To be adopted:

Proposed Changes to Geology Major Requirements

**Present:**

**Majors**
The Department of Earth Sciences offers B.S. degrees in Geology and Geophysics, and a B.A. degree in Geoscience Education. These degree programs are designed for students with a strong interest in various aspects of the Earth Sciences, and for students interested in secondary teaching with a science emphasis. The B.S. programs place substantial emphasis on fieldwork with field courses, field trips in all appropriate courses, and excursions between quarters. The B.A. degree places emphasis on the fundamentals of geoscience, with additional coursework in education.

**Teaching Credential and B.A. in Geoscience Education**
Teachers in the public schools in California must have a credential approved by the State Commission on Teacher Credentialing. The credential requires an undergraduate major, baccalaureate degree, and completion of a graduate credential program such as that offered by the Graduate School of Education at UCR.

Before admission and student teaching in a graduate credential program, the candidate must pass the California Basic Education Skills Test (CBEST) and demonstrate subject-matter proficiency by passing an examination. All candidates for a multiple subject credential to teach in the elementary grades must pass the Multiple Subjects, California Subject Exam for Teachers (CSET). Students are urged to start early, preferably as freshmen, selecting courses most helpful for this career. Details and counseling on the Prepare to Teach Program, a program for the multiple subject credential, are available in the Office of Interdisciplinary Programs, 2417 Humanities and Social Sciences.

**Proposed:**

**Majors**
The Department of Earth Sciences offers B.S. degrees in Geology and Geophysics. These degree programs are designed for students with a strong interest in various aspects of the Earth Sciences, and for students interested in secondary teaching with a science emphasis. The B.S. programs place substantial emphasis on fieldwork with field courses, field trips in all appropriate courses, and excursions between quarters.

**Teaching Credential**
(No Change)
Details and counseling on other programs are available in the Department of Earth Sciences or the Graduate School of Education.

UCR does not yet have a state-approved subject matter undergraduate program for earth science majors who wish to teach at the secondary level. The Teaching Credential in Science, geoscience authorization, is required for teachers who want to teach earth science/geoscience in middle school and high school. Students who plan to get this credential must take the CSET exams in Geosciences and should make certain their academic program includes preparatory course work. The Earth Sciences

Earth Science students interested in a secondary school science teaching career, who intend to obtain a Teaching Credential in Science, geoscience authorization, are encouraged to pursue the B.A. degree in Geoscience Education. This degree will best prepare such students for the state credentialing examinations, but is not intended for those students who wish to become professional geologists. Students who want to have the option to become either a professional geoscientist or to teach earth science in secondary schools should pursue both the B.S. in General Geology as well as the teaching credential from the Graduate School of Education.

Students in CNAS who intend to pursue a Teaching Credential in Science, with authorization in another science, should consider pursuing a Minor in Earth Sciences.

**Geoscience Education Major**

Students who chose the B.A. degree in Geoscience Education intend to teach earth science and general science at the secondary school level. Students receive Freshman- and Sophomore-level training in General Geology, training in introductory Biology, and Freshman-level training in Chemistry, Calculus, and Physics. They also take courses in Education that are required for state examinations and teacher credentialing in California. The B.A. in Geoscience Education degree is designed for prospective secondary science teachers; it will not lead to a career as a professional geologist.
Students who want to have the option to become either a professional geoscientist or to teach earth science in secondary school should pursue both the B.S. in General Geology as well as the teaching credential from the Graduate School of Education.

**Change of Major and Continuation Criteria**

Students wishing to change into or continue in the Geology major must be in good academic standing and show potential to graduate without exceeding 216 units.

