SACRAMENTO STATE

Course Change Proposal
Form A

Academic Group (*College*): **Natural Sciences & Mathematics**	Academic Organization (*Department*): **GEOLOGY**	Date: **March 1, 2007**
Type of Course Proposal: New _XX_ Change ___ Deletion ___	Department Chair: **DAVE EVANS**	Submitted by: **DAN DEOCAMPO**
Does this course fulfill a requirement for single-subject or multiple subject credential students? Yes ___ No _XX	For Catalog Copy: Yes _XX No ___ CCE: Yes ___ No ___	Semester Effective: Fall _XX Spring ___, 2007

This course replaces experimental course Subject Area (*prefix*) and Catalog Number (*course number*):	n/a
This Catalog Number (*course number*) is being replaced:	n/a

Change from:

Subject Area (*prefix*) & Catalog No. (*course no.*):	Title:	Units:

Change to:

Subject Area (*prefix*) & Catalog No. (*course no.*):	Title: **Geochemistry**	Units: **4**
GEOL 123/223		

JUSTIFICATION:

The purpose of this course is to provide students with a fundamental understanding of the geochemistry of Earth materials. This will provide a basis for a deeper understanding of geological processes in many different environmental contexts, from the deep interior of the earth to the human environment at the surface. In the professional geological community and in advanced academic settings, familiarity with chemical aspects of geological environments (i.e. igneous, sedimentary, metamorphic, and surficial) is fundamental to geologic problem solving. This will be cross-listed as an undergraduate and graduate course, and will expose undergraduates to more advanced applications carried out by the graduates, while providing a geochemical background for graduate students in their own work.

NEW COURSE DESCRIPTION: (Not to exceed 80 words, and language should conform to catalog copy. See http://www.csus.edu/acaf/univmanual/crspsl.htm - Guidelines for Catalog Course Description

Fundamentals of the geochemistry of Earth materials. Thermodynamics and kinetics of geological environments, silicates and carbonates, major element geochemistry, trace and rare earth element geochemistry, stable and radiogenic isotopes. Applications to studies of aqueous, pedogenic, igneous, sedimentary, and metamorphic environments. Analysis of geochemical aspects of contemporary resource, environmental, and paleoenvironmental problems.

Note: **Lecture 3 hours = 3 units; 170 minutes lab = 1 unit.**

Prerequisite: **CHEM 1A, MATH 30, GEOL 100, or permission of instructor.**

Corequisite:

CAN (California Articulation Number):

Graded: Letter _X_ Credit/No Credit___	Instructor Approval Required? Yes___ No_X_
Course Classification (*e.g., lecture, lab, seminar, discussion*): **Lecture (3 units) and Lab (1 unit)**	Title for SIS+/CMS (not more than 30 characters) **Geochemistry**
Cross Listed? Yes _ X _ No__	If yes, do they meet together and fulfill the same requirement, and what is the other course. Geology undergraduate / graduate cross listing. Will meet together. Students using this course for an undergraduate elective will not be allowed to take it subsequently for graduate credit.

How Many Times Can This Course be Taken for Credit? __1___

Can the course be taken for Credit more than once during the same term? Yes ___ No _X_

FOR NEW COURSE PROPOSALS OR SUBSTANTIVE CHANGES ONLY:

Description of the Expected Learning Outcomes: Describe outcomes using the following format: "Students will be able to: 1), 2), etc." See the example at http://www.csus.edu/acaf/example.htm

Students will be able to
1) Identify geochemical constituents in major igneous, metamorphic, sedimentary, and surficial environments.
2) Identify geological processes controlling geochemical signatures in major igneous, metamorphic, sedimentary, and surficial environments.
3) Interpret variability and identify trends and relationships among geochemical data from geological environments.
4) Identify the timescales of geochemical processes, and relevance to human society.

**Attach a list of the required/recommended course readings and activities [Note: it is understood that these are updated and modified as needed by the instructor(s).] This attachment should be forwarded only to your Dean's office, not Academic Affairs.

Assessment Strategies: A description of the assessment strategies (e.g., portfolios, examinations, performances, pre-and post-tests, conferences with students, student papers) which will be used by the instructor to determine the extent to which students have achieved the learning outcomes noted above:

All students will complete weekly laboratory reports.
There will be mid-term and final examinations.
In addition, graduate students will be required to write an extended literature review paper on a topic in geochemistry.

For whom is this course being developed?

Majors in the Dept _X_ Majors of other Depts __ Minors in the Dept _X_ General Education ___ Other ___

Is this course required in a degree program (major, minor, graduate degree, certificate? Yes __ No _X_

If yes, identify program(s):

Does the proposed change or addition cause a significant increase in the use of College or University resources (lab room, computer facilities, faculty, etc.)? Yes _ X _ No ___

If yes, attach a description of re sources needed and verify that resources are available.

This course will not increase WTU offered by the department because we will offer this course as a geology elective and include it in the rotation of geology elective courses offered. No additional elective sections will be offered in any semester as a result of approving this course. There will, however, be some expenses for lab supplies and expendable materials, which will be paid for by the department operating budget. We will apply for a $20 lab fee for this course. Please see "Laboratory Resources and Expenses" below.

Indicate which department or programs will be affected by the proposed course (if any). _Geology_____

The Department Chair's signature below indicates that affected programs have been sent a copy of this proposal form.

Approvals: If proposed change, new course or deletion is approved, sign and date below. If not approved, forward without signing to the next reviewing authority, and attach an explanatory memorandum to the original copy.

