

Proposal to the AAC Subcouncil on Tenure Line Allocation

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Summary

Geology is a broad subject that is of importance to everyone. It has importance in everything from choosing a home to understanding drought cycles, from local land use planning to the setting national and international policy. Geology involves the study and understanding of surface and ground water, floods and flood frequency, earthquakes and volcanic hazards, climate change over short and long time scales, mineral and fuel resources, waste disposal, and much more. To different degrees, all of these are vital for the maintenance, safety, and progress of modern society.

The Geology Department is very small for a lab science; small with respect to the other Union lab sciences and small with respect to peer undergraduate geoscience programs. With four faculty the Geology Department simply cannot offer an adequate modern geoscience curriculum, while at the same time offering an adequate number of introductory level courses for majors and non majors. There are several courses of interest to other disciplines at Union College that we, as part of a modern geoscience program, should offer to the rest of the college but cannot under current circumstances. These courses include Remote Sensing and Geographic Information Systems. We propose a substantial solution to these and other issues by hiring two new faculty in the Geology Department. The new hires, with current faculty, will fulfill six principal objectives:

- 1) To fill the most serious gaps in the geoscience curriculum.
- 2) To help construct interdisciplinary bridges between Geology and the other lab science disciplines.
- 3) To help construct interdisciplinary bridges between geography-oriented components of the social sciences.
- 4) To offer specific courses and a new range of research opportunities of interest to Environmental Studies, Geology, and Educational Studies students.
- 5) To expand introductory course offerings.
- 6) To reinstate a full complement of 10 labs per lab section for one introductory course per term.

Detail

Geology has 4 faculty: small relative to other Union science departments

The Geology Department is by far the smallest lab science, its four faculty representing ~10% of the lab science faculty (including Biology, Chemistry, Geology, Physics). With four faculty it is not possible to offer a modern, strong lab science major while at the same offering a good range

of quality introductory level lab courses. Indeed, the quality of introductory lab courses has recently been compromised by reducing from 10 to 5 the number of lab experiences per term, and eliminating labs from an introductory course. This change was made, under pressure from the administration, to alleviate college-wide needs for more introductory science courses, and to reduce concerns that Geology was not teaching enough students in total. As a result, Geology is the only science department offering only 5 labs in introductory courses for majors.

Geology has 4 faculty: small relative to comparable colleges

The average and median number of geoscience faculty at undergraduate institutions is 6, as determined in two recent (2000, 2002) reviews of 25 peer geoscience programs from Union's group of "comparison schools", and as estimated in a broader compilation by the American Geological Institute (1999, p. 13). Our department size of 4 therefore ranks low in comparison with similar institutions.

Geology contributes to several programs

Introductory level Geology courses are popular and contribute substantially to several other programs at Union:

1. Introductory geology courses form part of the core of the *Environmental Studies Program*.
2. Geology is an important resource for the *Educational Studies Program*. Typically 2 students a year major in Geology en route to an MAT or MST degree in earth science teaching, and several others take a smaller number of courses to complete curricula that were begun elsewhere. Geology is periodically asked to offer other courses such as meteorology, needed by Educational Studies, but is unable to do so.
3. For its size Geology is important to the *GenEd Program*; it offers accessible yet rigorous introductory level courses.
4. *Engineering* students take Geology courses to help fulfill elective science requirements.

Upper level Geology courses contribute to some other programs as well.

Geology relies on visitors and adjuncts

Geology routinely hires adjuncts to teach Hydrogeology, GEO-170, a course vital to any modern geoscience curriculum. It is central to all issues of flooding, water supply, and ground water contamination throughout the world. Historically this course has been taken by Geology, Civil Engineering, and Environmental Studies students.

Remote Sensing, GEO-23, has been taught in the past two years by visitor Joan Ramage. This popular mid-level course was taken by Geology, Environmental Studies, Physics, Engineering, and Educational Studies students. It is also a course obviously of interest to anyone studying aspects of anthropology, political science, economics, and sociology that involve interactions between people and their surrounding landscape.

A Geographic Information Systems (GIS) course has been needed for some time and will be taught (pending reapproval of funding) for the first time in winter, 2003, by an adjunct under the sponsorship of the Environmental Studies Program with support from Geology. This course will

be of major interest to students in Geology, Biology, Environmental Studies, Engineering, and the Social Sciences. Essentially all work involving spatial information now uses GIS databases. Such databases include geographic and geologic information, census data, criminal activity, emergency management plans, land use plans, and zoning district maps.

Geology has had a chronic problem of courses with wait lists

Historically most Geology introductory lab courses had wait lists. This was because, as a lab science with only four faculty, we were unable to offer large numbers of lab sections in introductory courses while at the same time offering a major curriculum.

