June 7, 2000

TO:      A. L. WILLIAMS, CHAIR  
          CNAS EXECUTIVE COMMITTEE  

FR:      IRWIN W. SHERMAN, CHAIR  
          RIVERSIDE DIVISION  

RE:      DELETION OF THE B.A. AND B.S. DEGREES IN GEOGRAPHY AND THE B.A. DEGREE IN  
          GEOLOGY  

Acting on behalf of the Riverside Division, the Advisory Committee approves and endorses the above referenced proposal.

   c:  M. T. Clegg, Dean, CNAS  
       M. O. Woodburn, Chair, Department of Earth Sciences  
       S. Stracener, CNAS Student Affairs
Executive Committee

College of Natural and Agricultural Sciences

Report to Riverside Division
November 7, 2000

To be adopted:
Incorporate Biogeography option into Geology major
Change name of Paleontology option to Geobiology option
Delete Geography major and Geomorphology option
Delete B.A. degree in department
Proposed changes to requirements for the B.S. degree in Geology

Present

MAJORS

The Department of Earth Sciences offers Bachelor of Arts degree in Geography and in Geology and Bachelor of Science degrees in Geography, Geology, and Geophysics. The B.S. degree programs are designed for students with a strong interest in the sciences who, after consultation with the undergraduate advisor, wish to emphasize this aspect of their education more extensively than is possible with the B.A. program. The programs in the Department of Earth Sciences place substantial emphasis on field work with field courses, field trips in all appropriate courses, and excursions between quarters.

The Department of Earth Sciences offers the M.A. and M.S. in Geography, the M.S. in Geological Sciences, the Ph.D. in Geography, and the Ph.D. in Geological Sciences.

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<th>Program</th>
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<tr>
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<td>Geophysics</td>
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ACADEMIC ADVISING
No change

TEACHING CREDENTIAL
No change

GEOGRAPHY MAJOR

Proposed

MAJORS

The Department of Earth Sciences offers Bachelor of Science degrees in Geology, and Geophysics. These B.S. degree programs are designed for students with a strong interest in various aspects of the Earth sciences. The programs in the Department of Earth Sciences place substantial emphasis on field work with field courses, field trips in all appropriate courses, and excursions between quarters.

The Department of Earth Sciences offers the M.A. and M.S. in Geography, the M.S. in Geological Sciences, the Ph.D. in Geography, and the Ph.D. in Geological Sciences.

DELETED

ACADEMIC ADVISING
No change

TEACHING CREDENTIAL
No change

GEOGRAPHY MAJOR

DELETED
The Geography Program offers two options for students who have a broad interest in Earth surface systems: Biogeography and Geomorphology. Spatial and temporal variations in physical phenomena and human activities, their interactions, and the processes producing spatial distributions are major concerns of geography. Geographers study such topics as climate and climatic change, processes in the evolution of landforms, ecology, distribution, and conservation of plant and animal species; the human use of the natural environment; and processes of urban growth and decline.

**BIOGEOGRAPHY OPTION**

Students fulfilling the Biogeography option study the distribution, structure, dynamics, and conservation of natural communities and ecosystems. Biogeography has foundations both in biological and earth sciences. The biogeography of species is studied to determine evolutionary and dispersal history over long time scales (see paleontology under Geological Sciences, below). Geographers investigate local and regional distributions in relation to the contemporary environment and impacts by people. Biogeographers also examine strategies which attempt to protect ecosystem and species diversity by integrating ecosystem management into human-impacted landscapes. Students in this option receive training in ecology, vegetation analysis, resource conservation, and management of natural lands.

**GEOMORPHOLOGY OPTION**

Students who choose the Geomorphology option study the nature and spatial pattern of landforms in relation to tectonics and the contemporary physical processes of weathering, erosion, and deposition. The ages of land features are evaluated to infer erosional and depositional histories and their relationship to climatic and tectonic change. Students who undertake this option obtain practical training in the evaluation of natural hazards in relation to land use and planning.

**GEOLOGY MAJOR**

The department offers two options for the Geology major: General Geology and Paleontology. Students who choose the Geology major study the structure, composition, and history of the earth, and in particular, its crust—the earth's immediate surface and underlying rocks. Geologists examine rocks and minerals in order to formulate and test theories on natural processes affecting the earth and to explore for mineral resources. They may also study fossil remains of animals and plant life and observe the flow of fluids and gases through...
rocks to determine the ages and rates of change of various parts of the earth’s crust, as well as the possibility of oil and gas deposits. They contribute to environmental impact studies by examining the effects of wind, water, earthquakes, landslides, or volcanic action on landforms. Geologists also determine sources of ground water and possible contamination effects.

