in science education towards student-centered, inquiry-based, active participatory learning (e.g. Culotta, 1994; Markovics, 1990) and the involvement of undergraduates in authentic scientific research (e.g. Goodwin & Hoagland, 1999; McConnaughay et al., 1999; McGinn & Roth, 1999).

Leaders in undergraduate science education (Project Kaleidoscope (PKAL) Faculty for the 21st Century (F21)) foresee a future of interdisciplinarity, integrated classroom-laboratories, engagement of all students in the active practice of science, and increased use of technology to support this active learning (PKAL, 1999). The emphasis will be less on content and more on process—teaching students how to learn on their own. The NSF notes: "Active research experience is considered one of the most effective ways to attract talented undergraduates to and retain them in careers in science and engineering, including careers in teaching" (NSF 00-107, 2000). They also note that:

> NSF encourages research by faculty members of [predominantly undergraduate] institutions, both to ensure a broad national base for research and to help faculty members stay at the cutting edge of their disciplines. Such research not only contributes to basic knowledge in science and engineering, but also provides an opportunity for integration of the excitement of scientific discovery into undergraduate education. As the ultimate in inquiry-based learning, undergraduate research is a critical component of high-quality education in science..." (NSF 00-144, 2000).

The USGS, through the EDMAP component of the National Cooperative Geological Mapping Program, has as an objective the expansion of "research and educational capacity of graduate and undergraduate academic programs that teach earth science students the techniques of geologic mapping and field data analysis..." (USGS, 1999). The EDMAP program supports this objective by funding qualified student-faculty cooperative research projects.

As one of the PKAL F21 group noted, "The best way to learn science is to do science, at any level, freshman to senior, major or non-major. Just as with language or art, there may be some fundamentals that can be introduced efficiently via texts and lectures, but ultimately, the student must practice" (PKAL, 1999). In Geology, practice entails an interdisciplinary approach based on detailed field observations (geologic mapping) and including the collection, interpretation, and application of quantitative geochemical and geophysical data.

Responding to Challenges & Opportunities

Curriculum

We are currently considering several changes in the Geology offerings and program. While these plans do not fully address all of the challenges facing us, they are a start. We face many constraints in considering possible changes to our program, including keeping the overall number of credits required at a reasonable level, as well as limitations on staffing, space, and other resources. Enhancing quantitative aspects, integrating the use of computers, and infusing the practice of research throughout our curriculum, do not by themselves require significant changes to our offerings or program, but rather faculty development and careful attention to what we do in each of our classes.

Currently, we accept GEOL 100 Perspectives of Earth in conjunction with its optional laboratory GEOL 101 Perspectives of Earth Lab in lieu of GEOL 201 Physical Geology as an introduction to the major and a substitute prerequisite. The effect of this has been that we find ourselves now teaching two only slightly different versions of what is essentially physical geology. We therefore are proposing to replace the current GEOL Perspectives of Earth with a new 100-level course on "Topics in Earth System Science," and eliminate the GEOL 101 Perspectives of Earth Lab course, advising students needing a laboratory science (i.e. Education majors) to take GEOL 201 Introductory Physical Geology (we will increase the offerings of this course to accommodate the expected increase in demand). The new "Topics" course will allow more flexibility and greater variety in our General Education offerings, but will require guidance for adjunct instructors.

One of the particular strengths of our offerings is the integration of lecture and laboratory in GEOL 201 Introductory Physical Geology. In other disciplines, and with GEOL 100 and GEOL 101, introductory lectures and labs are listed independently and students can mix and match lecture and lab sections. In these courses, there must either be a great deal of coordination, or the lecture and lab must stand on their own independently. Under our system, however, students have the same instructor, and instructors have the same students, for both the "lab" and "lecture" portions of the course, which facilitates integration in much the same manner as in an upper-level course. We still need to make sure to share with these students everything that is exciting about geology.

While many students in GEOL 100 do also take the GEOL 101 laboratory, many do not, which inhibits what can be done in the GEOL 100 lecture. So one weakness of our offerings, which certainly is not unique, is the inability to offer a laboratory experience to all of our general education students.

New developments in our equipment and facilities will enable us to add a laboratory component in analytical geochemistry to the GEOL 412 Geochemistry course, and will other-wise enhance research opportunities for students and faculty.

Recognizing the desirability of a four-course load for our students, and in keeping with some college-wide agitation on this issue, we propose to adjust the credits from 3 to 4 for GEOL 303 Structural Geology, GEOL 306 Stratigraphy & Sedimentation, and GEOL 305 Paleontology, as these upper-level courses are already very demanding, include integrated laboratory components, and entail many contact hours, including extended out of class field trips.

To better address issues around Teacher Certification and Earth system science, we propose to establish (or resurrect?) a distinct Earth Science option or track within the existing Geology major.

To offer qualified students the opportunity to undertake a real Senior Thesis research project, we propose to add a Geology Honors Program, adapting from the established Psychology Honors Program—the only departmental Honors Program at KSC.

Since General Education is such a significant part of what we do in the Geology Program, we should also consider carefully the newly adopted Goals for General Education at KSC (Senate Document 99/00-23) and consider revising old or developing new courses that serve this audience. We must constantly ask ourselves, how can we enhance the role of research, writing, oral presentation, quantitative reasoning, critical thinking, and computer use, in all of our courses?

We must also address the issue of learning outcomes assessment, as discussed in the section on Learning Outcomes Assessment. Some options that we are considering include:

* Requiring all graduating students to take and submit scores from the Educational Testing Service's Geology Graduate Record Examination (normally something students might do if applying to graduate school).
* Requiring all graduating students to take the ASBOG Fundamentals of Geology Examination. This exam is used by many State Boards of Geology for examining applicants for licensure as Professional Geologists. New Hampshire has recently passed legislation requiring licenses of professional geologists practicing in the state, and intends to use the ASBOG exam. ASBOG is promoting the use of their examination for the assessment of college and university geology programs, when such use is not in conflict with the applicable state professional geologist licensure law (ASBOG, 1999).
* Requiring all graduating students to submit to an oral examination before the faculty.
* Incorporating Field Methods and a required capstone research experience into our program, in addition to offering qualified students the opportunity to undertake a real Senior Thesis research project, as discussed further in the section on Planning.

Resources

The library is currently aggressively seeking to enhance its collections in the sciences, and we need to participate in that process, by becoming more familiar with the collections, and suggesting items for weeding as well as for acquisition. We need also to consider realigning the library's journal subscriptions to perhaps better correspond with our course offerings. Similarly, we must be vigilant in keeping our mineral, rock, fossil and other collections well organized and useful.

Our planning for equipment acquisitions is a continuous and evolving process, as we sharpen the focus on just what our needs are and work to set priorities. As discussed in the section on Resources, we are actively seeking the resources we need, and taking advantage of what new resources we have.

In terms of physical space, we eagerly anticipate renewed, and more detailed, planning for a new Science building, and eventually, hopefully, construction of such. In the meantime, we continue to look at how we can best utilize the spaces that we have now. With minor renovations to the 205 complex complete, we need now to turn our attention to the Rock Room in the basement of Huntress Hall.

We await word from NSF regarding our proposal, now under consideration, to acquire an XRF Spectrometer (Allen et al., 2000); should that grant come through, it will drive much of our short term planning, including space renovation, equipment acquisition, and curriculum developments. In the event that it is not funded, we will re-assess, re-write, and re-submit, perhaps changing direction in the process.

Staffing

We do not foresee any changes in faculty, as all of the full-time faculty are tenured, none are quite at retirement age yet, and our enrollments are stable. All have recently completed (or are currently on) sabbatical leaves; coverage has been managed internally.

We will continue to rely on adjuncts and need to work with the College on building and retaining a pool of willing and qualified instructors. The integration of adjuncts into the deliberations of the faculty, the provision of support for them, and the evaluation of their teaching are important issues near the top of the College's agenda, although much depends on the resolution of the Adjunct Association's right to pursue Collective Bargaining.

We do, however, feel a need for laboratory and/or technical support staff. Responsibilities would include organization, cataloging, and maintenance of the Department's collections, maintenance of equipment, etc ...

Addressing the challenges of enhancing quantitative aspects, integrating the use of computers, and infusing the practice of research throughout our curriculum will require a faculty development effort more-so than changes in offerings or program structure. Developing a "habit of collective faculty deliberation" will certainly help facilitate this. We also need to set aside unfettered time, outside of field trips, in which to work together on the challenges outlined in the section on Strengths & Weaknesses—there is only so much that we can accomplish as individuals.

The Changing Academic Environment at KSC

Much is in flux at KSC right now (as always?), with many potential impacts to the Geology program. These include revisions to the General Education and ENST programs, creation of a General Science major, and evolution in the role of chairs as well as changes to our basic organizational structures.

With the adoption of Goals for General Education (Senate Document 99/00-23), the College is once again moving slowly forward towards revision of our General Education program. What form a new program might take remains to be seen, but the Geology Department is comfortable that it will continue to have an important role in General Education at KSC.

The ENST Program is poised to again make significant modifications to their program. Initially they will be adding new courses to their existing program, but they ultimately envision a whole new structure. Just what impact these changes might have on the Geology program has yet to be determined. But again, the Geology Department remains comfortable that it will continue to have an important role in the ENST program.

A new interdisciplinary major in General Science is being proposed. This program would require Geology courses, at least at the introductory level. Beyond that, it remains unclear what impacts it would have on our program. We do not anticipate that it would draw many students away from the Geology program, although it could. Equally as well, it could expose new students to Geology who might not otherwise get such exposure, thereby creating a new pool of potential Geology majors.

As discussed previously (see section on Faculty), for many years Geology was part of the Physical Science "section" together with the Physicists and Chemists. Recent restructuring has created several new, small, departments across the College, each with its own chair—the Department of Geology is one of them. Across the college, departments are still sorting out the impact of change from "section" coordinators to department chairs. The role of chair is a new and evolving one here at KSC. Organizationally, will departments of only 3 faculty really be viable? If not, what sorts of re-alignments would be best?

