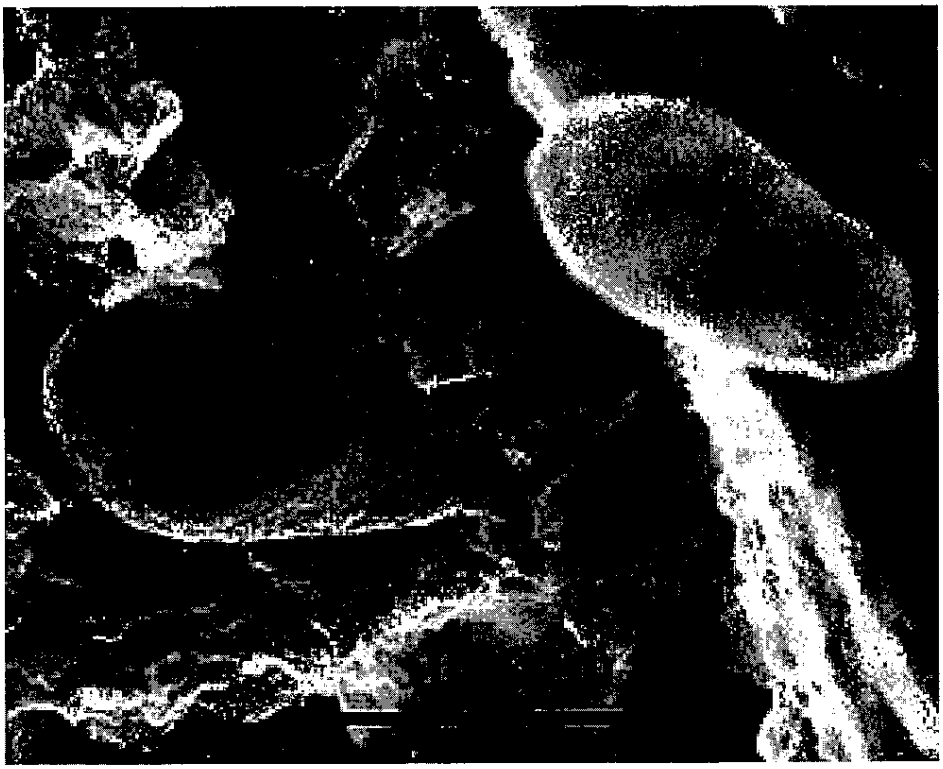
THE GEOCHEMICAL NEWS

Newsletter of The Geochemical Society

NUMBER 96 **JULY 1998**

Microbes as Geochemical Agents



In this issue:

See the program
for the 8th V. M. Goldschmidt Conference
to be held in Toulouse, France,
Aug. 30-Sept. 3, 1998:

http://www.obs-mip.fr/omp/umr5563/prog.html

THE GEOCHEMICAL SOCIETY

The **Geochemical Society** is a nonprofit scientific society founded to encourage the application of chemistry to the solution of geological and cosmological problems. Membership is international and diverse in background, encompassing such fields as organic geochemistry, high and low-temperature geochemistry, petrology, meteoritics, fluid-rock interaction, and isotope geochemistry. The Society produces a **Special Publications Series**, ***The Geochemical News*** (this quarterly newsletter), and (jointly with the Meteoritical Society) the journal ***Geochimica et Cosmochimica Acta***; grants the **V.M. Goldschmidt, F.W. Clarke** and **Clair C. Patterson Awards**, and, jointly with the European Association of Geochemistry, the **Geochemistry Fellows** title; sponsors the **V.M. Goldschmidt Conferences**, held in North American in odd years and elsewhere in even years, jointly with the European Association of Geochemistry; and co-sponsors the Geological Society of America annual meeting and the spring meeting of the American Geophysical Union. The Society honors the memory of our first President, F. Earl Ingerson, and our first Goldschmidt Medalist, Paul W. Gast, with the **Ingerson** and **Gast Lectures**. The Geochemical Society is affiliated with the American Association for the Advancement of Science and the International Union of Geological Sciences.

Members of the **Organic Geochemistry Division** are individuals with interests in studies on the origin, nature, geochemical significance, and behavior during diagenesis and catagenesis of naturally occurring organic substances in the Earth, and of extraterrestrial organic matter. GS members may choose to be affiliated with the OGD without any additional dues. The OGD presents the **Alfred E. Treibs Award** for major achievements in organic geochemistry, and **Best Paper** awards (student and professional) in organic geochemistry.

Editor's Corner

Dear Readers:

Please feel free to contact us with contributions for *The Geochemical News*. We want to publish all the geochemical news that's fit to print -- and you are the reporters!

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visit the new Geochemical Society website:

http://www.geochemsoc.org

From the Coordinator of Internet Resources

The long-awaited, much anticipated face-lift for our web site continues, after a temporary suspension to fix incompatibilities with new database software. Hopefully this is behind us at last, so let's move on to the agenda for this issue of the Geochemical News.

