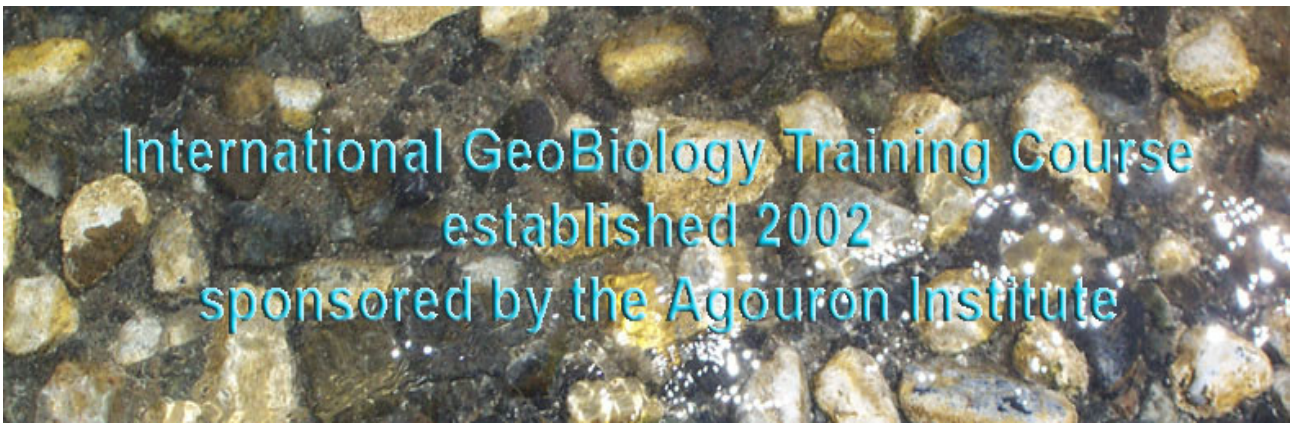


Why we need a geobiology course

Geobiology is an emerging, interdisciplinary field at the boundary between life and earth sciences. It builds on the interfaces between biogeochemistry, mineralogy, microbiology, molecular biology and paleontology. The geobiology course aims at an in-depth treatment of how these sciences interact and how the interactions can shape our understanding of the evolution of the earth. Internationally recognized scientists teach an intensive laboratory, lecture and field course on geobiological topics at an advanced level to selected graduate students, postdoctoral scholars and junior faculty from all over the world.

What the course attempts to offer

Over a period of six weeks the participants are exposed to scientific disciplines which contribute to what is called geobiology today: precambrian chemistry, microbial evolution and ecology, geology, geochemistry, earth systems sciences and geo-genomics. Reading rock records, measuring geochemical gradients in mats and sediments and isolating DNA are practiced in the field and in the laboratory. Strengths and limitations of different scientific approaches are discussed, theories on how nucleic acid sequence data can be used for the reconstruction of phylogenetic relationships and evolution and interpreting genome information are taught by specialists from different disciplines.

Defining Geobiology

Initiating future collaborations

What the course should lead to

The course initiates interactions between scientific fields that are not usually combined, such that areas of microbiology, chemistry and geology can contribute to an understanding of earth history and evolution. It provides for the interdisciplinary training of a new generation of scientists and promotes the development of collaborations between established investigators and young researchers. It addresses important problems in geobiology and aims at facilitating a common “geobiological language” which is essential for progress in this new field. It makes participants aware of the diversity in metabolic activities present in the microbial world, offers insights into the history of life on earth and on approaches to discovering life on other planets. It opens minds to discoveries and promotes respect for the biosphere as the earth’s life support system.

Encouraging exploration into fields outside one's own expertise

How the course is structured

The course comprises lectures, laboratory work, colloquia, symposia and field trips. Field experiences combined with theory and practical work promote the exchange of concepts and hypotheses between different disciplines; they initiate a mutual understanding of each others' scientific fields, open eyes and minds for modern geobiological processes and for their reconstruction from rock records, and lead to an appreciation of working methods in the different fields of geobiology.