The recently announced retirement of the Dean of Arts & Humanities has prompted the Vice President for Academic Affairs to initiate discussions regarding the overall structure of the academic divisions. While we can only speculate what might happen, it could be a useful exercise to envision possible scenarios: the Department of Geology, or the Department of Earth Science, or Earth and Planetary Science (incorporating the physicists), or Earth and Environmental Science (incorporating the ENST program), or Geology & Geography, or Geosciences, etc ... For the time being, we prefer to remain the Department of Geology.

Finally, while the implementation of new technologies, and other changes in institutional practices, are intended to be improvements (such as with the new student information system), there is often much upheaval before gains are realized. This is certainly not unique to KSC. Change in our work environment is the one constant we can expect. Some changes we can plan for, other changes we need to be able to react to. It is to these ends that developing (or improving) a "habit of collective deliberation" within the Geology department (and across the college) will be important.

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Appendix I: Geology Program Review AOC-Subcommittee Report Spring 1990-Spring 1991

Dr. Stephen Cone, Dr. Rose Kundanis, Dr. Judith Lister

After thorough review and discussion, the AOC-subcommittee on Geology submits the following report to the Academic Overview Committee. Data and information contained in it have been compiled from the program's self-study, the exit interview with the evaluators, the external reviewer's report, and the subcommittee's campus perspectives.

This subcommittee would like to recognize the quality efforts of Drs. Bill and Nielsen. The enthusiasm and dedication they demonstrate had been contagious and has had significant impact on those students pursuing a major in Geology. The commitment to field trips and individual research projects is commendable and academically appropriate. The intellectual breadth that this faculty offers to Keene State students should be duly noted and endorsed.

Facility concerns should be noted and it is this committee's opinion that a review of the Science Center's space allocation would be appropriate at this time. We acknowledge that space limitations exist, however, we suggest that some programs have changed. These changes may be exhibited by an increase/decrease in program size or by divisional/institutional emphasis give to a specific program. It appears warranted that these priorities should be revisited and issues of expansion, maintenance or reduction be addressed.

This report supports the hard work and dedication exhibited by the resident faculty members, Drs. Bill and Nielsen and will endeavor to provide observations and suggestions that will contribute to the future success of this program offering. This committee acknowledges the resource limitations under which the Geology program currently is operating. These restrictions are not only felt in this program but are also noted campus-wide. It is important to note this limitation because this review will attempt to address this unit in light of this concern.

Our initial observation relates to the emphasis in the self-study and the external review that centers on the offerings in the major. We acknowledge the need of a faculty member to devote time an energy to their discipline and further note the reinforcement derived from motivated majors. But given the importance of this content area, it would seem appropriate that proportionate emphasis be directed toward the General Education service offerings. We feel that the current focus appears to neglect the importance of this discipline in the General Education service component and although the service offering is referenced, it appears that the majority of effort has been directed toward the major. It should be noted that approximately sixty percent of the two full-time faculty member's loads are devoted to the 200-level "introductory/general education" courses. Adjunct faculty are employed in the offering of the 100-level "introductory/ general education courses. The external reviewer's report noted that it is essential for full-time faculty to teach the introductory-type courses and this, in fact, is the direction that this discipline should continue to follow. The result of such an effort would establish Geology as a discipline that is central to General Education.

A second point offered in the external reviewer's report would enable further attention to General Education service offerings. This viewpoint related to the specificity and limited focus of some courses would suggest combining some courses (i.e. optical mineralogy and mineralogy -petrography) as a means of addressing workload. The number of courses offered within the major is large. We support the concept of appropriate combination of course offerings as a means of addressing staffing and maintaining the quality noted in the reviews. A major that is offered by two full-time faculty members is a challenge. A reference to the time and effort required to offer “lab/field-related” courses is vital because this acknowledges the “overload” aspect of Drs. Bill and Nielsen’s teaching responsibilities. The scheduling of courses in the Geology major must address the frequency of offerings that would enable the existing faculty to provide timely and quality programming. It would enable this discipline to employ the available resources through utilization of a sequential/rotational offering of courses.

The Geology self-study and the external reviewers noted that a large number of students enrolling in the geology offerings are Education majors. This is inevitable given the proportion of the student body at this institution who are majoring in one of the majors associated with teacher certification. It is the opinion of this subcommittee that the external reviewer’s suggestion of requiring Historical Geology in the “Education” major is not a viable option. However, we support the continued inclusion of such a course in the General Education offerings that would be available to the entire student body.

This committee submits its report in complete agreement and with the understanding that this institution must address resource and curricular questions. The Geology discipline appears poised for expansion and the appropriateness of this content area (environmental concerns) would seem to indicated that this discipline would be one on which to focus. Therefore this subcommittee proposes two sets of recommendations. Any implementation of these recommendations should also reflect the mission of this institution, including but not limited to General Education and Teacher Education. The recommendations are divided into two categories based on the assumptions that “resources are available” or that “resources are unavailable or limited.”

If Resources are Available ... we recommend that Geology be <u>expanded</u> with:

1. a new faculty line;
2. full-time faculty teaching more sections of introductory level courses;
3. consolidation of certain courses in the major; and
4. reallocation of space with the Science Center.

If Resources are Unavailable or Limited ... we recommend that Geology be <u>maintained</u> with:

1. a restructuring of the major, including by not limited to consolidation of certain courses in the major;
2. consideration given to utilizing adjunct faculty for “major” courses so that full-time faculty may teach more sections of introductory level courses.

A related point concerning the major involves the process of registration on this campus. It is worthy of note because those students in their first or second year at Keene State are unable to register for introductory Geology courses (low random numbers) that would influence their decision to pursue a major in Geology. Although it is not the charge of this subcommittee to address registration, it should be noted for consideration in AOC directives to the Senate.

Finally, we again endorse the efforts demonstrated by the Geology unit and hope that the viewpoints expressed in this report will not only reinforce the excellent effort that they have demonstrated but will also enable them to address those concerns that have been noted.

Appendix II: Course Descriptions and Syllabi

The number of credits for each course is given in parantheses after tbe course title.

GEOL 100 PERSPECTIVES OF THE EARTH (3)
A survey of the earth sciences; Earth's setting in space; atmosphere and matter; oceans; materials and processes of the solid earth; origin and history of the earth. (Not open for credit toward a major program in science.) Fall, Spring

Syllabi: Allen, Fall 1999
Leger, Fall 2000
Nielsen, Fall 2000

GEOL 101 PERSPECTIVES OF THE EARTH LAB (1)
Introduction to minerals and rocks. Interpretation of topographic and geologic maps. Two-hour lab exercises and required field trip(s) provide first-hand experience in physical geology. Prerequisite: concurrent enrollment in, or prior completion of, GEOL 100. Fall, Spring

Syllabi: Allen, Fall 1995
Leger, Fall 2000

GEOL 201 INTRODUCTORY PHYSICAL GEOLOGY (4)
An introduction to the Earth, emphasizing an overview of the external and internal processes which shape the planet. Labs emphasize the study of Earth materials and topographic maps. 3-hour lecture, 2-hour lab (field trips may be required). Fall, Spring

Syllabi: Allen, Fall 2000
Nielsen, Fall 2000
Bill, Fall 1999

GEOL 202 HISTORICAL GEOLOGY (4)
An introduction to Earth History and the processes which have shaped the Earth since its formation. Topics include absolute and relative correlations, plate tectonics, and the origin and evolution of the atmosphere and biosphere. 3-hour lecture, 2-hour lab (some Saturday field trips required). Prerequisite: GEOL 201 or GEOL 100 and 101. Spring

Syllabus: Bill, Spring 2000

GEOL 206 OCEANOGRAPHY (3)
Introduction to the study of the sea; nature of sea water and its processes; marine life; features and sediments of the ocean floor; theories on the origin of ocean basins, trenches, ridges, and continental terraces. Fall, Spring

Syllabus: Bill, Spring 2000

GEOL 210 THE HYDROLOGIC CYCLE (3)
An introduction to the study of water and its flow through the global environment, from precipitation to ground water, rivers, lakes, the ocean and back. Occasionally

Syllabus: new course not yet offered

GEOL 298 INDEPENDENT STUDY (1-6)
An opportunity for a qualified student to explore work in an area of individual interest, selected and pursued in consultation with a faculty member. Consent required of the instructor who will supervise the independent study and the appropriate divisional dean. Repeatable to a total of 6 credits.