THE BROWSER BLUES

A number of users have reported problems on the site that have been traced to the latest crop of browsers (both Navigator and Internet Explorer). These problems are particularly frustrating. As a Mac-only shop, we do not have the resources to test the web site using all browsers on all platforms. If you have experienced difficulties, please do take a few moments to report the problem, giving me enough information to locate the offending page (describe the problem and note the URL, browser type and version, and computer platform).

NEWS AND ANNOUNCEMENTS

A current news and announcements feature has been added to the GS web site. A digest of news headlines will load on the home page (coming shortly), and you can view the full text of announcements by following the links (here now, accessible via the pull-down menus). Initially all GS members will be able to post items, subject to a few simple rules of the road. We will moderate submissions only if it becomes necessary due to abuse or an overwhelming number of news items. The Job Board and Events Calendar, also both available for posts by all GS members, will be on-line soon and are the appropriate venues for employment and event items.

1998 MEMBERSHIP DIRECTORY

The GS Membership Directory from the 1998 round of applications and renewals is on-line. Membership forms processed after that date will be added or revised periodically. The new directory contains very few home page URLs so, if you'd like a link to your web address from the directory, please use the interactive form on the GS web site to update your records.

GS MAILING LISTS

A GS list server is now on-line with three public mailing lists: GS-Talk@lists.geochemsoc.org, GS Organic@lists.geochemsoc.org, and GS-Announce@lists.geochemsoc.org. GS-Talk is a general-purpose mailing list. Subscribers can post questions and answers to the list, subject to provisions of the list charter. GS-Organic is similar to GS-Talk, but targets more specialized topics in organic geochemistry by members in the Organic Geochemistry Division. GS-Announce is a broadcast-only list that will disseminate time-sensitive information to members who have provided an e-mail address. Please use the Web form to update your records if your membership application or renewal did not include an e-mail address! You can subscribe to or unsubscribe from GS-Talk and GS-Organic directly from the GS web site (follow the link in the home page pull-down menu).

DISCUSSION FORUMS AND ASK-A-GEOCHEMIST

We'd like once again to encourage members to make use of these services, which are finally back on-line after prolonged pest extermination (some bugs self-inflicted and others related to software upgrades). Feel free to visit and post questions and answers, but keep in mind Ask-A-Geochemist is intended more for the public. Technical questions should be directed to the discussion forums. The success of Ask-A-Geochemist depends on volunteers who will respond to questions in a timely fashion. New features make it unnecessary for volunteers to monitor the web site for new postings. Thus far we have only one volunteer. Please contact me for more information if you can help answer questions.

THE DATABAG

Work on the DataBag continues, with development on both a thermodynamic database and a petrologic database. The thermo database is designed to interface with the mineralogical and crystallographic database under development by the Mineralogical Society of America, but it will have a stand-alone search form for use by GS members. The petrological database, still in the embryonic development stage, will use familiar triangular composition diagrams to retrieve major, minor, and trace element data for various rock types or compositional ranges, as individual or grouped analyses. We are currently looking for data sets! Please contact me if you can contribute published geochemical data, preferably in an electronic format (the more QA/QC the better). We're also open to suggestions for other types of geochemical data that are amenable to database retrieval on the GS web site.

EDUCATIONAL OUTREACH

The GS, together with the Mineralogical Society of America, is moving forward to collaborate with the Ridge Inter Disciplinary Global Experiments (RIDGE) Initiative to co-develop the educational outreach module on marine geoscience (and in particular the mineralogy and geochemistry of submarine hydrothermmal vents). In addition to th wealth of scientific data and imagery that RIDGE brings to this effort, their network of researchers and connections with other like-minded organizations will be invaluable in selecting content appropriate for the K-12 community. We again appeal to the GS membership for volunteers to assist in content development!

Mark Bloom, Coordinator of Internet Resources
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Notes from the Business Manager

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AGU SPRING MEETING IN BOSTON

We signed up 24 new members! We would like to thank Nick Hjerdt from SUNY-ESF Syracuse, NY for all his help recuiting student members to join the Geochemical Society. We enjoyed meeting quite a few of our members who stopped by the booth. Those who stopped by received a sticker with The Geochemical Society logo for their name tag and a pen with the GS web site address.

AGU FALL STUDENT AWARD

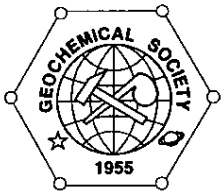
Professional members of the Geochemical Society may submit a name of a student with the criteria listed below to receive free registration which also includes all technical sessions to the Fall AGU meeting held in December 1998 in San Francisco.

1. List of student publications (main and coauthor)
2. Student research, past & current
3. any other criteria deemed appropriate in considering this student for this award.

Deadline for this submission: August 1, 1998. Send to the Business Office via e-mail, fax or mail. Discussion and voting for this award will be held at the Business Meeting in August at the Goldschmidt Conference in Toulouse. The student will be notified in September and the award will be announced in the October newsletter.

Welcome to our new members who have joined the GS since April. As of June 12th, 1998 The Geochemical Society has a total of 1616 members!