General Geology Option
Students entering the General Geology option study the nature, distribution, age and origin of minerals, rocks and their contained fossils, placed within a global framework of the Earth as an evolving geologic system. The option entails a broad range of geologic training including geology, geophysics, geochemistry and paleontology. An emphasis is also placed on field work (mapping, sampling) and thoughtful analysis of geologic data (including statistical and graphical analysis with computers). Though broadly-based, the option provides the student some flexibility to pursue specific geologic areas of interest at the upper division level. Graduates of the General Geology option are qualified to pursue almost any professional career in the Earth Sciences, and are well-suited to tackle graduate research at the M.S. or Ph.D. level.

Geobiology Option
The Geobiology option offers broad-based geological training combined with a special emphasis on paleontology and organism/time interactions. Students take the geology core, but at the undergraduate upper-level focus on courses related to the fossil record, evolution and biodiversity, sedimentology, stratigraphy, and biogeography. The graduate will leave with a marketable geology degree coupled with special insight into historical aspects of life’s place and role on this planet.

Biogeography Option
Students entering the Biogeography option study spatial and temporal distribution, structure, dynamics and conservation of natural communities and ecosystems. Biogeography has foundations both in biological and earth sciences. The biogeography of species is studied to determine evolutionary and dispersal history over long time scales as well as recent, local and regional distributions in relation to our contemporary environment and impacts by people. Students in this option receive training in ecology, vegetation analysis, resource conservation and management of natural lands.
In both lower- and upper-division courses, the curriculum in Geography provides an overview of the earth sciences. Students are required to take an analytical course series in remote sensing and geographic information systems, which have become essential tools in geographic research. Students must also develop complementary background in either statistics, computer science, or calculus. Usually by the sophomore year, students must have selected a curriculum option. In each option, students must fulfill required and elective courses from outside the major and within upper-division Geosciences.

The following are the requirements for the Bachelor of Arts and the Bachelor of Science degree in Geography. Students must complete the core requirements and choose one option.

**Core requirements (20 units)**
1. Lower-division requirements: GEO 001, GEO 002, GEO 006
2. Upper-division requirements: GEO 156, GEO 157

**Option requirements**

1. Biogeography Option
   a) BIOL 005A, BIOL 005B, BIOL 005C, BIOL 017
   b) PHYS 040A-PHYS 040B-PHYS 040C
   c) CHEM 001A-CHEM 001B-CHEM 001C
   d) MATH 009A-MATH 009B
   e) Four (4) units from STAT 100A or STAT 120A
   f) BPSC 146
   g) GEO 003/BIOL 010, GEO 158, GEO 160, GEO 162A, GEO 167, GEO 168A, GEO 168B
   h) For the BS: 16 units related to the major from ANTH 116A-ANTH 116B, ANTH 132, BIOL 105, BIOL 118, BIOL 163, BPSC 143/BIOL 143, ENSC 100, ENSC 163, GEO 151, GEO 152/BIOL 152, SWSC 102

2. Geomorphology Option
   a) CHEM 001A-CHEM 001B-CHEM 001C
The course requirements are the same for the B.A. and the B.S. degrees in Geology. All courses in Geosciences that are prerequisites for other courses in the major must be passed with a grade of "C-" or better before proceeding in the sequence. For example, GEO 001 is a prerequisite for GEO 030.

The Department offers two options to majors in Geology: General Geology and Paleontology. All students majoring in Geology are normally required to take the core curriculum common to both options. In addition, they must fulfill the requirements of either the General Geology option or the Paleontology option.

### Core requirements

1. BIOL 002 or BIOL 005A
2. PHYS 040A-PHYS 040B-PHYS 040C
3. MATH 009A, MATH 009B-MATH 009C
4. CHEM 001A-CHEM 001B-CHEM 001C
5. GEO 001, GEO 003/BIOL 010, GEO 030, GEO 101, GEO 102, GEO 116, GEO 118

### Option requirements

1. General Geology Option
   a) GEO 123, GEO 124, GEO 125

### GEOLGY

All courses in Geosciences that are prerequisites for other courses in the major must be passed with a grade of "C-" or better before proceeding in the sequence. For example, GEO 001 is a prerequisite for GEO 030.

The department offers three options to majors in Geology: General Geology, Geobiology and Biogeography. All students majoring in Geology are normally required to take a core curriculum. Both General Geology and Geobiology options require the Geology core curriculum presented below. The Biogeography option utilizes the Life Sciences core curriculum, enhanced by inclusion of required and optional Geology coursework as indicated below.