As described above, we have increased enrollments by cutting the number of lab experiences in each lab section of *all* introductory courses from 10 to 5 per term, removing all labs from GEO-11, and introducing a new non-lab course Restless Oceans. We now have dramatically higher overall enrollments and fewer oversubscribed courses (GEO-11 this winter *did* have a long wait list), but at the expense of a much reduced lab experience. We very much need to offer at least one course per term with the full ten labs for Geology majors, potential Geology majors, Environmental Studies students, and GenEd students who actually want and should have available the full lab experience.

Geology has some large courses

Introductory courses in the 2001-2002 academic year have been reasonably large: Restless Oceans had 107 students; Environmental Geology had 36 (1½ times usual enrollments); Earth and Life Through Time had 32 (double usual enrollments) with a long wait list. A new administrative rule forbidding any science course counting for GenEd credit to have more than 40 students will doubtless reduce overall enrollments slightly and bring wait lists back. It is clear that there is a large interest in the Union community for introductory geoscience courses and there is need to expand geoscience introductory course offerings.

Geology has several major curriculum gaps

There are several important gaps in the Geology curriculum, as determined by: 1) surveys of the geoscience industry (petroleum, environmental, and mining sectors) done by the American Geological Institute; 2) by our review of course offerings by 25 peer geoscience programs; 3) by our own observations of ongoing changes in emphasis in geoscience; and 4) by reviewing reports from our alumni of skills and knowledge they need for their work and graduate study. We conclude that eight areas represent major geoscience curriculum gaps that should be filled:

Economic geology

Geographic information systems (GIS)

Remote sensing

Surface and ground water geology

Global Climate Change

Global tectonics

Paleontology

Sedimentary Petrology

We recognize that, under current circumstances at Union, filling positions to effectively teach in all eight of these areas is impossible. We therefore concentrate on the first four courses, which are the most important for meeting our stated goals:

Economic geology. This course will examine the genesis of mineral deposits of economic importance. Ore deposits will be examined in terms of plate tectonics, physical and geochemical models, ore mineralogy, ore processing, mineral extraction economics, mineral market economics, and environmental matters. The importance of this field is increasing with population growth and rapid economic development of China and most other nations. This course would be of particular interest to Geology, Environmental Studies, Chemistry, Engineering, and Economics majors.

Geographic information systems (GIS). This would be a computer-oriented course involving hands-on use of GIS software to investigate the development and use of GIS databases in several different fields. GIS software can manipulate any kind of information that is referenced to a position on the Earth. Such information can include land use, crime data, geologic mapping information, crop data, resource information, vegetation and ecologic data, environmental monitoring data, and social statistics including most census data. This course would be of particular interest to Geology, Biology, Environmental Studies, Engineering, and Social Science majors.

Remote sensing. This is a computer-oriented hands-on course (taught the past two years by visitor Joan Ramage) using image processing software to manipulate and extract information from remote sensing images of the Earth's surface. Remote sensing is used to monitor volcanoes, forest fires, floods, droughts, crop productivity, ecological changes, weather patterns, land use changes in developing and farm areas, ocean currents, ocean productivity, military developments, and battlefields. Remote sensing is increasingly being used to *predict* crop productivity, drought effects, and epidemics of diseases that depend crucially on seasonal environmental characteristics. This course is of particular interest to Geology, Biology, Physics, Environmental Studies, and Social Science majors who have interests in how conditions at the Earth's surface affect people.

Surface and ground water geology. A steady supply of large amounts of water is vital for all aspects of modern society including agriculture and industry. Too little water resulting from drought or exhaustion of surface or ground water resources, or too much water from floods, are chronic problems that cause tremendous economic and social hardship ranging from serious to catastrophic. These problems are worsening as world population grows, as ground and surface water resources reach their limits or are exhausted, and as people increasingly crowd into areas problematic with respect to water issues. This course will cover the areas of water measurement in terms of flow and other characteristics, ground water storage, flow, and recharge, surface water storage and flow, flood prediction, flood hazard mitigation, water distribution, and water resources as related to climate change. This course would be of interest to Geology, Biology, Environmental Studies, and Social Science majors in particular.

Each of these courses is not only vital for the maintenance of a modern geoscience program, but each course is clearly of interdisciplinary interest. Each of these courses can be taught at different levels and with different emphases, and we anticipate introductory-level courses derived from Economic Geology and Surface and Ground Water Geology, and we anticipate

Social Science-oriented versions of Geographic Information Systems and Remote Sensing.