We welcome some of our newest members, who signed up at the Spring AGU Meeting in Boston. *(Clockwise, starting in upper left: Linda Elkins, MIT; Karen Viskupic, MIT; Rosario Scheerhorn, Univ. Texas - Austin; Ian Jones, Univ. Texas - Austion; Nick Hjerdt, SUNY - Syracuse; Danny Welsch, SUNY - Syracuse; Lori Keith, Univ. of Maryland).*



THE GEOCHEMICAL SOCIETY

1999 Officer and Director Candidates

The Geochemical Society has a 16-member Board of Directors composed of 9 Officer-Directors and 7 Non-officer Directors. The terms of Directors are either two years (President, Vice-President, Past-President, Organic Geochemistry Division Chair) or three years (all other Directors) and are staggered. Officer-Directors whose terms continue through at least 1999 are Michael J. Drake (President), Michael F. Hochella, Jr. (Vice-President), Donald Elthon (Treasurer), S. Ross Taylor (International Secretary), Alex N. Halliday (Past-President), Michael D. Lewan (OGD Chair), and Steven A. Macko (OGD Secretary). Non-officer Directors through at least 1999 are Lynn M. Walter, Jochen Hoefs, Albrecht W. Hofmann, R. Keith O'Nions, and Edward M. Stolper. Dr. Hofmann was appointed by the Board to serve the remainder of the term of Karl K. Turekian, since the Board unanimously voted in 1997 to eliminate the *Geochimica et Cosmochimica Acta* Executive Editorship as a Board-level position. Directors whose terms expire at the end of 1998 include David J. Wesolowski (Secretary), Scott M. McLennan (Special Publications Editor), Susan L. Brantley (Director), and Everett L. Shock (appointed by the Board to serve the remainder of Dr. Hochella's Director term, as he stepped into the Vice Presidency).

The By-Laws of the Geochemical Society require that its members be notified of the candidates for new Officers and Directors, who are proposed by the Nominations Committee and approved by the Board of Directors of the Society, well before the end of the calendar year in which Directors' terms expire. The purpose is to allow the general membership to nominate additional candidates for those positions that are up for election. Please consider the candidates listed below carefully and propose others only if you feel this is in the best interest of the Society.

Additional nominations may be made by at least ten (10) members of the Society, the nominees must be Society members, and they must agree to serve if nominated. **If you are satisfied with the proposed slate of officers and directors for 1999, do nothing. Additional nominations must be submitted by August 1, 1998,** to the Secretary of the Geochemical Society (Dr. David J. Wesolowski, Chemical and Analytical Sciences Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee, 37831-6110, USA (Tel: 1-423-574-6903; Fax: 1-423-574-4961; Email: dqw@ornl.gov).

Proposed Slate of New Officers and Directors of the Geochemical Society

DIRECTORS:

Kristin Vala Ragnarsdottir *(1999-2001)*
Department of Geology
University of Bristol
Bristol, Avon, UK

Everett L. Shock *(1999-2001)*
Dept. Earth and Planetary Sciences
Washington University
Saint Louis, Missouri, USA

OFFICERS:

For Secretary (1999-2001)
David J. Wesolowski
Chemical and Analytical Sciences Div.
Oak Ridge National Laboratory
Oak Ridge, Tennessee, USA

For Special Publications Editor (1999-2001)
Scott A. Wood
Dept. Geology and Geol. Engineering
University of Idaho
Moscow, Idaho, USA

--- CALL FOR PAPERS ---

Geochimica et Cosmochimica Acta

Special Issue in Honor of Dr. Werner Stumm

A Special Issue of *Geochimica et Cosmochimica Acta*, in honor of Dr. Werner Stumm is being planned for publication early in 1999. We would like to invite you to contribute with an article on a subject within the field of Aqueous Geochemistry. This Special Issue is prompted by the award of the 1998 Goldschmidt Medal to Professor Stumm. It will include contributions to be presented during the Special Symposium of the Goldschmidt Conference in Toulouse in late August, but submission for this volume is open to anyone who wishes to contribute.

Submissions will be expected to meet normal GCA standards and will be peer-reviewed. Manuscripts must be mailed on or before 15 October 1998 to one of the addresses below. We have decided that the collection should be assembled and published rapidly. To make this possible, we ask contributors to hold tightly to the following schedule:

15 October 1998	Submission deadline
26 October	Articles in the hands of the reviewers
30 November	Reviews finished and returned to Assistant Editors
11 December	Articles in the hands of the authors for revisions
15 January 1999	Revised articles resubmitted
25 February	Special Issue assembled, edited and sent to GCA
Spring 1999	Publication of the Special Issue

Those who submit manuscripts will be asked to review two or three other papers. We ask that you be prompt with reviews so that the Issue can be published with a minimum of delay.

We look forward to an exciting collection of first class work to honour a man who, with his science and his energy, has contributed a great deal toward building the foundations for a new branch of geochemistry which is as important to environmental water quality as it is to low temperature sedimentary processes. We look forward to your contribution.