GEOL 301 MINERALOGY (4)
Introduction to crystallography; physical and chemical nature of minerals; description and determination of important economic and rock-forming minerals; origin of mineral deposits. 5-hour lecture, lab. Prerequisites: CHEM 111/115, GEOL 201, or permission of instructor. Fall, odd years

Syllabus: Nielsen, Fall 1999

GEOL 302 PETROLOGY (4)
The origin, occurrence, description and classification of the more common types of rocks,

with emphasis on igneous and metamorphic rocks. 5- hour lecture, lab, field trips. Prerequisite: GEOL 301. Spring, even years

Syllabus: Nielsen, Spring 2000

GEOL 303 STRUCTURAL GEOLOGY (3)
Study of the structural features of rock bodies and interpretation of these features in terms of the forces that caused them; methods of geological field work; graphic representation of geological field data; interpretation of geological maps; preparation of field reports. 5-hour lecture, lab, field work. Prerequisites: GEOL 201-202, or permission of instructor. Spring, odd years

Syllabi: Allen, Spring 1999
Nielsen, Spring 1997

GEOL 305 PALEONTOLOGY (3)
The description, classification, geographic and stratigraphic distribution, evolution, and uses of invertebrate fossils; some attention to environments of life forms. 2-hour lecture, 2-hour lab. Prerequisites: GEOL 202 and BIO 151, or permission of instructor. Spring, even years

Syllabus: Bill, Spring 2000

GEOL 306 STRATIGRAPHY (3)
Principles of stratigraphy and sedimentation; properties and classification of sedimentary rocks; sedimentary processes and environments; stratigraphic procedures and correlations; and stratigraphic relationships of North America. 2-hour lecture, 2- hour lab. Prerequisite: GEOL 202. Fall, odd years

Syllabus: Bill, Fall 1999

GEOL 309 GEOMORPHOLOGY (3)
Nonglacial surface processes. The evolution of land forms and influence of lithology, tectonics, and climate on land forms. Surface processes related to land use and environmental planning. Labs involve interpreting topographic and geologic maps, field projects. Prerequisite: GEOL 201 or GEOL 100/101. Fall, even years

Syllabus: Bill, Fall 1998

GEOL 310 GLACIAL GEOLOGY (3)
Study of the mechanics of glacial origin and movement, characteristics of existing glaciers, and an interpretation of Pleistocene glacial features. Emphasizes the glacial topography of northeastern North America, with special attention to New Hampshire examples of alpine and continental glaciation. 2-hour lecture, 2-hour lab, field trips. Prerequisite: GEOL 309, or permission of instructor. Spring, odd years

Syllabus: Bill, Spring 1999

GEOL 315 ENVIRONMENTAL GEOLOGY (4)
Relationships between humans and our geological environment, including resources, hazards, and human impacts. Field methods in obtaining geologic information for resource evaluation and protection, risk reduction, and environmental remediation. 3-hour lecture, 2-hour lab, field trips. Prerequisites: GEOL 201 or GEOL 100 and 101. Formerly GEOL 450. Fall

Syllabus: Allen, Fall 2000

GEOL 401 OPTICAL PETROGRAPHY (3)
The effects of crystalline structure on light rays; the application of these effects to the identification of min-erals and rocks in thin section using the polarizing microscope. 4-hour lecture, lab. Prerequisite: GEOL 302. Fall, even years

Syllabus: Nielsen, Fall 2000

GEOL 412 GEOCHEMISTRY (3)
Abundance of the chemical elements and the principles of distribution and migration of elements in geological environments. Applications to selected examples. Prerequisites: CHEM 112/116 and GEOL 302, or permission of instructor. Spring, even years

Syllabus: Allen, Fall 2000

GEOL 440 EVOLUTION OF EARTH AND LIFE (3)
The origin and evolution of the earth and its living inhabitants, emphasizing the interrelationships of the planet and its biosphere. Topics will include the origins of cellular and multicellular life and the causes and significance of mass extinctions. Also listed as BIO 440. Prerequisites: BIO 151/152, 153/154, and GEOL 201 or BIO 151/152, GEOL 201, and GEOL 202, or permission of instructor. Spring, even years

Syllabus: Nielsen & Wise, Spring 2000

GEOL 460 HYDROGEOLOGY (4)
Occurrence and movement of groundwater as it relates to the hydrologic cycle, water resource evaluation (well hydraulics), and transport and fate of contaminants; theoretical and practical aspects, including computer modeling. Three-hour lecture, two-hour lab; field trips may be required. Prerequisites: GEOL 201 (or equivalent), MATH 151, and PHYS 141, or permission of instructor. Spring, odd years

Syllabus: Allen, Spring 1999

GEOL 490 ADVANCED SPECIAL TOPICS (1-4)
Study of a selected topic in Geology at an advanced level. May be repeated to a total of 8 credits as topics change. Prerequisite: permission of instructor. Frequently

GEOL 498 INDEPENDENT STUDY (1-6)
Advanced study of various fields of Geology through individual reading, writing, laboratory work and/or field investigation; involves a research project and submission of a written report. One-hour conference. May be repeated to a total of 6 credits. Fall, Spring

Syllabi for the courses listed follow (pages not counted in numbering sequence), *and/or* are available online at http://kilburn.keene.edu/GEOL/ProgramReview/appendices/syllabi.html

Notes

Appendix III: Program Requirements (Catalog Information)

Geology, BS*

Geology is the study of the Earth and its environs. It involves detailed consideration of Planet Earth's interior and its surface, as well as consideration of the hydrosphere, atmosphere, and setting in space. These studies are central to an understanding of the earth's past, present, and future environments and the interrelationship between earth and humanity. Students graduating from this program are prepared for traditional positions with oil and mining companies, and state and federal geological surveys as well as positions in the rapidly growing fields of environmental geology, hydrogeology, resource planning, and engineering and consulting firms, or to enter graduate study. By completing the teacher education option, students are prepared for certification as Earth Science teachers in secondary schools.

GENERAL EDUCATION REQUIREMENTS (minimum) 42 credits

The following required courses in Biology, Chemistry, Mathematics and Physics may apply toward the Sciences/Mathematics component (D) of the General Education requirements or electives (III).

- BIO 151/152 Life: Diversity and Lab
- CHEM 111/115-112/116 General Chemistry I, II and Labs
- MATH 151 Calculus I
- PHYS 141, 142 College Physics I, II or PHYS 241, 242 University Physics I, II
- Select one of the following:
  - MATH 141 Introductory Statistics
  - MATH 152 Calculus II
  - Any course in Computer Science

For teacher certification in Earth Science (secondary), the following courses must be included in the General Education requirements: a U.S. History course in the Arts and Humanities component (B); a Geography course in the Social Sciences component (C).

MAJOR REQUIREMENTS 40 credits

- GEOL 201 Introductory Physical Geology or GEOL 100/101 Perspectives of the Earth & Lab
- GEOL 202 Historical Geology
- GEOL 301 Mineralogy
- GEOL 302 Petrology
- GEOL 303 Structural Geology
- GEOL 305 Paleontology
- GEOL 306 Stratigraphy & Sedimentation
- Four Geology courses (12 credits) at the 300-level or above. ASTR 307 maybe used to satisfy part of this requirement. A summer field course is recommended, especially for those planning graduate study.
- Select one of the following:
  - GEOG 323 Cartography and Surveying
  - GEOG 325 Cartography and Computer Mapping
  - GEOG 326 Geographic Information Systems
  - GEOG 327 Intro to Remote Sensing
  - GEOL 206 Oceanography
  - MET 220 Climatology
  - MET 225 Meteorology

ELECTIVES (minimum) 44 credits

For teacher preparation in Earth Science (secondary), the following courses are required (34 credits): *Courses designated with an asterisk require a minimum of one to three hours of field work in the schools or service learning.

- Orientation
  - ESEC 100 Introduction to Teaching
- Learners
  - ESEC 150 Development, Exceptionality, and Learning I*
  - ESEC 250 Development, Exceptionality, and Learning II
- Fundamentals
  - ESEC 282 Literacy in Content Areas*
- Settings
  - ESEC 320 Educational Environments and Practice

Methodology
- ESEC 385 Methods: Secondary
- ESEC 386 Methods: Field Experience

Systems
- ESEC 450 Seminar: Educational Principles

Practice
- ESEC 460 Student Teaching

The following course is highly recommended:

Pedagogy
- ESEC 387 Creating Social Contexts for Learning

Degree requirements 126 credits

Environmental Studies, BS

Environmental Studies is an interdisciplinary program comprised of courses in Biology, Chemistry, Economics, Geography, Geology, and Political Science. The major is designed with two options, Environmental Policy and Environmental Science, to prepare students for a wide range of environment-related career opportunities. Students intending to major in Environmental Studies should select an advisor and formally declare their major as early as possible, preferably by the end of their first year.

GENERAL EDUCATION REQUIREMENTS (minimum) 42 credits

Because of the interdisciplinary nature of the major and because some required courses are prerequisite to others, the Social Sciences (C) and Sciences/Mathematics components (D) of the General Education requirements (12 credits each) are automatically fulfilled. ENG 202 may apply toward the Arts and Humanities (B) General Education requirements (3 credits). Thus, 27 credits of the major may apply toward completion of General Education requirements.

MAJOR REQUIREMENTS

Environmental Studies Core (29 credits)

All Environmental Studies students must take the following common core of courses, giving them broad exposure to the wide range of fields of environmental study and background for further specialization:

- ENST 100 Introduction to Environmental Studies
- ENST 495 Seminar
- ECON 202 Microeconomics
- ENG 202 Expository Writing
- POSC 201 Introduction to Political Science
- GEOG 204 Physical Geography
- GEOL 201 Introductory Physical Geology
- MATH 141 or PSYC 251 Statistics
- BIO 151/152 Life: Diversity and Lab

Environmental Science Option *Requirements for the Policy Option are not listed here.*

This option is designed for students wishing to acquire a strong environmentally oriented background in the Natural Science areas. Students completing this option should be prepared to explore and resolve scientific problems relating to the environment, or alternatively, to continue environmental science studies at the graduate level.

- BIO 153/154 Life: Processes and Lab
- CHEM 111/115 and 112/116 General Chemistry I, II and Labs
- GEOL 206 Oceanography
- PHYS 141 and 142 College Physics I, II
- MATH 130 Precalculus or MATH 151 Calculus
- Specialization Requirement: 16-19 credits in either Biology, Chemistry, or Geology as outlined below; or in an individualized specialization approved by the ENST Steering Committee in advance.

Environmental Geology Specialization (17-19 credits) *Requirements for the Specializations in Biology and Chemistry are not listed here.*

- GEOL 202 Historical Geology
- Two of the following "environmental" Geology courses:

GEOL 315 Environmental Geology
GEOL 412 Geochemistry
GEOL 460 Hydrogeology
One of the following "structural" Geology courses:
GEOL 303 Structural Geology
GEOL 306 Stratigraphy
GEOL 309 Geomorphology
One of the following map skills courses:
GEOG 323 Cartography and Surveying
GEOG 326 Geographical Information Systems
GEOG 327 Introduction to Remote Sensing

ELECTIVES 36 - 48 credits

Degree requirements 126 or more credits

Geology Minor

20-22 credits

The Geology minor consists of six courses in Geology beyond any used to fulfill the Sciences/Mathematics component (D) of the General Education requirements.