**Freshmen (2nd and 3rd quarter)** must demonstrate progress in basic sciences and aptitude for geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- MATH 009B eligible (e.g. completion of MATH 9A or MATH 8B with grades of C- or better)
- CHEM 001B eligible (e.g. completion of CHEM 1A with a grade of C- or better)
- One of GEO 001, GEO 002, and GEO 003 completed with a grade of C- or better

**Sophomores** (up to 89.9 cumulative units) must demonstrate sustained progress in basic sciences and aptitude for geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- CHEM 001C completed with passing grades
- MATH 009C eligible (e.g. MATH 9B with grade of C- or better)
- Two of GEO 001, GEO 002, and GEO 003 completed with no grade below C- after repeats

**Juniors** (90 – 134.9 units) must demonstrate near completion of basic sciences and aptitude for upper-division geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- CHEM 001C and MATH 009C completed with passing grades
- PHYS 040B or PHYS 002B and PHYS 002LB eligible (i.e. completion of one quarter of college physics with C- or better)
- GEO 002, GEO 003, and GEO 115 or GEO 122 (and all prerequisites) completed with no grade below C- after repeats

**Freshmen (2nd and 3rd quarter)** must demonstrate progress in basic sciences and aptitude for geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- MATH 009B eligible (e.g. completion of MATH 9A or MATH 8B with grades of C- or better)
- CHEM 001B eligible (e.g. completion of CHEM 1A with a grade of C- or better)
- One of GEO 001, GEO 002, or GEO 003 completed with a grade of C- or better

**Sophomores** (up to 89.9 cumulative units) must demonstrate sustained progress in basic sciences and aptitude for geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- CHEM 001C completed with passing grades
- MATH 009C or MATH 046 eligible (e.g. MATH 9B with grade of C- or better)
- Two of GEO 001, GEO 002, or GEO 003 completed with no grade below C- after repeats

**Juniors** (90 – 134.9 units) must demonstrate near completion of basic sciences and aptitude for upper-division geology by satisfying the following three criteria by Spring Quarter or Summer Session:

- CHEM 001C and MATH 009C or MATH 046 completed with passing grades
- PHYS 040B or PHYS 002B and PHYS 002LB eligible (i.e. completion of one quarter of college physics with C- or better)
- GEO 002, GEO 003 and GEO 115 or GEO 122 (and all prerequisites) completed with no grade below C- after repeats
Seniors (135+ units): must have completed all but 1 course of the geology core requirements by Spring Quarter or Summer Session, as follows:

- CHEM 001C, MATH 009C, and PHYS 040C or PHYS 002C and PHYS 02LC completed with passing grades.
- BIOL 002 or BIOL 005A and BIOL 05LA, and STAT 100A or STAT 155 completed with passing grades.
- GEO 001, GEO 003, GEO 115, and GEO 122 or GEO 101 (and all prerequisites) completed with no grade below C- after repeats.

Transfer Selection Criteria

Applicants to majors in the College of Natural and Agricultural Sciences are selected on the basis of academic preparation, as assessed by their GPA and the strength of preparation for the intended major. A GPA of at least 2.70 is required. (This is a baseline GPA for consideration and not a guarantee of admission.)

In addition, applicants will need to complete college courses comparable to at least two of the following UCR year-long sequences in order to meet selection criteria for this major. Courses must be completed with “C” grades or better:

MATH 009A, MATH 009B, and MATH 009C (mandatory)

And at least one sequence from:

1. BIOL 005A/Biol 05LA and BIOL 005B (and BIOL 005C, if articulated)
2. CHEM 001A, CHEM 01LA, CHEM 001B, CHEM 01LB, CHEM 001C, and CHEM 01LC
3. PHYS 040A, PHYS 040B, and PHYS 040C
4. MATH 010A, MATH 010B, and MATH 046

Courses must be completed with a letter grade, with no grade lower than a “C.” Students should visit assist.org for updated and comprehensive major preparation.

Major Requirements
Geology Major
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 122.

The department offers four options to majors in Geology: General Geology, Geobiology, Geophysics, and Global Climate Change. All students majoring in Geology are normally required to take the core curriculum.

General Geology, Geobiology, Geophysics, and Global Climate Change Options
Core Requirements (72-74 units)
1. Lower-division requirements (58-59 units)
   a) GEO 001, GEO 002, GEO 003/BIOL 010
   b) BIOL 002 or both BIOL 005A and BIOL 05LA
   c) Either CHEM 001A and CHEM 01LA or CHEM 01HA and CHEM 01HLA, either CHEM 001B and CHEM 01LB or CHEM 01HB and CHEM 01HLB, either CHEM 001C and CHEM 01LC
   d) MATH 008B or MATH 009A, MATH 009B, MATH 009C
   e) PHYS 040A, PHYS 040B, PHYS 040C
2. Upper-division requirements (19-20 units)
   a) GEO 101, GEO 115, GEO 122
   b) STAT 100A OR STAT 155