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1998 GORDON RESEARCH CONFERENCE ON ORGANIC GEOCHEMISTRY

HOLDERNESS SCHOOL, NEW HAMPSHIRE, AUGUST 9-14, 1998

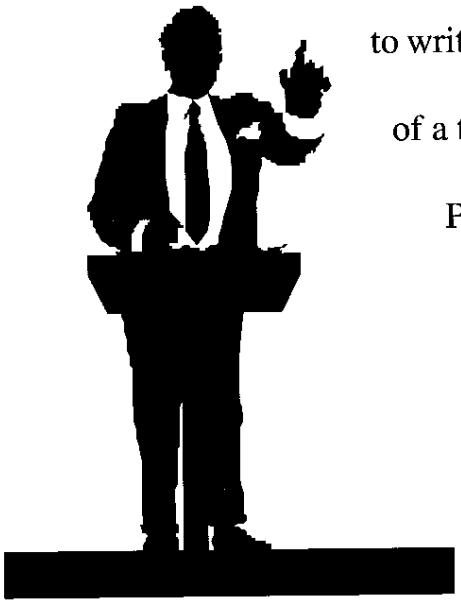
Kenneth E. Peters, ***Chairman (214-951-3272, kepeters@dal.mobil.com)***
John I. Hedges, ***Vice Chair (206-543-0744, jihedges@u.washington.edu)***

This conference is designed to stimulate discussion of cutting-edge research and improve cooperation among geochemists, microbiologists, geologists, chemists and others, especially in disciplines related to fossil fuels. Developments in organic geochemistry are critical to the world economy because they improve success in the exploration and production of fossil fuels. Generous discussion periods will follow each invited talk. All applicants are encouraged to submit posters to the Vice Chair.

Early application to this conference is strongly recommended. Application forms and the final program are available on the web at HTTP://www.grc.uri.edu. The following is an abbreviated summary of session topics and discussion leaders.

- **GEOCHEMICAL EVIDENCE FOR PAST LIFE ON MARS (David DesMarais)**
- **ORGANIC MATTER PRESERVATION IN SEDIMENTS (Cindy Lee)**
- **GEOCHEMISTRY OF HYDROTHERMAL ECOSYSTEMS AND DEEP-EARTH MICROBES (Roger Summons)**
- **CHEMOSTRATIGRAPHY AND THE GEOCHEMISTRY OF MAJOR TIME BOUNDARIES (Lisa Pratt)**
- **COMPUTATIONAL ORGANIC GEOCHEMISTRY (Yungchun Tang)**
- **THERMOCHEMICAL SULFATE REDUCTION (Martin Fowler)**
- **GENERATION AND PREDICTION OF HYDROCARBON GASES, CARBON DIOXIDE, AND NITROGEN (Francois Lorant)**
- **GENERATION AND EXPULSION OF HYDROCARBONS (Dan Jarvie)**
- **RESERVOIR FLUIDS, SEALS, AND DYNAMIC PROCESSES (Peter Meulbroek)**

Authors wanted!



to write brief review articles, letters, and other communications of a timely nature for publication in *The Geochemical News.*

Please contact the Editor with your ideas for articles.

(Where else can you get published within 3 months?)

ANNOUNCING A TOPICAL CONFERENCE

The Origin of the Earth and Moon

December 1–3, 1998 Monterey, California

http://cass.jsc.nasa.gov/meetings/origin98/

SPONSORS

Geochemical Society
Lunar and Planetary Institute
National Aeronautics and Space Administration

The 1988 conference *The Origin of the Earth* was an excellent meeting that produced a classic, frequently cited text on the subject. The 1984 conference *The Origin of the Moon* was arguably the most successful conference ever held in planetary geology, bringing together the key players who then and there formulated, debated, refined, and established the giant impact theory of lunar origin. In recent years there have been major advances in these areas, particularly in the fields of geochemistry and petrology. It has become very apparent that a meeting that focuses on the origin of the Earth and Moon, as coupled problems, would be invaluable. For example, discussions about the development of the Earth's atmosphere or hypotheses concerning magma oceans and core formation are esoteric unless constraints on the nature of the interactions that generated the Moon are incorporated. As such, we believe that this conference should focus on the very earliest histories of these bodies, so that nearly everyone present will share a common interest in all aspects of the discussion.

Therefore, this conference is being planned just prior to the 1998 Fall AGU Meeting in San Francisco to encourage interested scientists worldwide to attend and contribute to what we hope will be the third in a series of highly successful topical conferences on origins of planets.

For further information concerning the conference, and to be added to the mailing list for future announcements, please send your request to:

The Origin of the Earth and Moon Conference
Lunar and Planetary Institute
3600 Bay Area Boulevard
Houston TX USA
E-mail: simmons@lpi.jsc.nasa.gov

CONVENERS

Alex N. Halliday
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Michael Drake
University of Arizona
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SCIENTIFIC ORGANIZING COMMITTEE

Alan P. Boss
Carnegie Institution of Washington

A. G. W. Cameron
Harvard College Observatory

John H. Jones
NASA Johnson Space Center

H. Jay Melosh
University of Arizona

R. Keith O'Nions
Oxford University

Everett Shock
Washington University

David J. Stevenson
California Institute of Technology

G. Jeffrey Taylor
University of Hawai'i

S. Ross Taylor
Australian National University

Plan to Attend the Eighth Annual V.M. Goldschmidt Conference

August 30 - September 3, 1998
Toulouse, France

The Eighth Annual V.M. Goldschmidt Conference will be held in Toulouse, France from Sunday August 30 to Friday September 3, 1998. The meeting will be followed by optional field excursions to the neighboring Pyrénées mountains.This will be the first time that the Goldschmidt will be held in France. The location of the meeting, Toulouse is a university town known for its tradition of culture and 'art de vivre'.