GEOL 201 Introductory Physical Geology or GEOL 100/101 Perspectives of the Earth & Lab
GEOL 202 Historical Geology
Four additional courses (12-14 credits) at 300-level or above selected under advisement of Geology faculty and major advisor.

General Education Requirements

All bachelor's degree programs have the same General Education requirements. These requirements seek to broaden, deepen, and integrate understanding of the most significant aspects of humanity's heritage. These studies also enhance the student's capacity for aesthetic enjoyment, critical thinking, creativity, abstract and logical reasoning, and oral and written communication. It is also recommended that students develop competence in a second language, acquire or enhance computer literacy, select an experiential learning opportunity in which discipline-based knowledge can be applied in a real-life setting, and continue their general education throughout the bachelor's degree program. All students are urged to complete at least one interdisciplinary course approved for such purposes by the College Senate Curriculum Committee. In general, the selection of courses for purposes of General Education is open. However, some major programs specify courses because (1) they are required or suggested prerequisites for major courses, (2) the courses are an integral part of the overall goals of the major program, or (3) they fulfill competency standards required for certification and licensing.

A. English Language Competence

Essay Writing (ENG 101) is required of all students. It should be completed during the freshman year and is not open to juniors or seniors unless they are transfer students.

B. Arts and Humanities

A minimum of five courses totaling at least 15 credits as follows:

* One course in literature, which may be: English (any 200-300 level course except 202, 203, 204, 205, 301, 302, 303, 310, 311,382), French 340, 498, or German 498, or Spanish 498 (when topics focus on literature). ENG 101 does not satisfy this requirement.
* One course in History
* One course in Art, Communication, Film Studies, Music, or Theatre and Dance.
* Two courses from Arts and Humanities disciplines: American Studies, Art, Communication, English, Film Studies, History, Journalism, Modern Languages, Music, Philosophy, Theatre and Dance, or an approved interdisciplinary course (designated IDAH).

C. Social Sciences

A minimum of four courses totaling at least 12 credits in three or more of the Social Sciences disciplines: Economics, Geography, Political Science, Psychology, Sociology/Anthropology, or an approved interdisciplinary course (designated IDSS).

D. Sciences/Mathematics

A minimum of four courses totaling at least 12 credits as follows:

* One course in Biology
* One course in the Physical Sciences (Astronomy, Chemistry, Geology, Meteorology, or Physics)
* Two courses from Sciences/ Mathematics disciplines: Astronomy, Biology, Chemistry, Computer Science, Environmental Studies, Geology, Mathematics, Meteorology, Physics, or an approved interdisciplinary course (designated IDSM).

Appendix IV: Desired Learning Outcomes

We want our students to understand the workings of the natural world and the process of science, and we want them to be able to read, observe and think critically, reason quantitatively, undertake research, and communicate effectively—in other words, to engage in the scientific process. We would like geology and general education students to acquire, to different degrees, the following:

Knowledge of:

* the methods and history of scientific inquiry as an approach to observing and thinking about the world around us. Science is not a static body of factual knowledge that just exists—it is a dynamic knowledge base continually re-created and enhanced by the new discoveries of scientists involved in research—people searching for answers to their questions.
* internal and surficial Earth processes, of descriptions of major Earth systems, and of the history of the Earth.
* Earth materials and resources, through the study and interpretation of rocks and their constituent minerals, with an understanding of fundamental relationships between chemical composition, mineralogy, rock-type, tectonic setting, and global biogeochemical cycling. One can read quite a bit of history from a simple rock—and the history of that rock, the processes by which it was formed, deformed, metamorphosed, and eroded, are the processes that shape the world around us.
* environmental issues related to earth processes, materials and systems.
* the contributions of geology to society.
* the vocabulary of geology, both verbal and visual (ie., map representations).

Experience with:

* the methods of scientific inquiry, with practice in the skills of observation, analysis, problem solving and critical thinking.
* working cooperatively in teams.
* geological field and research methods, including geological mapping, historical and environmental interpretation, and the collection, interpretation, and application of quantitative geochemical and geophysical data.
* using computers in addressing quantitative problems, in managing and analyzing large datasets, and in preparing maps, graphs, illustrations and figures for scientific reports.

And the ability to:

* find, review, and comprehend appropriate scientific literature.
* think and visualize in 3 (spatial) and 4 (space & time) dimensions, over a wide range of length and time scales (atomic to universal, instantaneous to forever).
* reason quantitatively, and to apply quantitative approaches in problem solving and scientific investigation.
* effectively communicate scientific information and ideas in writing, orally, and visually.

These objectives are in concert with many of the Goals for General Education at KSC (Senate Document 99/00-23).

AIPG Desired Learning Outcomes

The AIPG (1991) has also enumerated a set of desired learning outcomes for students graduating from undergraduate geology programs:

> A student entering a career in the geosciences must have gained experience in the field, the laboratory and on the computer. An undergraduate who is well-prepared should be able to do the following:
>
> * identify fossils, minerals, and rocks;
> * recognize and map bodies of rock exposed in the field and from imagery;
> * correlate bodies of rock from surface and subsurface information and recognize spatial relationships;
> * effectively use subsurface data and integrate it with surface data;
> * interpret geologic structures, age sequences, geologic histories, and conditions of formation;
> * recognize and map surficial material other than bedrock;
> * evaluate sites for mineral extraction, suitability for land use, and susceptibility to environmental damage;
> * apply current technology and theories;
> * think critically, define problems, quantify parameters and provide solutions;
> * communicate effectively to a variety of audiences
> * effectively use the major information sources and know the orgranization of geology as a science and a profession;
> * recognize career opportunities;
> * appreciate obligations and responsibilities of a geologist to an employer and to society; and
> * respect other disciplines and their professionals.

ASBOG Task Analysis

Also of interest with regard to desired learning outcomes of undergraduate geology programs, in 1995 ASBOG completed a task analysis of the professional practice of geology, for the purposes of developing national examinations for the licensure of professional geologists (Whisonant & Philley, 1998; Warner et al., 1999).

Eighty-eight geological tasks were identified, and assigned to one of 13 content domains. Over 1200 professional geologists evaluated each task on the amount of time they spent on it and it's importance in protecting public health, safety and welfare. The tasks were weighted by the formula, weight = time spent x importance^2. These weightings were used in developing examinations on the Fundamentals of Geology (FG) and on the Professional Practice of Geology (PG). The table below is adapted from Warner et al., 1999. Tasks tested on the FG exam are ranked in order of descending weight, followed by tasks tested only on the PG exam. (Four of the 88 possible tasks were determined to be unimportant in the licensure of professional geologists and are not tested on either exam.)

Tasks tested on the ASBOG Fundamentals of Geology Exam

#	Task Statement	Wgt	%FG	%PG	Content Domain
3	Identify, locate and utilize available data sources.	9.12	10	—	Research & Methods
9	Write and edit geologic reports.	8.55	10	3	Research & Methods
12	Read and interpret topographic and bathymetric maps.	7.14	8	—	Research & Methods
8	Construct and interpret maps and other graphical presentations.	6.67	8	2	Research & Methods
63	Determine groundwater flow systems.	4.6	5	1	Hydrogeology
62	Determine physical/chemical properties of aquifers and vadose zones.	3.75	4	1	Hydrogeology
35	Identify structural features and their interrelationships.	3.7	4	—	Structural Geology
60	Utilize chemical data to evaluate hydrogeologic conditions.	3.28	4	1	Hydrogeology
48	Identify landforms.	3.18	3	—	Geomorphology
18	Identify and classify major rock types.	3.12	3	—	Petrography/Petrology
5	Construct borehole and trench logs.	3.04	3	1	Research & Methods
27	Identify rock sequences.	2.9	3	—	Stratigraphy/Historical
28	Establish relative position of rock units.	2.82	3	—	Stratigraphy/Historical
37	Determine orientation of structural features.	2.51	3	—	Structural Geology
19	Determine physical properties of rocks.	2.38	3	—	Petrography/Petrology
76	Describe and sample soils for geologic analysis and materials properties testing.	1.88	2	1	Engineering Geology
10	Interpret and analyze aerial photos/imagery	1.6	2	1	Research & Methods
32	Correlate rock units.	1.53	2	1	Stratigraphy/Historical
39	Map structural features.	1.53	2	1	Structural Geology
24	Evaluate geochemical data.	1.46	1	1	Geochemistry
41	Interpret structural features.	1.44	1	1	Structural Geology
30	Interpret depositional environments.	1.41	1	1	Stratigraphy/Historical
72	Develop and interpret engineering geology maps & sections.	1.41	1	1	Engineering Geology
57	Perform geological interpretation of geophysical data.	1.34	1	1	Geophysics
70	Identify & evaluate potential seismic & other geologic hazards.	1.26	1	1	Engineering Geology
33	Interpret geological history.	1.16	1	1	Stratigraphy/Historical
13	Identify minerals and their characteristics and uses.	1.13	1	—	Mineralogy
55	Select methods of geophysical investigations.	1.11	1	1	Geophysics
20	Determine chemical properties of rocks.	1.02	1	—	Petrography/Petrology
21	Determine types and/or degrees of rock alteration.	0.98	1	—	Petrography/Petrology
51	Determine geomorphic processes and development of landforms and soils.	0.8	1	1	Geomorphology
14	Identify mineral assemblages.	0.71	1	—	Mineralogy
29	Determine relative and absolute ages of rock units.	0.71	1	—	Stratigraphy/Historical
22	Determine suites of rock types.	0.6	1	—	Petrography/Petrology
36	Select features for structural analysis.	0.51	1	1	Structural Geology
38	Perform qualitative and quantitative structural analyses.	0.51	1	1	Structural Geology
53	Determine age relationships of landforms and soils.	0.47	1	1	Geomorphology
79	Perform geologic interpretations for mineral reserves.	0.41	1	1	Mining Geology
44	Estimate relative geologic ages of rocks.	0.4	1	1	Paleontology
42	Interpret tectonic history.	0.36	1	1	Structural Geology
15	Determine probable genesis and sequence of mineral assemblages.	0.35	1	—	Mineralogy
16	Identify minerals on the basis of exposures and drillholes.	0.33	1	—	Mineralogy
31	Perform facies analyses.	0.33	1	1	Stratigraphy/Historical
78	Implement field investigations on prospects.	0.32	1	1	Mining Geology
45	Identify fossils.	0.28	1	—	Paleontology
85	Perform geologic interpretations of physical properties and hydrocarbon reserves.	0.22	1	1	Petroleum Geology
84	Implement field investigations on prospects.	0.14	1	1	Petroleum Geology