Proposed faculty lines

We propose to add two new geoscience faculty:

- 1) **Economic geology.** This person would have broad expertise in economic geology and would benefit Geology, Environmental Studies, Educational Studies, Economics, and possibly Chemistry. This person would be familiar with the U.S. and international mineral and oil exploration and extraction industries, the history of mineral exploration and utilization, and with the economics of mineral resource markets and exploitation. We envision this person teaching an introductory course on the origin, exploration, and extraction of the resources that power industrial society, and upper level courses that may include economic geology (geologic perspective), the economics and politics of mineral and fuel resources, petroleum geology, mine site reclamation, tectonics and ore genesis, structural geology, petrology, and remote sensing. This last course would be of particular importance to the Biology and Physics departments, and to social science majors concerned with the geographic landscape in which human affairs take place. Remote sensing is an important and pervasive component of military surveillance, flood and volcano monitoring, long-term monitoring of environmental changes such as desertification and deforestation, and monitoring land development including cityscapes. Research areas would probably be in the areas of resource exploration, ore genesis, and ore petrology and geochemistry.
- 2) **Hydrogeology.** This person would have broad expertise in the general fields of water flow and flow modeling, ground water extraction, and water chemistry. This person would serve principally Geology and Environmental Studies, and potentially Physics, Chemistry, and Biology departments, the social sciences, and Educational Studies. We envision this person teaching an introductory course on regional water resource issues (as Phil Snow heads for retirement) such as those in the U.S. west and Atlantic coast, and in the Middle East. Upper level courses would be in the general areas of hydrogeology, sedimentary petrology, flood hazard prediction and assessment, and geographic information systems (GIS). The latter course will be of particular importance and interest to Biology majors and any part of the social sciences interested in geographic-oriented information, such as census data, marketing, and political polls. Research areas might include aquifer studies, water geochemistry, contamination remediation techniques, flood modeling, landslide hazards, and sedimentology.

As indicated, one or both of these proposed new hires would be able to teach GIS and/or Remote Sensing. Each would have a sufficiently broad background to permit the teaching of a broad range of courses to an undergraduate audience. They would be capable not only of teaching their upper level courses on a reasonable rotation schedule, but also capable of teaching introductory level lab and/or non-lab courses. Combined with the current staff, and factoring in increased flexibility derived from sharing course teaching loads, additional curriculum goals may be met.

One might wonder if remote sensing and GIS are too much to expect economic geologists and hydrogeologists to teach. We think not because these techniques are becoming widespread

and are used extensively in these two disciplines. We think we can find highly qualified candidates fitting these characteristics.

In summary, both of the proposed new faculty will help support the Geology Department and several other programs spanning the sciences and social sciences. They will fill important gaps in the Geology curriculum, and expand geoscience GenEd offerings. Further, they will permit the Geology Department to expand its outreach to the rest of the Union College community. Ultimately, this will improve the level of the liberal arts education at Union.

References

American Geological Institute, 1999, Report on the status of academic geoscience departments, 14 p. (<http://www.agiweb.org/career/rsad1999.pdf>).