Global Climate Change Option (59 units)
1. Lower-division requirements (20 units)
   a) BIOL 005B, BIOL 005C
   b) GEO 009, GEO 010 and GEO 011
2. Upper-division requirements (39 units)
   a) GEO 118, GEO 136 or GEO 137, GEO 152 or GEO 153, GEO 157, GEO 160, GEO 169
   b) Fourteen (14) units of related upper-division course approved by the undergraduate advisor

General Geology Option (58 units)
1. GEO 100, GEO 116, GEO 118, GEO 123
2. GEO 102A (44 units in one quarter), or GEO 102A and GEO 102B (44 units in
two quarters), or GEO 102A, GEO 102B, and GEO 102C (44 units in three quarters). 
3. One course from GEO 157, GEO 160, GEO 161, GEO 162, GEO 169
4. One course from GEO 124, GEO 132, GEO 136, GEO 137
5. One course from GEO 140, GEO 144, GEO 145, GEO 147.
6. GEO 151 or GEO 152/BIOL 152
7. Eight (8) additional units of related upper-division courses approved by the undergraduate advisor

Geobiology Option (58 units)
1. BIOL 005B, BIOL 005C
2. GEO 100, GEO 116, GEO 118, GEO 123
3. GEO 102A (44 units in one quarter), or GEO 102A and GEO 102B (44 units in two quarters), or GEO 102A, GEO 102B, and GEO 102C (44 units in three quarters)
4. Three courses from GEO 151, GEO 152/BIOL 152, GEO 160, GEO 169
5. Four (4) additional units of related upper-division courses approved by the undergraduate advisor

Geophysics Option (55 units)
1. MATH 046
2. PHYS 040D, PHYS 040E
3. GEO 116, GEO 118, GEO 132, GEO 140, GEO 144, and GEO 145 or GEO 147
4. Two additional 4-unit upper-division courses in Geosciences
5. Two upper-division physical science courses approved by the undergraduate advisor

Justification: Majors
The Geoscience Education Major was established in 2008 with the hope of attracting a significant number of additional majors into Earth Sciences. This has not proven to be the case: to date only a single student has graduated from that program, and thus our experience shows that the major is not of sufficient attraction to merit continuation. We have not abandoned our mission in this area, and we are presently in the initial stages of discussion with the Education Department centered on their proposal of a Minor in Science Education. Our conviction that in the current employment environment students are better served graduating with the General Geology degree and then moving onto teacher training at the graduate level. Such a course of study provides the students with a wider variety of options than teaching alone, and a better fundamental grounding in geosciences. A number of our graduates have taken this route: the experiment of a geoscience education degree suggests that that students prefer to receive a full training in
geology, prior to obtaining training in education. Accordingly, the Department has voted to remove the Geoscience Education Major after reviewing the results of our 5 year experiment.

**Justification:** Change of Major and Continuation Criteria
A review of the MATH 09C and MATH 046 syllabi conducted by the department following a recent departmental retreat opined that the subject matter of MATH 09C (improper integrals, infinite series, Taylor’s series, and Taylor’s theorem) is less appropriate to students in the Geology degree than the topic covered in MATH 046 (differential equations). Therefore, MATH 046 is a viable and in many cases preferable requirement option. As students taking the PHYS 040 series are required to take MATH 09C, we do not wish to deter students from taking MATH 09C as a class option that fulfills Geology requirements, but our complementary revision of the curriculum allowing students to take the PHYS 002 series as an alternative to the PHYS 040 will provide a route by which students can complete their degrees having taken both MATH 046, and completed the Physics requirement. We are grateful to the Math Department for their active engagement as we deliberated on this issue.