Tasks tested only on the ASBOG Professional Practice of Geology Exam

#	Task Statement	Wgt	%FG	%PG	Content Domain
4	Plan and conduct field operations.	12.24	—	4	Research & Methods
2	Interpret regulatory constraints.	10.59	—	3	Research & Methods
65	Evaluate groundwater quality.	9.36	—	3	Hydrogeology
11	Design & interpret data from geologic monitoring programs.	8.63	—	3	Research & Methods
68	Plan and evaluate remedial action programs.	8.38	—	2	Hydrogeology
66	Design wells and drilling programs.	7.84	—	2	Hydrogeology
59	Design and interpret hydrogeologic testing programs.	7.7	—	2	Hydrogeology
7	Develop and utilize Quality Assurance/Quality Control procedures.	5.68	—	1	Research & Methods
6	Design and conduct laboratory programs & interpret results.	5.55	—	1	Research & Methods
64	Evaluate groundwater resources.	5.09	—	1	Hydrogeology
69	Provide geological information and interpretations for engineering design.	4.36	—	1	Engineering Geology
54	Identify potentially hazardous geomorphological conditons.	3.48	—	1	Geomorphology
26	Make recommendations based upon results of geochemical analyses.	2.87	—	1	Geochemistry
71	Provide geologic consultation during and after construction.	2.66	—	1	Engineering Geology
74	Define and establish site selection and evaluation criteria.	2.54	—	1	Engineering Geology
67	Develop groundwater resource management plans.	2.36	—	1	Hydrogeology
75	Design and implement field and laboratory programs.	2.31	—	1	Engineering Geology
1	Evaluate property/mineral rights.	1.97	—	1	Research & Methods
23	Establish analytical objectives and approaches.	1.97	—	1	Geochemistry
61	Apply geophysical methods to analyze hydrogeologic conditions.	1.88	—	1	Hydrogeology
58	Identify potentially hazardous geological conditions by using geophysical techniques	1.71	—	1	Geophysics
52	Interpret geomorphic field data.	1.7	—	1	Geomorphology
49	Determine methods of investigation.	1.59	—	1	Geomorphology
17	Predict subsurface mineral characteristics on the basis of exposures and drillholes.	1.3	—	1	Mineralogy
56	Perform geophysical investigations in the field.	1.09	—	1	Geophysics
25	Construct models based upon results of geochemical analyses.	1.06	—	1	Geochemistry
40	Correlate separated structural features.	1.05	—	1	Structural Geology
50	Perform geomorphic field investigations.	1.02	—	1	Geomorphology
73	Evaluate materials resources.	1.02	—	1	Engineering Geology
34	Establish stratigraphic classifications.	0.88	—	1	Stratigraphy/Historical
82	Provide geologic interpretations for mine abandonments/closures/restorations.	0.86	—	1	Mining Geology
81	Provide geologic interpretations for mine development and production activities.	0.71	—	1	Mining Geology
80	Perform economic analyses/appraisals.	0.69	—	1	Mining Geology
77	Formulate exploration programs.	0.63	—	1	Mining Geology
88	Provide geologic interpretations for well abandonments/closures/restorations.	0.44	—	1	Petroleum Geology
87	Provide geologic interpretations for development and production activities.	0.41	—	1	Petroleum Geology
83	Formulate exploration programs.	0.31	—	1	Petroleum Geology

Tasks not important for the licensure of professional geologists

#	Task Statement	Wgt	%FG	%PG	Content Domain
43	Identify applicable type of paleontological investigation.	0	—	—	Paleontology
46	Correlate rocks biostratigraphically.	0	—	—	Paleontology
47	Identify fossil assemblages and make paleoecological interpretations.	0	—	—	Paleontology
86	Perform petroleum economic analyses/appraisals.	0	—	—	Petroleum Geology

Appendix V: Geology Student Research

Year: 2000
Student: Destiny Saxon
Title: Geological Mapping of Lake Sunapee and Surrounding Area, New Hampshire
Advisor: Tim Allen
Funding: USGS EDMAP Program grant to Tim Allen, $5540
Publication: work in progress

Year: 2000
Student: Dan Crosby
Title: X-ray crystallography, computational chemistry, and luminescence measurements of laser dye molecular systems
Advisor: Jerry Jasinski (Chemistry)
Funding: ACS-PRF Summer Undergraduate Research Fellowship, $3000
Publication: work in progress

Year: 1999-2000
Student: Carol Leger
Title: Petrographic Evidence Supporting Various Carbonate Depositional Environments
Advisor: Steve Bill
Funding: KSC Undergraduate Fund, $275
Publication: work in progress

Year: 1999
Student: Dina Andretta
Title: Geologic Mapping and Petrography, Lake Sunapee Area
Advisor: Tim Allen
Funding: KSC Undergraduate Fund, $600
Publication: work in progress

Year: 1998
Student: Carol Leger
Title: 500 Million Years of Earth History at Turner's Falls
Advisor: Peter Nielsen
Funding: none
Publication: Nielsen et al., 1998a

Year: 1997-1998
Student: Carol Leger & Christina Burt
Title: Geologic Map evaluation of lithologic units in central Maine for suitability as aggregate
Advisor: Steve Bill
Funding: Pike Industries, Inc., $375
Publication: report submitted to Pike Industries, Inc.

Year: 1996-1998
Student: Jamie O'Rourke, with Bill Graham (1998), and Todd Stiles (1996-1997)
Title: Ground Water Geochemistry
Advisor: Tim Allen
Funding: KSC Undergraduate Fund, $629
Publication: O'Rourke et al., 1998

Year: 1996-1998
Student: Marc Reinhold
Title: A spectrophotometric technique for measuring Optical Rotatory Dispersion within arbitrarily cut crystals.
Advisor: Russ Harkay (Physics)
Funding: KSC Undergraduate Fund, $1500
Publication: Harkay & Reinhold, 1998

Year: 1997
Student: Mike Smith & Andrea Grunauer
Title: Winter Soil Moisture Balance
Advisor: Tim Allen
Funding: none
Publication: O'Rourke et al., 1998

Year: 1997
Student: Alice Beltran
Title: Characterization and Geochemistry of Rocks from Mexico
Advisor: Tim Allen
Funding: Part of an NSF-REU program in Geology at Bates College and in Mexico
Publication: none (?)

Year: 1996
Student: Todd Drozd
Title: Infiltration & Soil Moisture
Advisor: Tim Allen
Funding: none
Publication: O'Rourke et al., 1998

Year: 1995-1996
Student: Marc Heilemann
Title: Predicting Volcanic Eruptions at Mt. Cotopaxi in Ecuador
Advisor: Tim Allen
Funding: none
Publication: on the web at: http://kilburn.keene.edu/Courses/GEOL498/cotopaxi/

Year: 1995-1996
Student: Mike Ravella & Don Lance
Title: Infiltration and Ground Water Recharge
Advisor: Tim Allen
Funding: KSC Undergraduate Fund, $946
Publication: O'Rourke et al., 1998

Year: 1995
Student: Judith Martin
Title: Evaporation & Solar Energy
Advisor: Tim Allen
Funding: none
Publication: O'Rourke et al., 1998

Year: 1994-1995
Student: Tric Drobat & Jeff Villanova
Title: Stable Isotope Systematics of Groundwater Recharge
Advisor: Tim Allen
Funding: KSC Faculty Development grant to Tim Allen, $1400
Publication: O'Rourke et al., 1998

Year: 1994-1995
Student: Don Lance
Title: Geologic Mapping, West Branch Peabody River, Pinkham Notch
Advisor: Tim Allen
Funding: none
Publication: none

Year: 1994-1995
Student: Tric Drobat
Title: Structural Controls on Fluorite Mineralization at the Wise Mine, Westmoreland, New Hampshire
Advisor: Peter Nielsen
Funding: none
Publication: Drobat & Nielsen, 1995

Year: 1990-1992
Student: Bob Perkowski
Title: Rift-Related Fluorite-Quartz-Barite-Base Metal Deposits in Southwestern New Hampshire
Advisor: Peter Nielsen
Funding: none
Publication: Howe et al., 1995

Year: 1991-1992
Student: Mark Nimiroski
Title: Shoreline Erosion at Surry Mountain Dam
Advisor: Steve Bill
Funding: none
Publication: none

Year: 1987
Student: Ronald Vagnone
Title: Paleoenvironment of the Keene Valley
Advisor: Steve Bill
Funding: none
Publication: none