#### General Geology and Geobiology options

**Lower-division Core Requirements:**

1. GEO 001, GEO 002, GEO 003/BIOL 010, GEO 020, GEO 030
2. BIOL 002 or BIOL 005A
3. CHEM 001A-CHEM 001B-CHEM 001C
4. MATH 009A, MATH 009B, MATH 009C
5. PHYS 040A, PHYS 040B, PHYS 040C

**Upper-division Core Requirements:**

GEO 100, GEO 101, GEO 102, GEO 116, GEO 157, GEO 180

**Upper Division Option Requirements:**

1. General Geology Option
   a) One course from GEO 118, GEO 160, GEO
b) Four courses from GEO 120, GEO 126, GEO 132, GEO 137, GEO 139, GEO 140, GEO 141, GEO 151, GEO 152/BIOL 152, GEO 162A, GEO 162B

161, GEO 162

b) One course from GEO 123, GEO 124, GEO 132, GEO 137

c) GEO 002 and GEO 107 are recommended

c) One course from GEO 140, GEO 141, GEO 145

d) One course from GEO 151, GEO 152, GEO 153

e) Sixteen (16) additional units of upper-division related courses approved by the Undergraduate Advisor

Paleontology Option

a) GEO 120, GEO 137, GEO 151, GEO 152/BIOL 152

b) BIOL 003 or BIOL 005B, BIOL 005C, BIOL 102, BIOL 105

c) GEO 002 and BIOL 117 are recommended

c) GEO 002 and BIOL 117 are recommended

d) One course from GEO 151, GEO 152, GEO 153

e) Sixteen (16) additional units of upper-division related courses approved by the Undergraduate Advisor

2. Geobiology Option

a) GEO 118

b) Three (3) courses from: GEO 151, GEO 152, GEO 153, GEO 168A or 168B

c) Sixteen (16) additional units of upper-division related courses approved by the Undergraduate Advisor

c) Sixteen (16) additional units of upper-division related courses approved by the Undergraduate Advisor

2. Biogeography Option

The Biogeography option utilizes the Life Sciences core curriculum, enhanced by inclusion of both required and optional Geology coursework as indicated below.

Lower-division Requirements:

1. GEO 001, GEO 002, GEO 003/BIOL 010
2. BIOL 005A, BIOL 005B, BIOL 005C
3. CHEM 001A, CHEM 001B, CHEM 001C
4. MATH 009A, MATH 009B
5. PHYS 002A, PHYS 002B, PHYS 002C, PHYS 002LA, PHYS 002LB, PHYS 002LC, or PHYS 040A, PHYS 040B, PHYS 040C
6. One of STAT 100A or STAT 120A

Upper-division Requirements:

1. GEO 157, GEO 167, GEO 168A, GEO 168B
2. CHEM 112A, CHEM 112B, CHEM 112C
3. One of BCH 100 or BCH 110A
4. Two (2) courses from GEO 151, GEO 152, GEO 153
5. Two (2) courses from GEO 160, GEO 161, GEO 162
6. Sixteen (16) additional units of upper-division related courses approved by the Undergraduate Advisor

Sample Program

DETECT
Justification for Biogeography Option in the Geology Major

The department has faculty to cover the proposed biogeography option. This option has been modified for students well versed in the biological sciences who wish to major in biogeography, including its subcomponents landscape ecology and the conservation of biological resources. We have modified requirements from the previous catalogue version. The biogeography option adopts the Life Science Core Curriculum. It also requires GEO 001, 002, and 003, Geographic Information Systems, a series of courses in biogeography/landscape ecology/conservation, paleontology, and two courses in geomorphology/atmospheric science. The biogeography option gives flexibility in the fundamental background we desire from Earth Science students, to attract students as majors, and compliments Geobiology in the Department.

Justification for Geobiology Option

We justify replacing the current "Paleontology concentration" with a new "Geobiology Option" for three reasons:
1. It brings the option into line with the new core curriculum of the Geology major.
2. It better reflects current faculty strengths. The retirement of Dr. Woodburne and arrival of Dr. Hughes has shifted emphasis on undergraduate teaching from vertebrate paleontology toward invertebrate paleobiology.
3. It better reflects nationwide trends in the integration of geological and biological sciences, building a geographic and temporal framework for analysis of biodiversity.

Justification for Deletion of the Geography major

The Geography major has declined in previous years due to faculty retirement. No faculty in the Department of Earth Sciences desires to be associated with the Geography discipline. The remaining strengths of the Geography major (Biogeography option) have been incorporated into the Geology major. The proposal thus simplifies departmental structure without any losses of student programmatic flexibility. In fact, unification of these two majors should be of benefit to our students.

Justification for Deletion of B.A. Degree Option

Within the Earth Sciences department, Bachelor of Arts degrees have been routinely offered in both the Geology and Geography majors. These options have not been utilized within the memory of anyone within our department, and we are proposing the incorporation of the presently existing Geography major within the Geology major (as the Biogeography option). Deletion of the B.A. degree appears justifiable by the lack of demand both from students and from the marketplace where are students traditionally have been placed after graduation.