Toulouse, known as 'la ville rose' because of its magnificent brick-based architecture, is the fourth largest city in France. Situated in the south of France, Toulouse is located west of the Mediterranean Sea (90 miles/150 kilometers) and east of the Atlantic Ocean (150 miles/250 kilometers). Summer weather in Toulouse is typically pleasant and sunny, with daytime temperatures ranging from 75° F/24° C to 85° F/30° C.

The Goldschmidt 1998 Conference Venue, Université de Toulouse I, is located in the city center, close to hotels, restaurants, outdoor cafés, shopping, and several historical monuments and museums. The University of Toulouse is the second largest in France ; the campus is surrounded by churches, monasteries, and houses dating from the 11th to 17th centuries. The area surrounding Toulouse is equally interesting. Several exciting touristic destinations are within a very short distance: the medieval city of Carcassone, the Perigord and Dordogne valleys, and the Pyrénées Mountains.

The Conference is organized by the Observatoire de Midi-Pyrénées, an institution dedicated to teaching and research in Earth and Planetary Science, ranging from extra-galactic astronomy to the internal structure of the Earth. If you are interested in obtaining information regarding the conference, send an e-mail message to the organizers(goldconf@lucid.ups-tlse.fr) or to *see the complete program* for the conference, visit the web site at http://www.obs-mip.fr/omp/umr5563/goldconf98.html.

Hosted by
Observatoire de Midi-Pyrénées
Institut des Sciences de la Terre
CNRS/Université Paul-Sabatier

Sponsored by
European Association of Geochemistry
Geochemical Society
Université Paul-Sabatier
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Research Issues in Petroleum and Environmental Organic Geochemistry

Organic Geochemical Division (OGD) of the Geochemical Society (GS) Symposium:
Geological Society of America Annual Meeting, Toronto, Canada, October 25, 1998
Co-chaired by Barbara Sherwood-Lollar (bsl@quartz.geology.utoronto.ca) and
Michael D. Lewan (mlewan@usgs.gov)

This day-long symposium will host ten speakers to present current research issues in petroleum and environmental organic geochemistry. With employment opportunities continuing to grow in both of these disciplines, the symposium will provide students and the geological community with a comprehensive review of research challenges that lie ahead. Sufficient time after each presentation will be allotted for open discussion.

Environmental Geochemistry Research Issues

Geochemical ecology and biogeochemistry of contaminated groundwater:
Phil Bennett, University of Texas at Austin

Isotopic signatures as tracers of petroleum contamination in marine environments:
Michael Whiticar, University of Victoria

Stable carbon isotopes: Tools for detection of the origin and fate of organic contaminants:
Barbara Sherwood Lollar, University of Toronto

Atmospheric methane flux from coals related to mining and natural geologic processes:
Jerry L. Clayton, J. S. Leventhal, D. Rice, USGS, and M. Kotarba, University of Mining &Metallurgy/Krakow

Sunlight induced reactions in organic matter in natural waters- impacts on availability/mobility of metals:
Dave Sedlak - University of California/Berkeley

Petroleum Geochemistry Research Issues

Petroleum Source Rock Assessment-Analytical Methods, Sampling, and Volumetric Assessments:
Barry Katz, Texaco

Research Issues Concerning Kinetics and Mechanisms of Petroleum Generation and Expulsion:
Michael Lewan, USGS

Oil Maturity, Oil Mixes, and the Nature of Reservoir Boundaries- Recurring Issues in Exploration and Development Geochemistry:
Mark McCaffrey, ARCO

Molecules and Mazes-Geochemical Approaches to Understanding Petroleum Migration and Entrapment:
Steven Larter, University of Newcastle

Natural Gas Formation and Occurrences-Status and Outlook:
Martin Schoell, Chevron; Yongchun Tang, Chevron; and Lawrence Cathles, Cornell University

Microbes as Geochemical Agents

Jillian F. Banfield, Susan A. Welch, and Katrina J. Edwards
Department of Geology and Geophysics
University of Wisconsin-Madison

Microorganisms have probably been agents for geochemical change for over 85% of Earth history, and the linkages between the geochemical and biological evolution of the Earth are profound. It is widely accepted that microorganisms were largely responsible for accumulation of oxygen in the Earth's atmosphere and that, through their metabolism, they can dramatically alter elemental abundances and distributions. However, we have much to learn about the full range of microbial contributions to geochemical processes, both over geological time and in modern systems. With rare exceptions, microorganisms leave no clear fossil record, and until recently, their modern diversity was essentially unknown. The advent of molecular biological approaches represents a major breakthrough, allowing routine classification of individual cells from natural samples and identification of their contributions to geochemical environments. These developments are providing tremendous stimulus for new areas of investigation that bridge the disciplines of microbiology and geochemistry.