Appendix VI: Alumni 1991-2000

Geology majors

Source*		Year	Name	Graduate Study	Employer	Position
	+	2000	Dina Andretta			
	x	2000	Adam Layman	BS Education in progress	Keene State College	student teacher
	+	2000	Carol Leger		Keene State College	college adjunct instructor
ar	+	1999	Damian M Grava			
ar	—	1998	Bryan WCunningham			
ar	x	1998	James W O'Rourke		Jaworski Geotech	Environmental Technician
ar	x	1998	Mark E Reinhold	MS Geology in progress	UNC Wilmington	graduate student
ar	+	1997	Sharon E Monahan			
ar	+	1997	John E Quay IV			
ar	—	1996	Gregory M Dimacale			
ar	x	1996	Charles M Kerwin	PhD in progress, MS Geology 2000, UNH	UNH	graduate student
ar	—	1996	Donald S Lance III			
ar	x	1996	Michael R Ravella	MS Hydrogeology 1998, Boston University	HSI GeoTrans	Project Hydrogeologist
ar	+	1996	Dana C Wood		Conval Regional HS	Science Teacher
ar	x	1995	Patricia A Drobat	MS Hydrogeology 1998, Wright State University	Roux Associates	Senior Hydrogeologist
ar	na	1995	Harry H Fleming III			
ar	x	1995	Brenda Ann Melius		Concepts NREC	Mech. Engineering Asst.
ar	x	1994	Scott D Mackay	1 yr, University of Utah	Eastern Mountain HS	Science Teacher
ar	—	1994	William F Simons	MS Geophysics 1997, UNH		
ar	na	1993	Barry A Arseneau			
	x	1993	Sandra K Cook		State Government	Administrative Assistant
ar	+	1993	C Edmund Lipinski III		USGS, Rhode Island	
ar	x	1993	Mark T Nimiroski		USGS, Rhode Island	Hydrologist
ar	x	1993	Lon Weston		Integral Access, Inc.	Systems Engineer
ar	x	1992	David A Jones	MS comp. sci. in progress MS Geology 1996, ASU	Northern Ariz. Univ.	graduate student
ar	ba	1992	Heidi M Lanzelin			
ar	x	1992	Matthew R Palfy		USDA	Food Inspector
ar	x	1992	Robert J Perkowski Jr.		self-employed	stock trader
ar	+	1991	Tracy H Dorgan		Tetra Tech NUS, Inc.	Geologist
ar	x	1991	David J Mancinelli		Haley & Aldrich, Inc.	Field Geologist
ar	x	1991	Laurie G Nash		Supercuts	hairstylist

ENST-Geology specialization (including some with Geology minors)

	—	2000	Corey Rouseeau			
	x	1999	Sam T Davis		Kraft	Testing Technician
ar	x	1999	Sean D Kennedy		Jaworski Geotech	Environmental Technician
ar	+	1999	Brian D Mayer			Well Driller
	x	1998	Alice Beltran		TRC Environmental	Energy Project Assistant
	x?	1998	Jared Bosse		Beech Hill Hosptial	Recr. Therapy Instructor
	x?	1998	Jessica S Ford		Able Environmental	Environmental Technician
	x	1998	William J Graham		ENSR	Environmental Geologist
ar	—	1998	Reid W Harte			
	ba	1998	Tracey Salls			
	—	1997	Heidi Tompkins			
	—	1996	David Gambaccini			
ar	x?	1995	Lisa A Laraway	MBA in progress	Allmerica Insurance	Reinsurance Accountant
ar	—	1995	Michael J Majersky			
ar	x	1995	John Shepardson		self-employed	housebuilder

Source*		Year	Name	Graduate Study	Employer	Position
ar	—	1995	Jeffrey T Villanova			
ar	—	1994	Michael J McGann			
ar	—	1991	Marshall A Davenson			

ENST majors with unknown (possibly Geology) or other specializations

Source*		Year	Name	Graduate Study	Employer	Position
	x	1999	Tatianna Batorfalvy		dental practice	Financial Cooridnator
	+	1997	Ramsey Graham		self-employed	mother
	na+	1997	Andrea Grunauer	MS Enviro, Geoscience 1999, Boston College		
	x	1997	Michael W Smith		Masenic Regional HS	Science Teacher
	—	1997	Glenn Witaszek			
	—	1994	Andrew D Allen			
	—	1994	Kristen Fiedler			
	—	1994	Andrew A White			
	id	????	John D'Andrea			
	id	????	Todd Drozd			
	id	????	Scott Ettl			
	id	????	Robert Havasy			
	id	????	Dan Molloy			
	id	????	Joel Rees			

Individualized majors (involving Geology)

Source*		Year	Name	Graduate Study	Employer	Position
	—	1999	Amanda J Wood			
	—	1997	Peter D Evans			
	na+	1996	Marc Heilemann		Compaq Computers	
	—	1994	Colleen Olszewski			
	id+	1994	Sarah Webb			
	id	????	Dave Koch			

Geology minors (non-ENST majors) or other/unknown

Source*		Year	Name	Graduate Study	Employer	Position
ar	na	1995	Susan Alice Dumas			
ar	—	1993	Maura Lynn Johnson			
ar	—	1993	Jessica L Young			
ar	—	1992	Michael Lucas Joyce			
ar	na	1991	Matthew Albert Seiler			
	—	1997	Asa Bagshaw			
	—	1996	Martine Q Schalke			
	ba	1995	Brian Fons			
	na	1993	Steve Charles Howe			

Selected alumni from before 1991

Source*		Year	Name	Graduate Study	Employer	Position
	+	1988	James Elliot		Jaworski Geotech, Inc.	Project Manager
	+	1988	Mark R Henderson		Jaworski Geotech, Inc.	Geologist
	+	1984	Richard J Eichhorn	MS Hydrology, UNH	Merrill Lynch	Financial Consultant
	+	1984	Carolyn Kruse Colonero		Geocrhon Labs	Stable Isotope Lab. Mgr.
	+	1983	Daniel Tinkham	MS Hydrology, UNH	Emery & Garrett	Hydrogeologist
	+	1976	Lindley S. Hanson	PhD Geology 1988, Boston University	Salem State College	Assoc. Prof. of Geology

*Source Codes
ar = alumni records, others determined by memory of the faculty
x = responded to alumni survey (Appendix X), + = information or contact other than alumni survey
x? = identification of alumni survey response uncertain, — = no response to survey
na = no address on record, ba = bad address, id = not identified in time for survey

Appendix VII: Faculty CVs and Evaluations

Timothy T. Allen

* Curriculum Vitae
* Self-Evaluation Statement, AY1999-2000
* DPEC Evaluation Letter, for the period 1997-1999
* Dean's Evaluation Letter, for the period 1997-1999

Steven D. Bill

* Curriculum Vitae
* Self Evaluation Statement (?)
* DPEC Evaluation Letter, for the period 1993-1998
* Dean’s Evaluation Letter, for the period 1993-1998 (?)

Peter A. Nielsen

* Curriculum Vitae
* Self-Evaluation Statement, AY1998-1999
* DPEC Evaluation Letter, for Promotion to Professor, 1998
* Dean's Evaluation Letter, for Promotion to Professor, 1998

These documents follow (pages not counted in numbering sequence), *and/or* are available online at http://kilburn.keene.edu/GEOL/ProgramReview/appendices/faculty.html

Notes

Appendix VIII: Detailed Equipment Inventory

Field and mapping equipment includes:

* ten Brunton Pocket Transits
* Thommen TX-18M Altimeter
* Pretel AltiPlus K2 electronic altimeter
* Magellan GPS300 hand-held 12 channel GPS receiver
* Trimble GPS receiver (circa 1992) shared with the Geography Department
* Weathermeasure Corp. Nautical Sextant model SB-10
* Teledyne Gurley #580 Alidade and Plane Table
* Fairchild F-71B Mirror Stereoscope
* two Radio Shack 40-channel CB two-way radios, with antenna
* miscellaneous measuring tapes, sighting levels, rock hammers, 10x handlenses, hard-hats, safety glasses, and student stereoscopes
* Group camping equipment including propane stoves, coolers, dishes, a screen tent, etc... (mostly belonging to the GEODES club)

Mineral, Rock and Sediment sample handling and preparation equipment includes:

* Hydraulic Rock Splitter
* 5-inch Disc Mill Pulverizer (needs overhaul)
* Highland Park Mfg. model U large rock slab saw (oil bath)
* Highland Park Mfg. model E2 small rock trim saw (water bath)
* Highland Park Mfg. model HP27 shaker polishing table (needs permanent attachment)
* two Covington Rotary Lapping Tables (one needs work)
* Ingram Labs 101 Thin Section Cut-Off Saw (needs overhaul)
* Ingram Labs 103 Thin Section Grinder (needs overhaul)
* Buehler Ltd. 30-8010 AB slide warmer
* Stabil-Therm Drying Oven
* USA Standard Testing Sieves
* BICO Porter Sand Shaker
* Humboldt H3980 Sediment Sample Splitter
* Branson 8200 Ultrasonic Cleaner Bath
* Waring Solid State Blender
* Raytech Tumble Twin Tumbler (slated for surplus?)
* Covingtons Tumbler (slated for surplus?)
* Raytech 8” Gem Maker GSP-8A (slated for surplus?)

Microscopy and related sample study equipment includes:

* eight American Optical Series 28 Stereoscopic Microscopes (illuminators need work)
* one American Optical Series 23 Stereoscopic Microscope
* three Leitz Wetzlar SM-Pol Polarizing Petrographic Microscopes (one needs work)
* one Leitz Wetzlar SM-LUX-Pol Polarizing Petrographic Microscope
* one Leitz Wetzlar LABORLUX-Pol Polarizing Petrographic Microscope (needs work)
* one Bausch & Lomb Dynoptic LS Polarizing Petrographic Microscope (needs work)
* one Vickers Polarizing Petrographic Microscope (needs work)

* one research grade Olympus BH-2/BHT Binocular Petrographic Microscope, equipped with:
  - Prior Model G digital electromechanical point counting stage
  - Sony SSC-C374 video camera
  - Olympus 35mm Camera Mount
* UVP Q-31 ultraviolet Mineralight
* UVP Model UVGL-58 ultraviolet Mineralight
* Geiger Counter (in the hands of Chemistry?)