The day typically begins with 2 to 3 lectures in the morning which are followed by instructed laboratory exercises and discovery motivated experimental work in the afternoon, and it ends with colloquia and/or special training sessions as requested by the participants.

Opening minds of young scientists

Learning about the role of the biosphere in shaping the geopsphere

Learning about the role of the geosphere in shaping ecosystems

How the course is taught

Some lectures illustrate the importance of microbes as living chemical agents and emphazise the roles microbes play in geochemical cycles, others address global environmental systems on the early earth and today and again others emphazise the diversity of genomes that harbor the majority of the geophysiological “inventions” made in the course of evolution. Computer modelling and exercises on particular course subjects are offered as requested by the participants. Current research themes are discussed during the open symposia on Saturdays. On field trips geological features and characteristic microbial habitats are pointed out and samples for further laboratory studies are collected. Chemical and physical measurements *in situ* and analyses of environmental samples employing *in vitro* and *in vivo* techniques are applied to define environmental determinants in particular habitats. The laboratory work is investigative, i.e. it promotes the discovery of new processes and microbes. Research themes are designed to educate students in current techniques in geobiology and to encourage independent research.

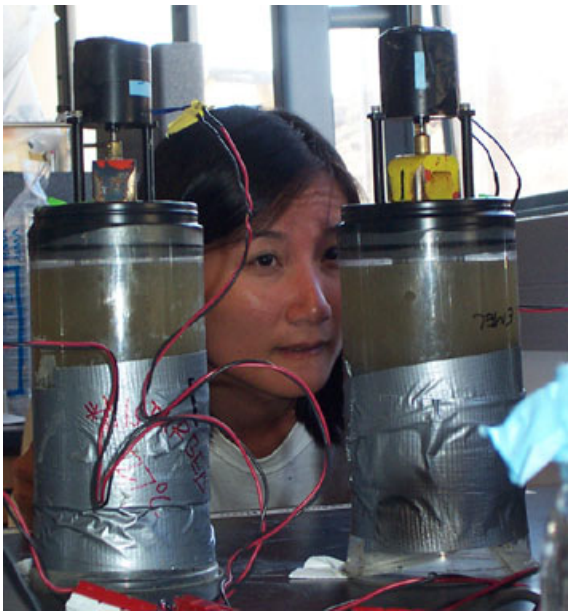
Teaching how to ask research questions in geobiology and ...

What has been offered in past courses

The 2003 field trip led to Yellowstone National Park to study modern biogeochemical processes and how they lead to rock records. In 2002 the course visited Mono Lake and Death Valley to study alkaline environments and ancient stromatolites. Symposia covered chemistry and the evolution of metabolism and how geochemical, mineral and rock signatures appear in the geologic record. Lectures were offered on topics such as „Life in extreme environments“, „Combining rock records and modern rock-forming processes“, „Thermophilic and cryophilic life styles“, „Genetic diversity and physiological flexibility of organisms“, „Phylogenetic diversity and the evolution of microorganisms“, „Dynamics of geochemical cycles today and in earth history“ and „Early earth organic biochemistry“. Special evening discussions addressed topics like „Thermodynamics applied to biogeochemical cycling“, „How bacteria become magnetotactic“, „Developing mathematical models for diffusion regulated ecosystems“, „ What is the evidence for a snowball earth?“, „Building phylogenetic trees“, „Designing probes and primers for PCR and FISH“ and “Large scale nutrient cycling in modern oceans“.