The number of new microbial species recognized in natural environments continues to increase at a dramatic rate due to the application of DNA and RNA-based approaches (Pace et al. 1986; Woese, 1987). The metabolisms and activities of these innumerable newly identified taxa must be deciphered and their distributions as a function of geochemical conditions must be determined. These are the steps necessary if we are to understand the diversity of ways in which microbes control elemental speciation and cycling.

In addition to DNA "fingerprinting" as a method of microbe identification, molecular data are used to establish the relatedness of individual species (phylogeny). Phylogenetic trees reveal evolutionary relationships, stemming from what is inferred to be a "common ancestor" (see review by Barns and Nierswicki-Bauer, 1997). The challenge now is to calibrate this evolutionary tree with geological time, so we can correlate the appearance of key microbial metabolisms with geochemical changes observed over Earth history. Inevitably, these discoveries will lead to a new, unified picture of geological evolution.

Microorganisms and early Earth history

The timing of the appearance of the first organisms remains unclear, though isotopic (Mojzsis et al. 1996) and fossil (Schopf and Packer 1987; Schopf, 1994) evidence suggests a date of between 3.55 and 3.85 Ga. A figure of about 3.5 Ga implies that it took no more than a billion years to evolve cellular architecture and metabolism (probably less, given that surface regions may not have become hospitable until about 4 Ga). A maximum estimate may be comparable to the length of time bracketing the appearances of the Ediacaran fauna and man. If other models for early Earth evolution are correct (e.g., Chang et al., 1983), inhospitable conditions at the Earth's surface would constrain the period required for cellular evolution to few hundred million years - perhaps only a period of time comparable to that in which dinosaurs existed on Earth.

Decades of research have sought synthesis routes for key primordial molecules, and to answer the question "how did life arise"? Despite this effort, success in creating basic building blocks such as amino acids, bases such as adenine and uracil, sugars such as ribose under early Earth conditions, or in polymerizing them into DNA, RNA, and proteins has been quite limited (Joyce and Orgel, 1993). Furthermore, the inherent susceptibility of DNA and RNA to hydrolysis makes fully aqueous pathways improbable (Pace, 1991). Elaborate coincidences of temperature, pressure, and unlikely abundances of compounds are not hallmarks of a believable model. The relevant pathways for synthesis of primordial molecules are probably simple, utilizing readily available components in geologically reasonable ranges of concentration. Minerals are key constituents of the Earth's surface, and their importance in explaining the origin of life may be fundamental. Mineral surfaces are periodic arrays of reactive sites that adsorb protons, water, metal ions, and organic molecules. They may be catalytically active (especially when irradiated by light), are sources of oxidizable and reducible compounds, are substrates able to selectively adsorb and orient molecules in stereospecific (and in some cases, isomerically specific) ways. Remarkably, however, the role of mineral surfaces in prebiotic syntheses has been considered by only a small number of scientists (e.g., Cairns-Smith, 1985; Ferris et al., 1996; Wächtershäuser, 1990; Huber and Wächtershäuser, 1997). Huber and Wächtershäuser demonstrated synthesis of methane thiol, a thioester, and acetic acid on metal sulfide surfaces, and Ferris et al. (1996) polymerized nucleosides on montmorillonite and amino acids on apatite. Short chains of amino acids have been formed by condensation reactions involving polyphosphates (Schlesinger, 1997 and references therein). This is particularly important because of the roles of organophosphate compounds in biochemical energy exchanges. However, the full potential for high yield synthesis of complex organic molecules through organic interactions with the diversity of natural mineral surfaces remains almost unstudied. This is an exciting research opportunity for mineralogists, geochemists, and organic chemists. Interdisciplinary effort that includes all of these aspects is probably required to develop feasible explanations for how prebiotic molecules were created and assembled into living things.

In the last couple of decades we have learned that processes at oceanic hydothermal vents have important consequences for ocean geochemistry. Recently, there has been considerable support for the idea that such vents were the Archean cradle of life. These environments provide sources of reduced compounds that may be critical for early metabolisms. Work by Wächtershäuser and colleagues has drawn important correlations between microbial core metabolism, Fe and S-bearing enzymes, pyrite-forming reactions, and reactions on pyrite surfaces. Supporting arguments for a hydrothermal vent site for the origin of life also come from the molecular phylogenetic approach. Early

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diverging species (closest to the "common ancestor") are typically anaerobic, live at high temperature (hypothermophilic), and derive metabolic energy from oxidation of inorganic compounds (Barns and Nierswicki-Bauer, 1997). Recent observations of visible light in deep oceanic vent environments suggests these sites may have also given rise to the primordial photosynthetic mechanism (which interestingly appears to involves a key Zn-bearing enzyme; Wakao et al., 1996).