Hydrogeologic equipment includes:

* Sand-Tank Ground Water Flow Demonstration Model (aka “the ant farm”)
* several bucket augers
* hammer soil-corer
* four Soil Moisture Equipment Corp. Jet-Fill Tensiometers
* Solinst model 101 electric water level meter, 100m
* WaterMark stainless steel water level tape, 30m
* one Solinst model 3001 LevelLogger self-contained pressure transducer and digital data-logger with optical reader computer interface
* two 12V submersible Ground Water purge & sample pumps
* Gurley Precision Instruments D622 Stream Current Meter with digital readout and both wading rod and bridge suspension systems.
* Hip-Boot and Chest Waders (belong to ENST)
* two Bi-Metal Soil Thermometers, 1 foot and 3 foot.
* Rainwise Tipping Bucket Rain Gauge

An associated meteorological station installed on the roof of the Science building, and shared among Physics, Geography, Geology and Environmental Studies, includes:

* Nimbus Digital Barometer and datalogger
* Nimbus Digital Thermometer and datalogger
* Nimbus Digital Precipitation Monitor and datalogger
* Nimbus Digital Wind Monitor and datalogger
* Nimbus Digital Remote Humidity Instrument and datalogger
* “class A” evaporation pan

Analytical and laboratory facilities includes:

Modular Multi-Purpose Vacuum Line Laboratory for preparing water and carbonate samples for Stable Isotope Analysis, established with funding from several sources, including a KSC Faculty Development Fund grant for collaborative research by Allen and Dr. Renate Gebauer (Biology & Environmental Studies), awarded in March 2000. The room in which this facility is located (Science 205B) underwent renovations over the summer of 2000, including the upgrading of electrical service and the installation of gas service. We are now setting the line up. At present, we intend to analyze the prepared gas samples (i.e. CO_2) using isotope ratio mass spectrometers at other institutions, such as Dartmouth College. For more information, see http://kilburn.keene.edu/ENST/isotopes/. Equipment housed in the laboratory includes:

* Custom glass vacuum line
* glass-blowing torch
* Edwards RV3 Vacuum Pump
* Edwards Active Pirani Vacuum Gauges
* NESLAB model RTE-211D refrigerated constant temperature water bath
* miscellaneous heaters, dewars, beakers, etc...
* Thermolyne F48025-80 8-segment programmable muffle furnace (on order)

Other laboratory and analytical equipment includes:

* Sartorius model 2462 Analytical Balance (needs repair or replacement)
* Voland & Sons 100-N equal arm Analytical Balance (condition unknown)
* Mettler PE3600 Balance (not working)
* Mettler P1210 Balance
* Central Scientific Hotplate
* VWR Dyla-Dual Stirrer/Hot Plate
* Precision Scientific Co. Beaker Heater
* Large Scissors Jack Stand
* two National micrometers
* Bunsen Burners, etc
* Miscellaneous Glassware
* Miscellaneous Chemicals
* Vreeland Direct Reading Spectroscope by Spectrex (condition unknown)
* CENCO HY-VAC vacuum pump (broken, slated for surplus)
* Huber Crystal Face Goniometer (slated for surplus)
* Oakton Pocket meters for pH, Conductivity, ORP and Temperature
* LaMotte test kits for Alkalinity, Hardness, Chloride and Sulfide
* Ward's Quantitative Chemical Set with Blowpipe (slated for surplus or disposal)

The chassis for an old film-based powder XRD belonging to Chemistry is in storage, and the Physics department may have some rudimentary geophysical instrumentation (electrical resistivity array, single-channel seismograph) of unknown condition. We also have the chart recorder and clock for a seismic monitoring station, although its condition is unknown.

Computing Equipment:

* Apple PowerBook 5300cs laptop computer, with SoftWindows 3 emulator
* Apple Macintosh Quadra 700 with video input/ouput
* Apple Macintosh Centris 650 with CD-ROM
* APS Technologies external CD-ROM drive (6x, SCSI)
* APS Technologies external hard disk drive (250Mb, SCSI)
* APS Technologies external magneto-optical cartridge drive (128Mb, SCSI)
* Iomega ZipPlus external cartridge drive (100Mb, SCSI/Parralel)
* MicroTech ScanMaker IIsp flatbed scanner (SCSI)

Two new computers, a Pentium III system and a PowerMac G4 system, have just recently been installed in the Geology Departmental Computing Cluster.

Notes

Appendix IX: Comparator Institution Comparisons

Twenty colleges from the USNH/KSCEA list of comparators, or list of CoPLAC members, offer degree programs in Geology (or equivalent) through departments of Geology (or equivalent; Table VIII-a). Curricula are compared in Table VIII-b. AIPG curricular recommendations and AGI survey results are also listed, as discussed in the section on Program Evaluation & Assessment: Outcomes.

Five additional colleges from these comparator lists offer degree programs in Earth Science (or similar) (usually for Teacher preparation) through departments of Geography, Environmental Studies, or Natural Science; another five offer only minor programs in Geology (Table VIII-c).

The remaining fifteen colleges from these comparator lists do not appear to offer any programs in geology (Table VIII-c).

Table VIII-a

	School	Department	#F	#A	Department Web Page
UC	Keene State College	Geology	3	1	http://www.keene.edu/programs/geol/
U	Adams State College	Geology & Enviro. Science	3	—	http://www.adams.edu/academics/science_math_tech/geology/geology.html
U	Austin Peay State University	Geology & Geography	6	—	http://www.apsu.edu/earthone/
U	California State Univ.-Bakersfield	Geology	5	1	http://www.cs.csubak.edu/Geology/
C	College of Charleston	Geology Department	11	—	http://www.cofc.edu/~geology/
U	Eastern Connecticut State Univ.	Enviro. Earth Science	6	—	http://www.ecsu.ctstateu.edu/depts/eearthsci/index.htm
C	Fort Lewis College	Geology Department	6	—	http://geo.fortlewis.edu/
U	Indiana University Northwest	Geosciences	4	4	http://www.iun.edu/~geos/
C	Mary Washington College	Enviro. Science & Geology	3	—	http://departments.mwc.edu/eesg/www/
U	Slippery Rock University	Enviro. Geosciences	6	—	http://ils.sru.edu/egeo/Index.htm
UC	Sonoma State University	Geology	5	—	http://www.sonoma.edu/Geology/
U	SUNY College Fredonia	Geosciences	6	—	http://www.fredonia.edu/department/geosciences/index.htm
C	SUNY College Geneseo	Geological Sciences	5	1	http://www.geneseo.edu/~gsci/
U	SUNY College Oneonta	Earth Sciences	9	—	http://www.oneonta.edu/~earths/index.html
U	SUNY College Plattsburgh	Center for Earth & Enviro. Sci.	8	—	http://www.plattsburgh.edu/cees/
C	University of Minnesota-Morris	Geology Discipline	4	—	http://www.mrs.umn.edu/academic/geology/
U	University of Southern Maine	Geosciences	5	—	http://www.usm.maine.edu/~geos/
U	University of Tennessee-Martin	Geology, Geography & Physics	4	1	http://www.utm.edu/departments/artsci/ggp/ggp.htm
U	Western Carolina University	Geosciences & Nat. Res. Mgmt.	5	1	http://www.wcu.edu/as/GeosciencesNRM/GEOSCIENCES/GEOSCIhome/GEOSCIhome.htm
U	Winona State University	Geology	4	3	http://www.winona.msus.edu/geology/index.html
	AIPG Education for Professional Practice (1991)		—	—	
	AGI Report on the Status of Academic Geoscience Depts. (1999)		6	—	

U = USNH/KSCEA Comparator Institution
C = Council of Public Liberal Arts Colleges (CoPLAC)
#F = number of full-time tenure-track faculty
#A = number of adjunct or visiting faculty or instructors

Table VIII-b

See notes on following page.