... and define approaches to finding answers

Approaching geobiology as an experimental science



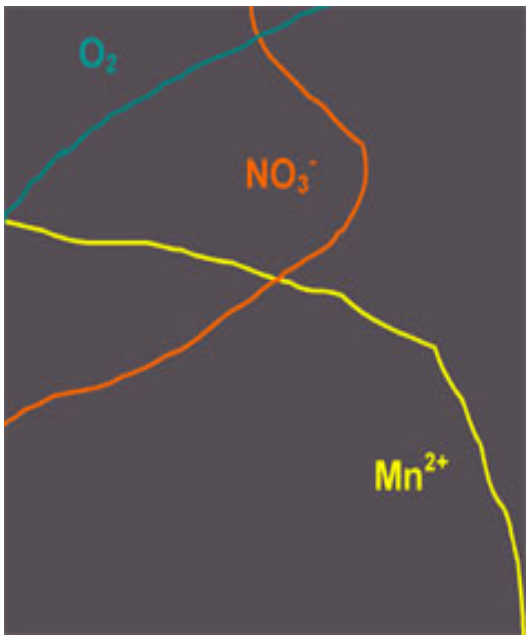
Why the course encourages small individual research projects

Investigative laboratory work is one of the key scientific and pedagogical feature of the geobiology course. Small projects are proposed and carried out by the students themselves with faculty support during the execution phase. The independent research activity aims at illustrating, applying and enlarging the understanding of basic concepts in the earth and life sciences which are applicable to geobiology, initiating innovation, encouraging quantitative analyses and modelling. There is emphasis on and strong guidance towards discovery.

How the course exposes participants to frontier research

Open symposia are offered every other Saturday. They are aimed at learning about ongoing research in geobiology and at creating opportunities to establish contacts to researchers in various geobiological fields.

Past symposia focused on “Biofilms and microbial mats in earth history” with T.Bosak, B.Fouke, N.Hinman, H.Hofmann, A-L.Reysenbach as the speakers, on the “Evolution of metabolism” with C.Cavanaugh, G.Cody, E.DeLong, L.Orgel, V.Orphan, N.Pace, and on “Biogeochemical Systems through Earth History” with A.Anbar, J.Farquhar, J.Hayes, L.Kump and B.Ward. The symposia for the 2002 course were on „The chemistry behind life“ with A.Ellington, Ch.Switzer, J.Szostak, S.Benner and G.R.Ghadiri, on „Stromatolites: linking the past and present“ with D.Canfield, J.Farmer, P.Visscher, S.Golubic and L.Prufert-Bebout, and on „Microbes, communities and metals“ with B.Bassler, J.Banfield, D.Lovley, R.Kolter and T.Beveridge.

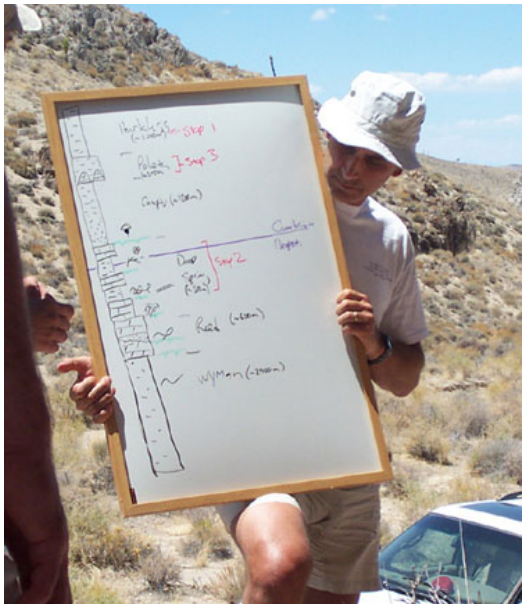


Using geochemistry to understand microbial ecology

Who teaches the course

The resident staff is augmented by visiting specialists and guest lecturers. Scientists who have contributed in earlier courses include: Andrew H. Knoll (Harvard University), John P. Grotzinger (MIT), James F. Kastings (Pennsilvania State University), David J. Des Marais (Nasa Ames Research Center), Dianne Newman (California Institute of Technology), Thomas Schmidt (Michigan State University), Gary Olsen (U. Illinois), Steven A. Benner (U. Florida), John Spear (U. Colorado), Scott Dawson (UC Berkeley), Brad Stevenson (Michigan State University), Brad Bebout (Nasa Ames Research Center), Dave Karl (U. Hawaii), Chis Martens (U. North Carolina), Ken Nealson (U. of Southern California), Daniel Sigman (Princeton).
The present course directors are Will Berelson (USC) and Kurt Hanselmann (U. Zürich).