Total lecture and lab section enrollments, per FTFE, 2001-2002

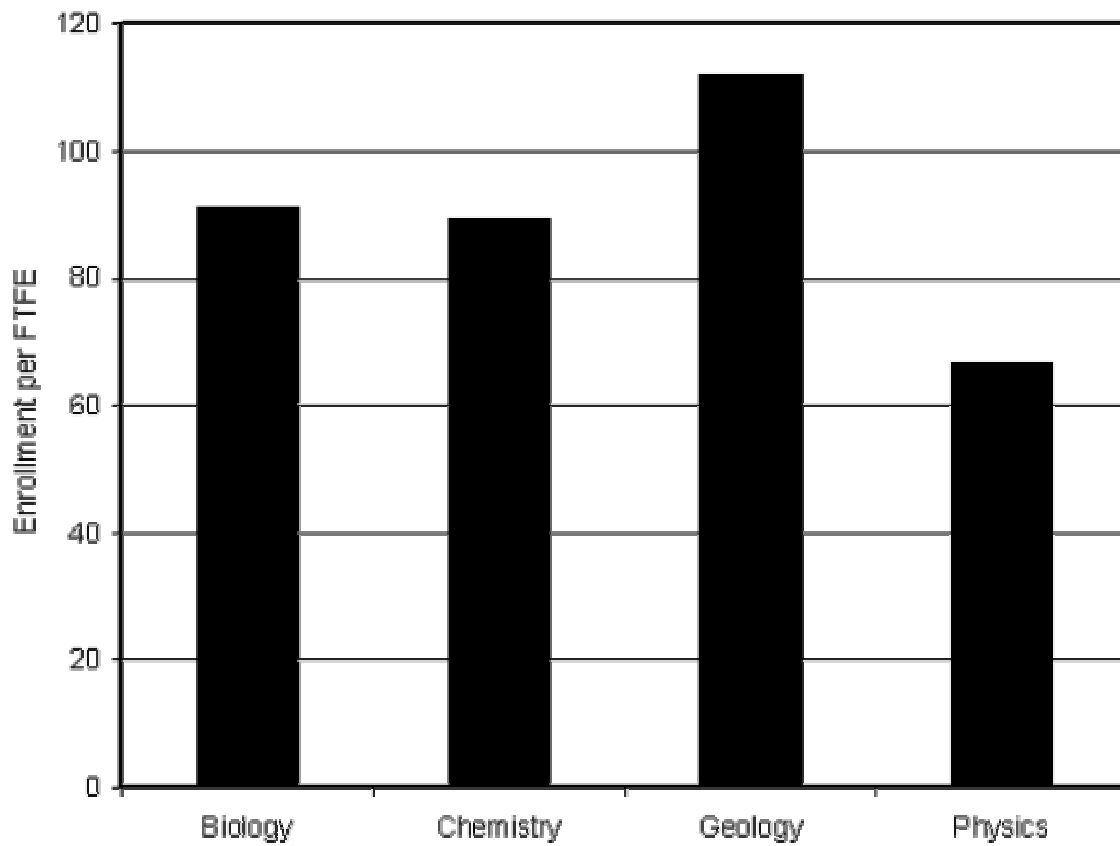


Figure 1. All lab science course enrollments, including enrollments in all lecture and lab sections: 2001-2002 academic year, actual counts from Registrar records. The point of this graph is to show that Geology slightly exceeds all other lab science departments in total enrollments per faculty member. See Table 1, row 1, for the actual enrollment numbers.

Total lecture section enrollments, per FTFE, 2001-2002

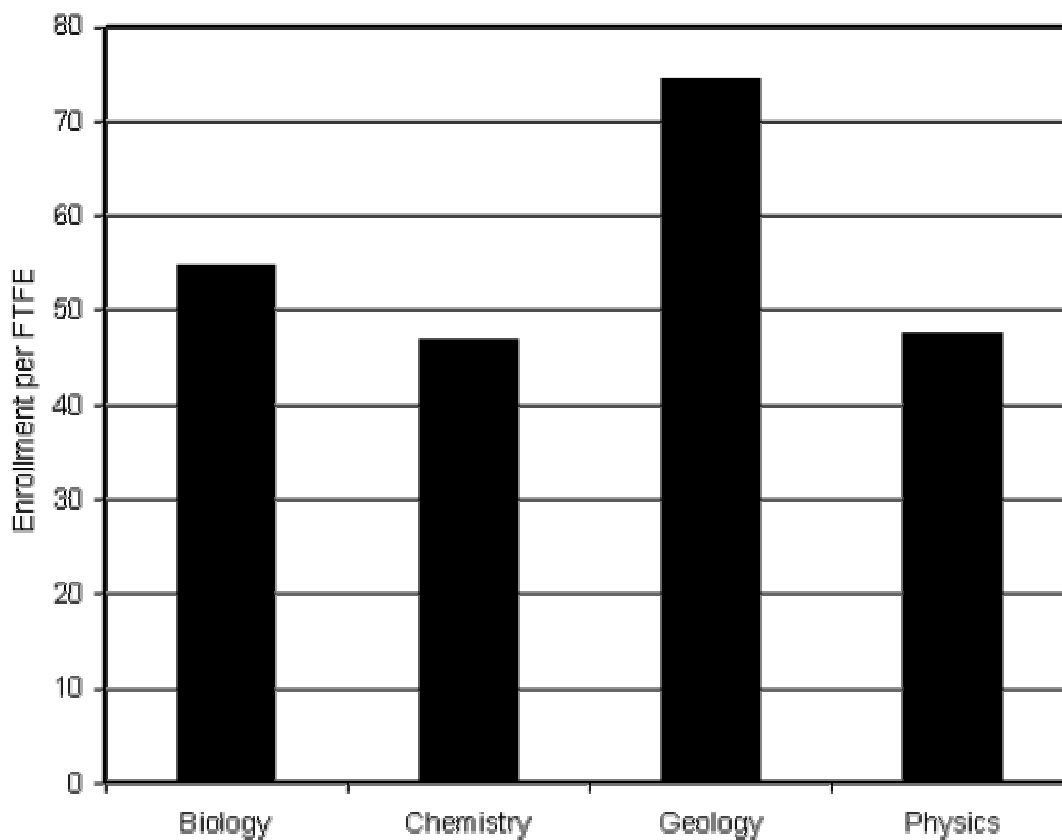


Figure 2. Total lab science enrollments in lecture sections only: 2001-2002 academic year, actual counts from Registrar records. The point of this graph is to show that Geology again slightly exceeds the other lab sciences in terms of total numbers of students in the department, per faculty member, regardless of whether labs are counted or not. See Table 1, row 2, for the actual enrollment numbers.