School	GEOL 201 Physical Geology	GEOL 202 Historical Geology	GEOL 301 Mineralogy	GEOL 302 Petrology	GEOL 303 Structural Geology	GEOL 306 Stratigraphy/Sedimentation+	GEOL 305 Paleontology	GEOL 309 Geomorphology	GEOL 310 Glacial Geology	GEOL 315 Environmental Geology	GEOL 460 Hydrogeology	GEOL 412 Geochemistry	GEOL 401 Optical Petrography++	Geophysics or Applied Geophysics+++	Tectonics+++	Economic Geology+++	Regional Geology+++	Field Methods or Field Geology+++	Research Method+++	Senior Seminar+++	Senior Thesis+++	GEOG 326 Geographic Info. Systems	GEOG 327 Remote Sensing	GEOL 210 Hydrology	MET 225 Meteorology	GEOL 206 Oceanography	ASTR 307 Astronomy	Chemistry (# of semesters)	Biology (#of semesters)	Physics (# of semesters)	Calculus (# of semesters)	Computer Science (# of semesters)
Keene State College	R	R	R	R	R	R	R	O	O	O	O	O	O	—	—	—	—	—	—	—	—	O	O	C	C	C	C	2	1	2	1	1
Adams State College	R	R	R	R	R	R	R	O	—	—	O	O	R	—	O	—	O	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Austin Peay State	R	R	R	R	R	R	R	R	—	O	O	O	—	—	O	O	C	—	—	—	—	—	C	—	—	O	—	2	2	2	2	—
CSU - Bakersfield	R	R	R	R	R	R	O	O	—	O	O	R-	—	R-	—	—	C	R	R	R	—	—	—	O	—	—	—	2	—	2	2	1
College of Charleston	R	R	R	R-	R	R-	R	O	—	O	C	C	C	—	C	O	O	R	R	—	C	C	O	—	—	—	—	2	—	2	2	—
Eastern Connecticut	R	R	R	—	R	R	—	R	O	O	O	O	—	—	—	—	—	R	—	—	—	R	—	R	O	O	O	2	—	2	1	—
Fort Lewis College	R	R	R	R	R	R	R	R	—	O	O	O	R	—	O	—	O	R	R	R	—	—	O	—	—	—	—	—	—	—	—	G
Indiana U Northwest	C	C	C	C	C	C	—	C	C	C	—	C	—	C	—	—	C	C	C	C	C	—	—	C	—	C	—	—	—	—	—	—
Mary Washington	R	R	R	R	R	R	C	—	—	C	—	C	—	—	C	—	—	—	—	—	—	—	—	C	—	—	—	—	—	—	—	G
Slippery Rock	R	R	R	R	R	R	R	O	O	—	O	O	—	O	—	—	—	R	R	R	—	—	R	O	C	—	—	2	—	2	3	R-
Sonoma State	R	R	R	R	R	R	R	—	—	O	—	O	R	O	—	O	C	R	R	—	—	—	—	O	—	—	—	2	—	2	2	—
SUNY Fredonia	R	R	R	R	R	—	—	O	—	—	—	O	—	O	—	—	—	R	—	R	—	—	—	—	—	—	—	2	—	2	2	1
SUNY Geneseo	R	R	R	R	R	R-	R	R	O	C	O	O	O	O	O	O	—	C	—	R	C	—	O	—	—	C	—	2	2	2	2-	1-
SUNY Oneonta	R	R	R	R	R	R	R	R	O	O	O	O	—	O	—	—	—	R	—	—	—	—	—	O	R	C	C	2	—	2	2	—
SUNY Plattsburgh	R	R	R	R	R	R	—	O	—	O	O	O	—	—	—	O	—	R	—	—	—	—	O	O	—	—	—	2	—	2	2	—
UMinn - Morris	R	—	R	R	O	O	O	O	O	—	O	O	—	O	O	—	O	R	—	R	O	—	O	—	—	—	—	2	1-	1-	1	1-
U Southern Maine	R	R	R	R	R	R	—	R	O	O	O	—	—	R	—	O	C	O	—	—	O	O	—	O	—	—	—	2	1-	2	3	1-
UTenn - Martin	R	R	R	R	R	R	R	O	—	O	—	—	—	—	R	—	—	R	—	—	O	—	—	O	—	O	—	—	—	—	—	—
Western Carolina	—	R	R	R	R	R	O	R-	—	R	O	—	O	—	O	O	—	R	O	R-	R-	—	—	R-	—	—	—	2	—	2	2	—
Winona State	R	R	R	R-	R	R	O	O	—	O	O	R-	R-	R-	R	O	O	R	—	R	—	O-	O-	—	C	C	C	2-	—	2-	2	1
AIPG (1991)	R	R	R-	R-	R	R	O	O	—	O*	O*	—	O	O*	—	S	O*	R	*	*	—	—	—	—	—	—	—	2	—	2	**	**
AGI (1999)***	—	—	97	93	94	100	100	85	—	89	73	65	74	—	74	—	51	81	—	—	—	40	27	67	—	—	—	—	—	—	2	—

R = course required
R- = course is one of two that could be used to meet a requirement
O = course is an option to meet elective requirements within major
C = course is offered, S = suggested elective course, G = course in computer applications offered within the Geology Department.

Table VIII-b Notes

* A capstone experience involving problem definition, data acquisition, analysis and conceptual integration is expected in every program, and may take the form of a special problem, undergraduate thesis, or as a major part of a course (see O*) (from AIPG, 1991).

** A passing grade in one or two courses of calculus does not assure proficiency in quantification and numerical solutions of geologic problems. At least one Required Geology course should integrate calculus and practical problem-solving, with the math courses as pre-requisites. Computer literacy is also essential; as is proficiency in effective communication (technical writing) (from AIPG, 1991).

*** Shown for each course is the percentage of Undergraduate Geology Departments polled by AGI offering such a course; the data do not reveal which courses are required versus which are elective (from AGI, 1999)

+some programs offer two separate courses in Stratigraphy and in Sedimentation

++some programs include optical techniques as part of either Mineralogy or Petrology (or both)

+++KSC does not offer an equivalent course

Table VIII-c

The following offer degree programs in Earth Science (or similar) (usually for Teacher preparation) through departments of Geography, Environmental Studies, or Natural Science:

U	Clarion Univ. of Pennsylvania	Anthro., Geog. & Earth Science	http://wwwartsci.clarion.edu/ages/ages.htm
U	Fitchburg State College	Geo/Physical Sciences	http://www.fsc.edu/geophysci/
U	Framingham State College	Geography	http://www.framingham.edu/
C	University of Maine, Farmington	Department of Natural Science	http://www.umf.maine.edu/cgi-bin/Department.cgi?Dept=NASC
C	Univ. North Carolina, Asheville	Environmental Studies	http://www.unca.edu/envr_studies/

The following offer only minor programs in Geology:

U	Bemidji State University	Ctr. Enviro., Earth & Space Stud.	http://ea.bemidji.msus.edu/ces/
C	Evergreen State College	only interdisciplinary programs	http://www.evergreen.edu/
U	Univ. of Colo., Colorado Springs	Geology	http://www.uccs.edu/~geology/
U	Univ. of Wisconsin, Stevens Point	Geography & Geology	http://www.uwsp.edu/geo/
U	Shippensberg State University	Geoenvironmental Studies	http://www.ship.edu/academic/artges.html

The following do not appear to offer any program in geoscience:

U	Armstrong State University	http://www.armstrong.edu/
C	Henderson State University	http://www.hsu.edu/
U	Indiana University South Bend	http://www.iusb.edu/
C	Massachusetts College of Liberal Arts	http://www.nasc.mass.edu/
C	New College of the University of South Florida	http://www.newcollege.usf.edu/
U	North Carolina Agricultural and Technical State University	http://www.ncat.edu/
C	Ramapo College of New Jersey	http://www.ramapo.edu/
U	Rhode Island College	http://www.ric.edu/
C	St. Mary's College of Maryland	http://www.smcm.edu/
U	Trenton State University (The College of New Jersey)	http://www.tcnj.edu
C	Truman State University	http://www.truman.edu/
C	University of Montevallo	http://www.montevallo.edu/
U	Univsersity of Wisconsin, Platteville	http://www.uwplatt.edu/
U	William Paterson College	http://ww2.wpunj.edu/
U	Worcester State College	http://www.worc.mass.edu/

U = USNH/KSCEA Comparator Institution, C = Council of Public Liberal Arts Colleges (CoPLAC)

Notes

KSC Geology Program Alumni Survey 2000

Please elaborate on your answers whenever appropriate. Attach additional sheets as needed. Please return in the enclosed postage-paid envelope to Geology, MS2001, Keene State College, Keene, NH 03435-2001, or by e-mail to tallen@keene.edu, by September 6th if possible. Thanks!

1. In what year did you graduate from Keene State College: _________

2. What was your Major? (if more than one, check all that apply)

- ☐ Geology
- ☐ Geology, Teacher Certification
- ☐ ENST-Geology Specialization
- ☐ Individualized, please specify: _______________
- ☐ Other, please specify: ____________________

3. Did you have a Minor(s)? If so, please specify: ____

4. Have you received any education or training subsequent to graduating from KSC? If so, please specify the field of study, year(s) and institution(s):

- ☐ Short Courses or Workshops: ____
- ☐ Master's Degree: ____
- ☐ Doctoral Degree: ____

5. Have you taken the Geology GRE or other assessment tests? If so, would you be willing to share your scores?

6. Do you hold a Professional License or Certification? If so, please specify: _________________________

7. How is your current employment (or graduate work if a student) related to your undergraduate education? (check all that apply)

- ☐ related to Geology
- ☐ related to Environmental Studies
- ☐ related to another field of Natural Sciences (e.g. Biology, Chemistry, Physics)
- ☐ not really related to my undergraduate major
- ☐ I am currently unemployed (skip to question 12)

8. How would your characterize your current position? (feel free to elaborate)

- ☐ Graduate Student
- ☐ Field Technician
- ☐ Laboratory Technician
- ☐ Project Scientist or equivalent
- ☐ Elementary School Teacher
- ☐ Secondary School Teacher
- ☐ College or University Faculty
- ☐ Other (please describe): ___________________

8a. If you care to, please tell us your Job Title/Description: ____

9. What tasks or skills does your current job involve? (check all that apply; feel free to elaborate)

- ☐ field work, mapping
- ☐ field work, sample collection
- ☐ laboratory analysis
- ☐ computer modelling
- ☐ writing
- ☐ quantitative reasoning
- ☐ graphics and illustration, including CAD or GIS
- ☐ use of computerized databases
- ☐ other (please describe): ____

10. For what type of organization do you currently work?

- ☐ Educational Institution (please circle Elementary, Secondary, or College)
- ☐ Government Agency (please circle Local, State, or Federal)
- ☐ Environmental Consulting Firm
- ☐ Mineral or Energy Resource Company
- ☐ Non-Profit Organization
- ☐ Other (please describe):______________________

10a. If you care to, please tell us the name of your employer: ____

11. What is your present annual salary range?

- ☐ Less than $25,000
- ☐ $25,000 to $50,000
- ☐ $50,000 to $75,000
- ☐ $75,000 to $100,000
- ☐ greater than $100,000
- ☐ would rather not say

12. What things do you remember most about your experience with the KSC Geology Program?

13. Were you active in the Geology Student Club (G.E.O.D.E.S.)? Did you attend any of the post-spring-semester field trips? If so, please specify.

14. Of all of the courses you took (including non-geology courses), which are the most valuable to you now (and why)?

15. Are there content areas and/or skills in which you wish you had better preparation? What courses (including non-geology courses) did you not take (or that weren't offered) that you now wish you had?

16. Do you have any advice for current and prospective Geology or ENST-Geology majors?

17. Would you like to receive a newsletter from the KSC Geology Department, with news about the Department and from other alums? ☐ Yes, by e-mail! ☐ Yes, by paper mail! ☐ No. If yes, please be sure to keep us updated with your current address!

18. Do you have any news that you would like to share in such a newsletter? Use additional sheets as needed.

Thank you for the feedback—we look forward to hearing from you! Alumni are more than welcome at GEODES social events, including the December holiday party and the July picnic. See http://kilburn.keene.edu/GEOL/GEODES/ for more information.