The impact of evolution of microorganisms on the mineralogy and geochemistry of the Earth's surface and near-surface regions would have been immediate and profound. Microbes affect the speciation and distribution of elements through redox reactions (some of which are part of microbial energy generation schemes), by inducing mineral precipitation within, on, or around cells, through release of organic and inorganic byproducts into the environment, and by directly or indirectly modifying the rates and mechanisms of mineral dissolution. The earliest cells probably obtained energy from redox reactions involving compounds such as H2, H2S, HS^-, S^Y, and others. Other energy sources that may be used to convert oxides of carbon to reduced organic molecules include Mn^{2+}, Fe^{2+}, $NO3^-$ and $NH4^+$. Microbes typically catalyze reactions with slow inorganic rates, and can accelerate reaction rates by many orders of magnitude. Organisms require fixed nitrogen, phosphorous for molecules such as DNA, RNA, ATP, etc., and a supply of metals used in the reactive sites of enzymes. Ocean and sea floor abundances and speciation of metals, sulfur, carbon, oxygen, hydrogen, and nitrogen and other elements would be especially prone to change with the advent of life at and near sites of hydrothermal activity.

Co-evolution of microorganisms and the Earth

We do not yet know the exact timing of the divergence of most groups of organisms with diverse metabolic capabilities. In some order, and over a critical period, microbes evolved the capacity to metabolize a diversity of inorganic and organic compounds, to photosynthesize, to engulf other organisms, to create new molecules through symbioses, to make minerals for protection from predators and toxic compounds, and to confer structural rigidity. Unfortunately, the mutation rate in the SSU r-RNA gene used to create phylogenetic trees is not constant, so the timing of important evolutionary events is not known directly. However, it should be possible to correlate a subset of metabolic innovations directly with the geological record. This effort will benefit from a more complete picture of the diversity of living things (allowing the distribution of metabolic capabilities to be mapped out more completely), refinements in our understanding of the mechanisms by which organisms generate energy from chemical reactions (e.g., the cytochromes involved), and improved knowledge of the history of mineralogical and geochemical changes over time.

The initial period of Earth history should show microbial evolutionary events most clearly. Photosynthesis is believed to have been a relatively early invention. In fact, the Warrawoona microbial fossils (3.5 Ga) show some morphological similarity to photosynthetic bacteria (cyanobacteria). This form of photosynthesis was apparently highly successful, and led to the proliferation of these bacteria and ultimately to the build up of oxygen in the atmosphere (Barns and Nierzwicki-Bauer, 1997).

Early in Earth history, the sulfur pool was almost entirely tied up in igneous rocks. However, due to weathering reactions and degassing, today it largely occurs in sedimentary rocks, including marine evaporites and sea water. Initially, sulfur occurred primarily as pyrite (FeS2), and thus in the -1 valence state. Over much of Earth history, microbial transformations of sulfur have probably driven the global sulfur cycle. Under anoxic conditions, $SO4^{2-}$ can be reduced by organisms, resulting in the release of reduced gases (primarily H2S) and deposition of pyrite and other metal sulfide minerals. Anoxic environments can also support sulfur-based photosynthesis, which may have been one of the first forms of photosynthesis on the Earth. Sulfur isotopic measurements (indicating low $\delta^{34}S$ values) from the late Archean suggest that the effects of these organisms on the sulfur cycle extend back to at least 2.75 Ga (Goodwin et al. 1976; Thode and Goodwin, 1983).

For much of the Archean, water, sediments and rock surfaces may have been colonized by prokaryotes and simple proto-eukaryotes (probably anaerobic heterotrophs that consumed organic debris produced by bacteria and Archaea; Kandler, 1994). Subsequent mitochondria-bearing eukaryotes probably arose by assimilation (endosymbiosis) of a bacteria (Margulis, 1970), and chloroplast-bearing cells by endosymbiosis involving a cyanobacteria (conferring eukaryotes the ability to generate energy by photosynthesis; Zablen et al., 1975). These "living colloids" present enormous quantities of reactive, often negatively charged surface area, with high potential for metal adsorption and mineral precipitation. As organisms of increasing complexity and sophistication evolved, so did their diversity of habitats. Today, cycles of most of the elements on the periodic table are affected, directly or indirectly, by microbial processes.

Over geologic time, microbes have played a key role in the creation of a habitable planet. The major feedback mechanism controlling the concentration of atmospheric CO2 is the weathering of Ca-Mg silicate minerals and subsequent precipitation of Ca-Mg carbonates. Since microorganisms affect biogeochemical weathering reactions and life may have been present for at least 3.5 Ga, it seems plausible that the biota could have moderated the CO2-Si cycle, and could have therefore affected pCO2 and global climate. The Earth's climate and atmosphere have changed substantially over the last 4.6 Ga, from the very hot CO2-rich pressure cooker atmosphere to the habitable planet we have today. Recent work by Volk and Schwartzman (Volk, 1998; Schwartzman and Volk, 1995) suggests that microbially mediated silicate weathering (and CO2 draw down) was responsible for the coevolution of climate and higher life forms. By lowering the Earth's surface temperature, simpler organisms paved the way for the evolution of higher life forms. Their model assumes that early in the Earth's history (the first half billion years of life or so), the land surfaces were covered with a cryptogamic crust, which accelerated silicate mineral weathering rates by a factor of ten, lowering atmospheric CO2 and temperature. The evolution of eukaryotes about two billion years ago is estimated to have enhanced weathering rates by about a factor of two over the 'cryptogamic effect'. In the last half billion years, the evolution of higher plants and formation of thick

soils boosted the biotic enhancement of weathering by another factor of five. The evolution of these organisms was constrained by upper temperature limits, with the appearance of each new life form resulting in an increase in the biotic enhancement of weathering and thereby a decrease in atmospheric CO2 and global temperature. Without this biotic enhancement of mineral weathering, the Earth's surface temperature would be about 30 degrees warmer today.