Total lecture section enrollments of Center 1 majors, per FTFE, 2001-2002

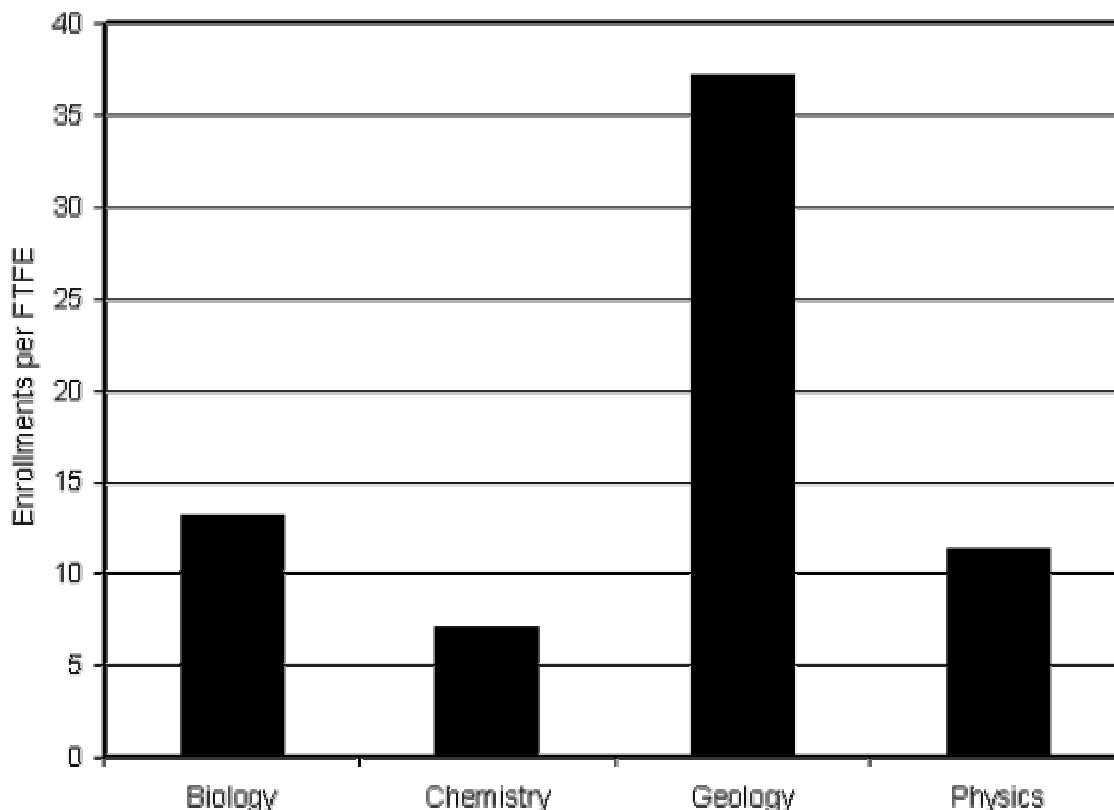


Figure 3. Enrollments of Center 1 majors in all lab science lecture sections: 2001-2002 academic year, actual counts from Registrar records. Note that, by this measure, Geology teaches more than twice as many Center 1 students per FTFE than any other lab science department. See Table 1, row 3, for the actual enrollment numbers. All students were classified into one or more categories depending on their declared major: science (S), engineering (E), or non-science (N), as follows:

- Undeclared majors (blank, LA undeclared, undeclared) counted as 0.2 toward S and 0.8 toward N.
- LA science counts as S.
- LA social science counts as N.
- LA humanities counts as N.
- Environmental Studies majors count 0.5 each for S and N.
- Psychology counts as S.
- MATH counts as N
- MAT Science counts as S.
- Double and ID majors: the two listed concentration areas counted 0.5 each toward the appropriate S, E, or N categories.
- Math and Computer Science counts as E.
- 7 and 8 year med students all count as S.

- Organizing Theme majors all count 0.2 for S and 0.8 for N.

Enrollments of Center 1 majors in science courses with no prerequisites, per FTFE, 2001-2002