Justification of Changes to the Geology Major

The undergraduate core curriculum in Geological Sciences traditionally has been centered on providing a basic educational background suitable for: a) professional careers in the exploration and production of nonrenewable geologic resources (i.e., petroleum geology and mining geology) and b) careers in academia and government research. In the past decade, however, we have seen a significant diversification in the career paths of most of our undergraduate majors.

In the professional career track, traditional oil and mining company jobs have been supplemented by new employment opportunities in the environmental monitoring and remediation aspects of earth science. In particular,
there are now a larger number of local and regional geological firms performing contract-based consulting on multi-
year projects.

In the academia and government research realm, traditional employment opportunities with large universities and
federal/state agencies have likewise been supplemented by new employment opportunities in local community
college and school districts, in local governments, and in local agencies responsible for resource management and
planning.

In concert with these new employment trends, our undergraduates have needed increased coursework in earth
surface processes, environmental geology, and computer aided data processing and analysis. Unfortunately, the
somewhat ad hoc addition of these new courses to our traditional curriculum has had an unintended effect on our
average course enrollments: we now have too many courses for our majors, with the result that our faculty spend
time teaching each course to too few students.

In order to respond to society’s changing needs for earth scientists, and in order to make our teaching more efficient
and effective, we seek to substantially revise and consolidate our undergraduate curriculum. The proposed revisions
are designed to yield a more coordinated set of core courses that will prepare our undergraduates for the increased
diversity of careers.

Some of our traditional core courses will be eliminated or consolidated into a fewer number of core courses, or they
will be listed as optional courses. Some courses that were once viewed as essential will become optional, and some
new courses now viewed as essential will become part of the core curriculum.

Summary of Proposed Changes to the Geology Major

The most dramatic proposed change in our curriculum is the condensation of the current sequence of core courses
GEO 30, 118, 123, 124 and 125. This 5-quarter sequence focused on the mineralogy and petrology of rocks as
optimized for careers in oil and mining and careers in academia, requiring detailed mastery of the polarizing optical
petrographic microscope. The essential elements of this former sequence are being condensed into a revised core
requirement of GEO 30 (mineralogy) and a new course GEO 100 (introductory petrology). The more advanced
aspects of mineralogy and rock genesis are now placed in the optional revised courses GEO 118 (sedimentology and
stratigraphy), 123 (advanced mineralogy) and 124 (advanced petrogenesis). The goal is to place less emphasis on
the optical microscope and allow more room for essential training in surficial geology and geographic information
systems (GIS).

In addition, we have recast our entire pool of optional courses into a cluster of four related topical groups, requiring
that each undergraduate take at least one course from each group. This solves a current breadth problem with our
curriculum, whereby geology undergraduates could obtain a degree with somewhat narrow training in the major
sub-disciplines of earth science. The new groups are designed to insure that each undergraduate receives suitable
breadth of training in all the major areas of the earth sciences.

Another concern with the former curriculum has been the long time gap between when a student takes calculus
(typically as freshman) and when a student learns how to apply it rigorously to earth science problems (typically as a
junior or senior). This time gap often results in a student’s reticence or uneasiness in making mathematical (and
statistical) manipulations of geologic data. Part of this reticence also follows from the inherently pure (non-applied)
nature of most calculus courses. To resolve this issue we have designed the new applied numerical methods course,
GEO 20, which will teach students how to apply mathematical and statistical techniques to common problems in
earth science, immediately after they have taken calculus. Students should take this core course in their sophomore
year.

Another issue has been the growing use of computers for database manipulation and management in the earth
sciences. We view it as essential that each graduate feel comfortable with using workstations, digitizers and plotters
to input, manipulate, analyze and depict data. For this reason we have made the formerly optional course GEO 157
(Automated Geographic Information Systems) a core required course for all of our undergraduates. In addition, the
new course GEO 20 incorporates training in computational resources into its syllabus. The result should be
graduates who are very comfortable using computers as a routine tool in scientific investigations.
Finally, our undergraduates have often finished their training without revisiting the topic of how all aspects of the earth sciences can be integrated into an understanding of the Earth as a dynamic system in space and time. They may start out with this viewpoint as wide-eyed freshmen in GEO 001-002-003, but by the time they are seniors their training has become somewhat compartmentalized and specialized. The goal of the new senior seminar course GEO 180 is to provide a concluding capstone course, reintegrating their training into a coherent view of the Earth as a system. They will typically take this course in their last quarter.

Effective: Fall 2000

Approved: Earth Sciences faculty meeting: January 12, 2000
Approved: CNAS Executive Committee: January 25, 2000
Approved: Committee on Educational Policy: April 6, 2000
Approved: Advisory Committee, Acting on behalf of the Riverside Division: 6/7/2000