Signatures:		4-9-07 **Date**
Department Chair:		
College Dean or Associate Dean:		4-9-07
CPSP *(for school personnel courses ONLY)*		
Associate Vice President and Dean for Academic Programs	CONDITIONAL APPROVAL 4/12/07	

Course Proposal: Geology 123, Geochemistry **Supplementary Information**
Submitted by Dan Deocampo, Department of Geology

Textbook:

Walther, J.V., 2005. Essentials of Geochemistry. Jones and Bartlett Publishers, Inc., Sudbury, MA, 704 pp.

Additional Readings (Optional for Undergraduates, Required for Graduate Students):

Allegre, C.J., Manheds, G., and Gopel, C., 1995. The age of the earth. Geochimica et Cosmochimica Acta, vol. 59, p. 1445-1456.

Anders, E., and Ebihara, M., 1982. Solar-system abundances of the elements. Geochimica et Cosmochimica Acta, vol. 46, p. 2363-2380.

Garrels, R.M., 1986. Sediment cycling and diagenesis. In *Studies in Diagenesis*, U.S. Geological Survey Bulletin 1578, p. 1-11.

Gibbs, R.J., 1970. Mechanisms controlling world water chemistry. Science, vol. 170, p. 1088-1090.

Hutchison, R., 1974. The formation of the earth. Nature, vol. 250, p. 556-568.

LeMaitre, R.W., 1976. The chemical variability of some common igneous rocks. Journal of Petrology, vol. 17, p. 589-637.

WalterR.C., Manega, P.C., Hay, R.L., Drake, R.E., and Curtis, G.H., 1991. Laser-fusion 40Ar/39Ar dating of Bed I Olduvai Gorge, Tanzania. Nature, vol. 354, p. 145-149.

Lecture Topics and Laboratory Activities:

Week 1: Introduction to Geochemistry. Geochemical Models, Geochemical variability, phases and concentration scales. Bulk geochemistry of the Earth, Meteorites, Earth density and rheology, pressure and temperature regimes.

Laboratory 1: Lab Safety; Intro to computational modeling (PHREEQC, SNORM, SUPCRT computer codes)

Week 2: Thermodynamics. Internal heat, reaction paths, 1st, 2nd laws of thermodynamics, determining Gibbs free energy, Gibbs free energy and geological pressure/temperature regimes.

Laboratory 2: Experimental determination of ΔG: Portlandite reactions at low temperature.

Week 3: Mixtures and Phase relations. ΔG in mixtures, mass action, G of aqueous species, phase rule.

Laboratory 3: Final measurements and calculations for Portlandite reactions.

Week 4: Mineral chemistry, ΔG and mineral stability, carbonate and silicate structures, minerals in solid solution.

Laboratory 4: Predictive modeling of x-ray diffraction of carbonates with variable Mg content.

Week 5: Aqueous solutions, acids, bases, pH, alkalinity, titrations, mineral solubility.

Laboratory 5: Experimental determination of mineral solubility in American River water.

Week 6: Natural aqueous solutions, river water, sea water, ground water, lake water.

Laboratory 6: Field observations, sampling, and analyses of natural waters.

Week 7: Igneous geochemistry, magma, melt speciation, water in melts, eutectics, solid solutions, phase relations.

Laboratory 7: Experimental determination of alkalinity by Gran titration: effects of rock type on groundwater.

Week 8: Pedogenesis, diagenesis, metamorphism, metasomatism, hydrothermal ores.

Laboratory 8: Field Trip: Geochemical parameters along the Lake Tahoe - Truckee River - Pyramid Lake transect.

Week 9: Radiogenic isotopes, decay, decay rates, systematics (Rb-Sr, Sm-Nd, U-Th-Pb, K-Ar, ^{14}C), fission track dating

Laboratory 9: Field Trip Write-up: Using geologic maps, USGS online water quality data, and field data from field trip.

Week 10: Stable isotopes, $\delta^{18}O$, $\delta^{13}C$, $\delta^{34}S$, fractionation, mineral-water exchanges.

Laboratory 10: Computer modeling of regional geologic controls on water quality: Sacramento River Watershed

Week 11: Stable isotopes and paleoclimatology, GISP/GRIP ice cores, benthic forams and paleoceanography.

Laboratory 11: Integration of student data from previous into Sacramento River Watershed regional model.

Week 12: Surface sorption geochemistry, ΔG, mineral surface chemistry, metal ion absorption.

Laboratory 12: Experimental determination of cation exchange capacity in soils.

Week 13: Kinetics, 1st order decay and growth, temperature dependence, water-mineral reactions, transport rates.

Laboratory 13: Experimental determination of the effect of nucleation on reaction rates: lacustrine trona precipitation.

Week 14: Oxidation - Reduction, ΔG of redox, Eh determination, Eh of surface waters, Eh of sedimentary pore fluids, Fe speciation.

Laboratory 14: Final measurements and calculations for trona reactions.

Week 15: Organic geochemistry, global carbon cycle, dissolved organic matter, diagenesis of solid organic matter.

Laboratory 15: Computer modeling of global carbon cycle, marine and terrestrial C uptake, and greenhouse effect.

Laboratory Resources and Expenses:

All required laboratory facilities (computers, software, fume hoods, wet lab) currently exist in the Geology Department in Placer Hall. Some glassware, and small amounts of relatively inexpensive reagents and natural geological materials will need to be purchased or collected. Costs for consumables and field expenses are estimated to total approximately $500. To offset this cost, we will apply for a $20 lab fee for each student, and the Geology Department will commit to pay the difference from Operating Expenses.

Lab equipment required (already owned):

- Assorted glassware (beakers, burettes, flasks)
- Assorted supports, ringstands, frames.
- Temperature, conductivity, and pH meters

Field equipment required (already owned):

- Temperature, conductivity, and pH meters
- Sample collection syringes

Consumables required:

- Assorted chemical reagents
- Quicklime (commercial grade)
- Syringe filters
- Field sample bottles