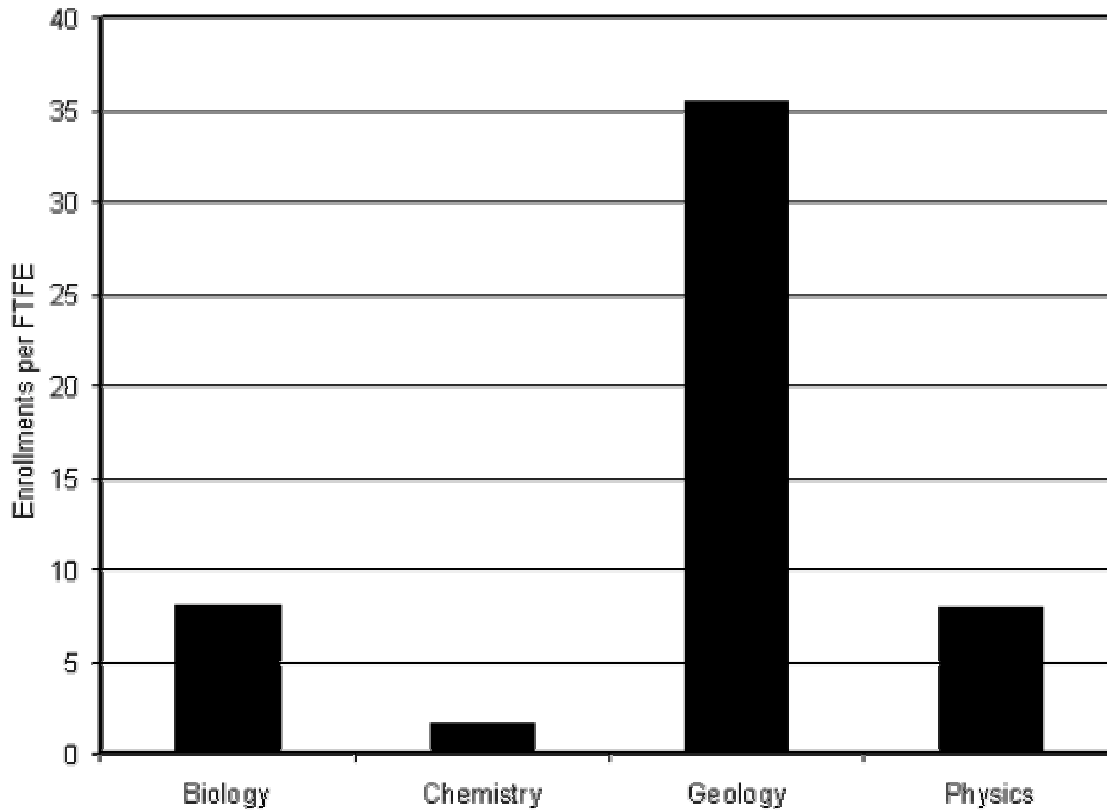


Figure 4. Enrollments of Center 1 majors (see definitions in Figure 4) in lab science lecture sections *that have no prerequisites*: 2001-2002 academic year, actual counts from Registrar records. The point of this figure is to show that Geology is contributing substantially to the GenEd program, and that demand for geoscience courses is high. This graph emphasizes the point that Geology is indeed going out of its way to teach generally accessible courses. See Table 1, row 4, for the actual enrollment numbers.

FTFE numbers in the lab sciences, 1998 AAC Subcouncil report

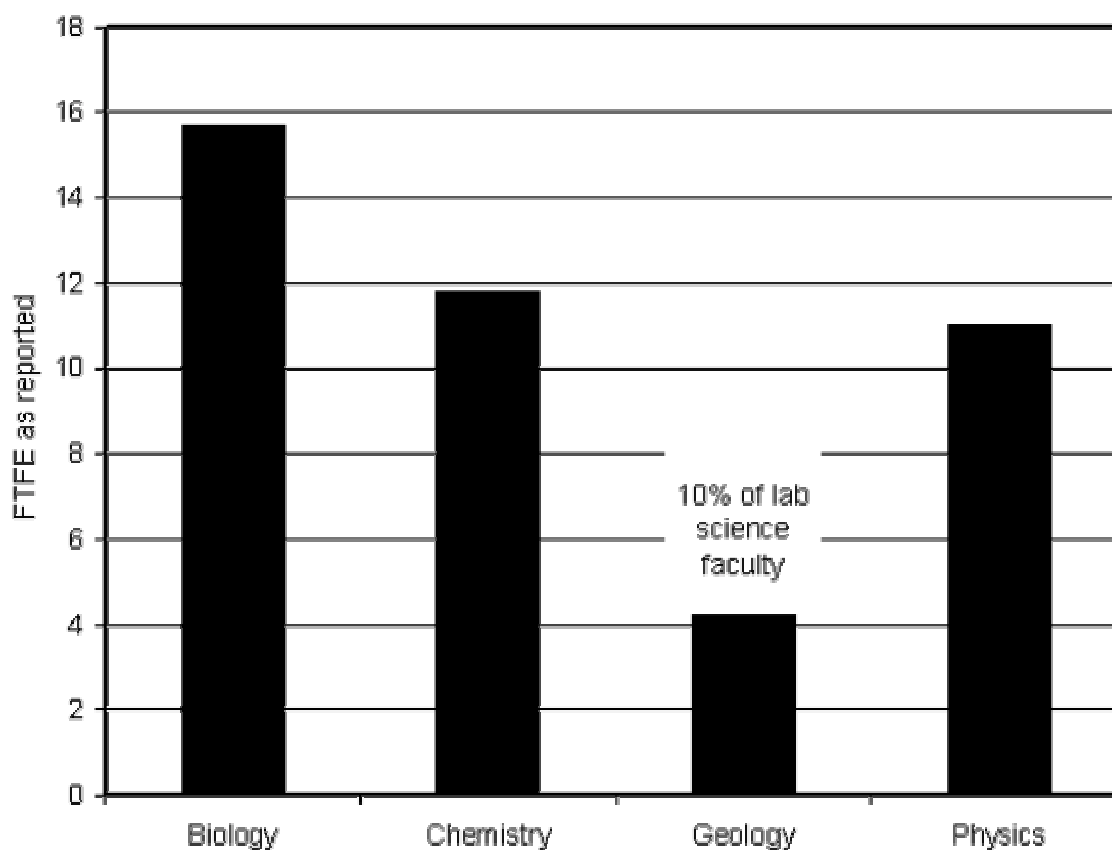


Figure 5. Number of FTFE (full-time faculty equivalents) in each of the lab science departments, based on data in the 1998 report of the AAC Subcouncil on Tenure Line Allocation.