**Justification:** Transfer selection Criteria
- The catalog descriptions indicate that PHYS 002, “General Physics,” is for biological sciences students and PHYS 040, also “General Physics,” is designed for engineering and physical sciences students. The geology major includes geophysical and geobiological options. Our core physics requirements should match that range.
- The two courses have comparable rigor. Credit is awarded for only one of PHYS 002 and PHYS 040. With grades of B in either series, students meet prerequisites for courses in the PHYS 041 course, intended for physics majors. The calculus prerequisites do differ. The calculus prerequisites to complete the PHYS 002 A-C series are MATH 009A and B; to complete PHYS 040A-C series MATH 009A, B and C are required. Geology majors will all complete three quarters of first-year.
- Geology majors will all complete three quarters of first-year calculus, regardless of their physics series.
- The geology major recruits students from several sources, including the biological sciences and engineering. Our core physics requirements should accommodate transfer from these majors. We must already accept PHYS 002 for students who change major after completing a life sciences core curriculum. The same option should be available to all geology majors. Current practice causes needless tensions.
- We seek greater scheduling flexibility. The current physics component of our core curriculum has caused severe scheduling difficulties when the Physics and Astronomy department cancels a section of PHYS 040 in which our students have registered. By accepting PHYS 002 or PHYS 040, we open more scheduling options to our students without placing additional stress on the ability of the Department of Physics and Astronomy to deliver its part of the CNAS curriculum. PHYS 002 brings two other scheduling advantages: the separable lab course and the possibility of completing MATH 009C and PHYS 002C concurrently.
- Most geology majors complete the General Geology track, even though their goals may favor geobiology or geophysics. We must also reckon with geology majors who change tracks before graduation. For these reasons we propose to accept PHYS 002 or PHYS 040 in the core curriculum of all options in the geology major, rather than differentiate the physics requirement by option.

**Justification:** General Geology, Geobiology, Geophysics, and Global Climate Change Options
Although Mineralogy remains a key discipline within Geology, technological advances have diminished the role of some of the skills current taught as part of GEO 123 (Analytical Mineralogy). Accordingly, we now feel that a revised GEO 122 better meets the requirements of the core curriculum, following revision
to introduce some essential elements of GEO 123 as presently taught. The proposed title change of GEO 122 (currently listed as "Introduction to Mineralogy") to "Mineralogy" better reflects this course as the broad and new "one-stop" for geology majors to learn core mineralogy skills (without preventing a course such as a revised GEO 123 "Advanced Mineralogy" from being proposed in the future). Most of the proposed content of GEO 122 is similar to presently taught though emphases will be shifted and some topics will be trimmed to accommodate the greater breadth of material that must now be covered. Changes to the course curriculum will reflect the need to integrate essential content from GEOL 123 (particularly practical optical mineralogy skills), as well as a refined emphasis on practical skills and knowledge (mineral identification, associations, environments, and anthropogenic uses).

Justification: Changing the Maximum Number of Credit Units for GEO 102
This class, commonly referred to as “Summer Field” serves as a capstone experience for those Geology majors in the General Geology option, the Geobiology option, and the Geophysics option. Presently students take the class at one of a variety of external field camps run by other universities where the students undertake field mapping of sedimentary, igneous, and metamorphic rocks. At present a maximum credit of 14 units may be awarded for the class, but the units provided by the camps generally do not exceed 9 units. Accordingly, the undergraduate advisor routinely has to write letters “waiving, without reservation, the 5 unit short fall.” By reducing the maximum number of units to 9 this persistent and time consuming requirement will be avoided.

The decision to rate our own GEO 102 course at 14-units is decades old and necessarily inexact. Students complete hundreds of hours of field work, rated like a lab at 3 hours per unit, plus the seminar-style evening sessions in which they are taught to draft professional maps and reports, which can be variously rated as 1 or 3 hours per unit depending whether the style on any given evening better resembles a lecture, discussion or lab. An alternative calculation considers that some of the field work is an outdoor lecture, with students doing follow-up; this leads to higher unit totals and ignores the presence of instructors at all hours of the course. For a "live-in" field course there may be no easy distinction between a discussion section and "group office hours" or between a lecture and a "working picnic lunch." Colleges inevitably differ in their unit calculation for these courses. Our approximate unit calculations were accepted again by the CNAS executive committee ~3 years ago when Financial Aid experts requested that we revise the course description to give students the option to spread the unit credit over more than one quarter.

Approvals:
Approved by the Department of Earth Sciences: September 26, 2014
Approved by the CNAS Executive Committee: March 13, 2015
Reviewed by the Committee on Undergraduate Admissions: April 27, 2015
Approved by the Committee on Educational Policy: May 5, 2015