Building confidence in cross-disciplinary communication



Being exposed to concepts in the geobiological sciences and to the views of those who represent them

Why and how the course promotes young faculty

Part of the course's mission is to train junior faculty by offering postdoctoral researchers intending to pursue an academic career the possibility to teach for 6 weeks in an interdisciplinary team on topics most relevant to geobiology and which they might want to follow in their research and teaching. By being a member of an international group of students, instructors and speakers, these junior faculty are given the opportunity to shape their opinions on geobiology and to assemble their first geobiology teaching curricula.

Junior faculty and students being exposed to rocks, mud, microbes and genes

What will be offered in the 2004 course

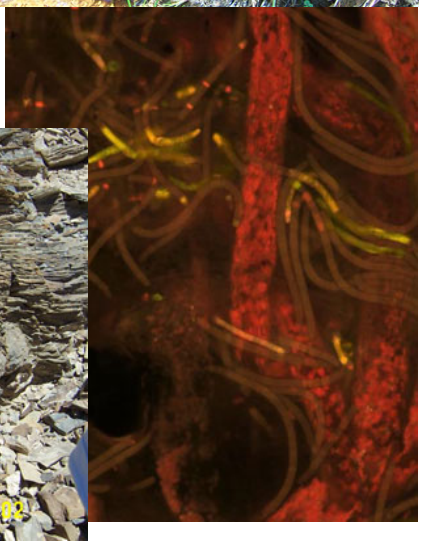
The course will focus on the following topics: “Changing geochemical cycles in earth history”, “From early chemistry to the evolution of metabolic diversity”, „The evolution of the eukaryotic cell“ and “Signatures of life in minerals, rocks and sediments”.
The course will emphazise processes in carbonate-rich marine environments, the geochemistry in anoxic sediments, the interactions of organisms with the lithosphere of their habitat, the isolation and cultivation of microorganisms that are distinguished by their phenotypic properties and on molecular methods for their genotypic characterization.

Establishing contacts with and being instructed by world-class scientists

Where and when the next course will take place

The present home base of the course is the Environmental Sciences Research Center of USC on Catalina Island. Course participants stay on campus and are expected to take part in all course activities fully. Normally courses begin in the middle of June and last for 6 weeks. The 2004 course will take place from June 10 to July 23. It will begin with a 2-day pre-course training session to bring students up-to-date on the basics of chemistry, geology and biology, followed by the field trip (June 12 to 19). The following five weeks are devoted to work in the laboratory and to smaller local field experiences.

Becoming familiar with large, small and microscopic geobiological features



Who may apply to the course and what participants are expected to contribute

The course is announced internationally. Participants should be relatively experienced in their scientific field. Basic knowledge of chemistry and biology are prerequisites for successful participation. The course requires complete student involvement in all aspects of the program for the full duration of the course. Proficiency in the English language is an essential prerequisite for participation since the course is taught in English.

The admission process is competitive. A maximum of 20 participants are admitted on the basis of their academic records, demonstrated research and/or teaching interests and abilities, originality, recommendations and career goals as they are related to the course objectives. All applications are reviewed by the selection committee.

Students from 17 different countries and 25 different universities participated during the first two courses. They came from the US, Australia, Cameroon, Spain, the Netherlands, Denmark, South Africa, Germany, Russia, Portugal, Indonesia, Turkey, Switzerland, Chile, Peru, Uruguay and the UK.

How to best find the course on the Internet: http://www.microeco.unizh.ch/geo/geobio04.html