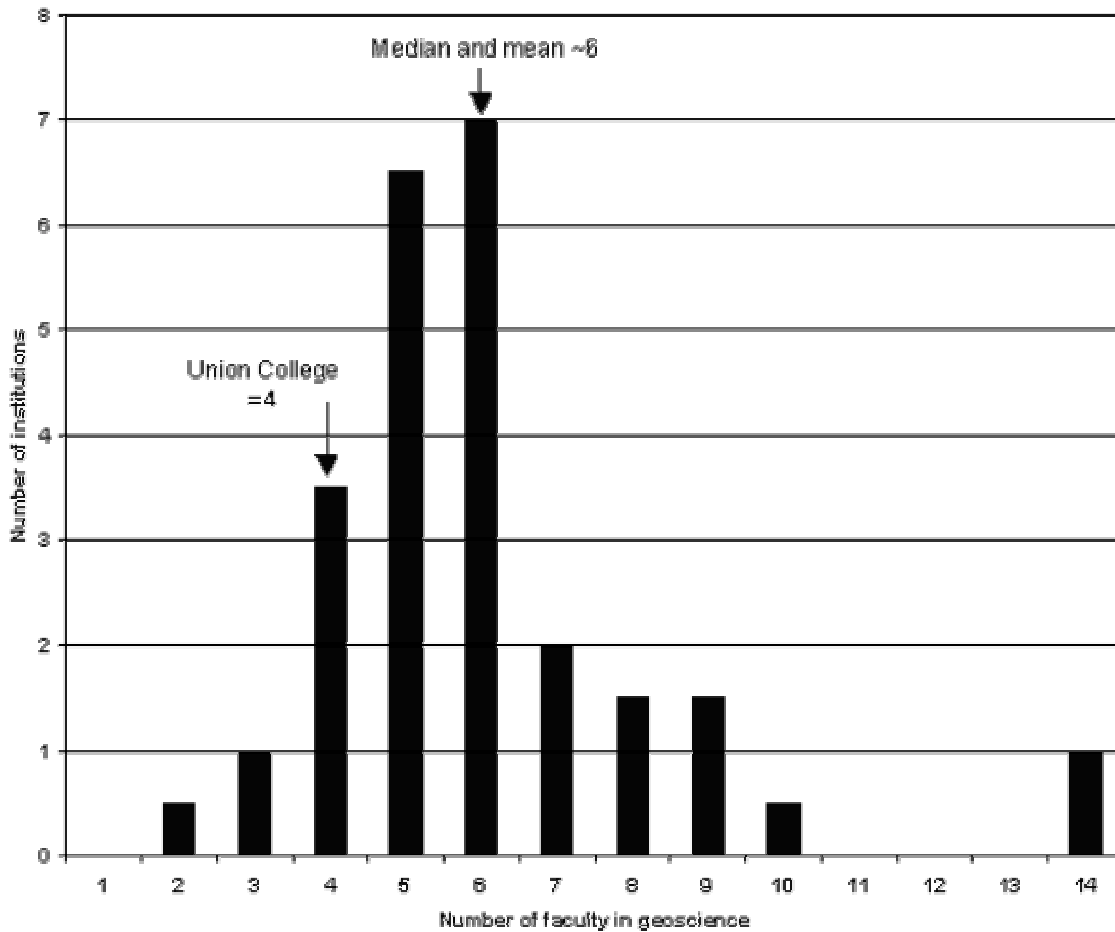


Figure 6. Number of geoscience faculty at the 25 peer geoscience programs, excluding visitors, emeritus, research, associated, and adjuncts, *but including lecturers and instructors as 0.5 faculty*. Also included are geography faculty that had at least modest teaching and research in geoscience fields. Data are from Table 2.

Explanation: The bars are located only at integer positions. Departments having calculated fractional faculty were split evenly between the two adjacent integer positions. For example, a department with calculated 2.5 faculty counted as 0.5 institutions with 2 faculty and 0.5 institutions with 3 faculty.

Table 1. Absolute numbers of faculty and numbers of enrolled students in different categories. Geology, with ~10% of the lab science faculty, exceeds 10% of the students in all categories showing that Geology is teaching a more than ample share of students and is doing a good job offering accessible introductory level courses.

	Biology	Chemistry	Geology	Physics		Biology	Chemistry	Geology	Physics
FTFE (1998 AAC subcouncil report)	15.7	11.8	4.2	11		37%	28%	10%	26%
Total enrolled students, all lab and lecture sections (see Figure 1)	1433	1054	470	733		39%	29%	13%	20%
Total enrolled students, all lecture sections only (see Figure 2)	859	554	313	522		38%	25%	14%	23%
Center 1 majors, lecture sections only (see Figure 3)	207	84	156	125		36%	15%	27%	22%
Center 1 majors, lecture sections of courses without prerequisites (see Figure 4)	127	19	149	87		33%	5%	39%	23%

Table 2. List of the 25 peer geoscience programs examined, and the number of full time faculty in the programs as shown in Figure 5 (data compiled in April, 2002, from college catalogs, the on-line American Geological Institute Directory of Geoscience Departments, and departmental web pages).

The 25 peer geoscience programs we compared Union Geology to	Full-time faculty: excludes visitors, emeritus, research, associated, adjuncts, lecturers, and instructors	Instructors and lecturers	Total with instructors and lecturers counted as 0.5 faculty
Lehigh	14	0	14.0
Colgate	9	1	9.5
Franklin & Marshall	9	0	9.0
Wesleyan University	8	0	8.0
Smith	7	1	7.5
R.P.I.	7	0	7.0
Bucknell	6	1	6.5
Amherst	6	0	6.0
Carleton College	6	0	6.0
Hobart & William Smith	6	0	6.0
Middlebury	6	0	6.0
Mt. Holyoke	6	0	6.0
Williams	6	0	6.0
Vassar	5	1	5.5
Hamilton	5	0	5.0
Oberlin	5	0	5.0
Skidmore	4	2	5.0
St. Lawrence	5	0	5.0
Trinity University	5	0	5.0
Bates	4	1	4.5
Colby	4	1	4.5
Union College	4	0	4.0
Dickinson College	4	0	4.0
Lafayette	4	0	4.0
Bowdoin	3	1	3.5
Wellesley College	2	1	2.5

Table 3. Courses not offered at Union College that are recommended by industry, popular at peer geoscience programs, or needed as determined by Union Geology faculty.

Level	Course titles	Course recommendations from the following perspectives					Importance, Union Geology	
		Petroleum industry	Environmental industry	Mining industry	Peer programs	Union Geology		
Introductory level courses (suggested courses, no one of which is critical)	Geologic hazards and society, meteorology, dinosaurs, mineral resources and society, etc.	Standard <i>lab-intensive</i> courses considered best.			Peer programs have a wide selection of intro courses	We perceive that there are needs for these courses	Geo majors, Ed. Studies, Environmental Studies, and GenEd	
	Economic geology	✓		✓	✓	✓	1	
	Hydrogeology		✓	✓	✓	✓ ^C	2	
	Climate change				✓	✓	3	
	Tectonics				✓	✓	4	
	Geographic information systems		✓ ^B	✓	✓	✓ ^C	5	
	Remote sensing	✓			✓	✓ ^D	6	
	Paleontology	✓			✓	✓	7	
	Mid-level courses, all of which are important	Sedimentary petrology	✓				✓	8
		Advanced environmental				✓		
Advanced oceanography					✓			
Advanced regional geology					✓			
Geostatistics				✓				
Instrumentation					✓			
Optical mineralogy		✓				✓ ^A		
Quaternary geology					✓			
A) ~1/5 course taught as part of Mineralogy.								
B) Strongly recommended by our recent graduates.								
C) Currently taught by adjuncts.								
D) Currently taught by a visitor.								

Table 4. We should be teaching eight new upper level courses to fill major curriculum gaps in the current geoscience curriculum. Several of these courses have application to other sciences or social sciences, and we expect the people hired to teach these courses will also be able to offer introductory and other courses of interest to various departments and programs besides those listed here. This is an expanded description of the eight new courses enumerated in Table 3.

Course title	Explanation
1) Economic geology	A major gap in our curriculum, importance is increasing with population growth and economic development of China and other nations. Of particular interest to Environmental Studies, Chemistry and Economics majors.
2) Hydrogeology	A major gap in our curriculum, importance increasing with population growth, industrialization, and climate change; vital for the large environmental industry employment field. Of particular interest to Environmental Studies, Chemistry, Economics, and Sociology majors.
3) Climate change	A major gap in our curriculum, a popular field for students and graduate schools, wide public and political interest. Of particular interest to Environmental Studies, Physics, and social science majors generally.
4) Tectonics	A major gap in our curriculum, vital for understanding basic aspects of geology, important for resource exploration, understanding natural hazards and Earth history. Of particular interest to Environmental Studies and possibly Physics majors.
5) Geographic information systems (GIS)	A major gap in our curriculum, of major importance in land use planning, resource exploration, geologic mapping, environmental monitoring, and social statistics. Of particular interest to Biology, Environmental Studies, and social science majors generally.
6) Remote sensing	A major gap in our curriculum needed for well-rounded, experienced geology graduates. Of particular interest to Biology, Physics, Environmental Studies, and social science majors having interests in how Earth surface conditions affect people (e.g., floods, droughts, desertification, military intelligence, urban growth).
7) Paleontology	A major gap in our curriculum, vital for climate record study, petroleum exploration, geologic mapping, stratigraphic correlation; recent students have gone elsewhere to learn; important for many graduate school interests. Of particular interest to Biology majors, but there is likely to be a general interest as well.
8) Sedimentary petrology	A major gap in our curriculum valuable for exploration and production geology, for climate change work, and for the environmental fields. Of particular interest to Biology and Environmental Studies students.