Current processes: microbial roles and new opportunities

Some of the ways in which microbes impact key elemental cycles have been understood for many years. In the following sections we discuss some relatively well known examples. However, our current knowledge is critically limited because we do not know which microbes exist in geochemical environments (and microenvironments), how they are organized into communities, or the full range of their geological consequences. Understanding of the diversity of microbes has been limited by our ability to grow the relevant species in the laboratory (only approximately 1% of microbes can be cultured; see reviews by Ward et al., 1992, Amman et al., 1995).

It is now routinely possible to obtain information about individual cells in natural samples without culturing. The approach involves DNA extraction from environmental samples, amplification of the relevant portion, and sequencing (the small subunit ribosomal RNA sequence is generally used; Woese, 1987). The results are used to identify the species (if the species has been previously characterized) and/or determine its phylogenetic placement (Zuckerkandl and Pauling, 1965; Pace et al., 1986; Ward et al., 1992, Amman et al., 1995). Online databases containing sequence for previously studied microorganisms include RDP (http://rdpwww.life.uiuc.edu, Maidak et al. 1997) and GenBank (http://www.ncbi.nlm.nih.gov/Web/Search/ index.html, Benson et al. 1998). Phylogenetic placement is possible even if the species is not closely related to a known organism (Giovannoni, 1991).

Molecular probes can be used to label cells with a specific DNA sequence, and to determine their distribution (e.g., in solution, on mineral surfaces, within biofilms; Amman et al., 1995). Readily available computer programs compare the known sequence for a microbe shown to be present by DNA analysis (or suspected to be present, based on other criteria) to sequences in databases in order to identify a portion that is unique to that organism. This is then used to design a probe that binds to the ribosomal RNA only of the targeted organism (e.g., DeLong et al. 1989). While not trivial, probing is not extremely complex and cell distribution can be quantified by optical (fluorescence; Fig. 1) microscopy. This method should be combined with laboratory studies to evaluate metabolism, symbiotic effects, and reaction kinetics.

In combination, the phylogenetic placements and cell distributions provide some information about metabolism and insights about how to approach culturing of interesting new species in order to complete their biological characterization. These sorts of methods hold tremendous promise for new understanding of how microbes affect geochemical cycles. Now we have the tools to study microorganisms in their full diversity, in situ, and it is time to begin to deploy these tools widely.

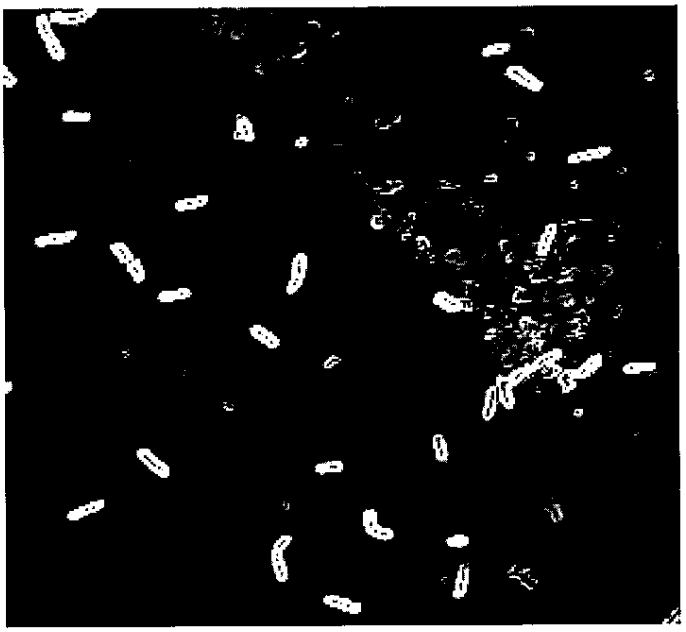

Fig. 2: Fluorescence image of microorganisms on a pyrite surface. These cells, shown to be bacteria using a domain-specific probe, induce oxidation rates by ~1.4 x 10^{-8} μM Fe $cell^{-1}$ day^{-1} (Edwards et al., 1998).

i) Microbes and silicate mineral weathering

An important step in soil formation involves colonization of rock surfaces by microbial communities. Colonization results in physical degradation, increasing the reactive surface area, resulting in substantial modification of Eh and pH conditions. Water retention is increased, and the concentrations of complexing agents and protons may be modified dramatically. These effects culminate in significant changes in mineral weathering rates (see Barker et al., 1997 for a review).

Silicate mineral weathering is arguably one of the most important reactions occurring at the Earth's surface and subsurface. Silicate mineral weathering reactions result in formation of new phases (e.g., clays and oxyhydroxide minerals), and modify aqueous and atmospheric geochemistry. Microbes can have direct effects on silicate weathering reactions, producing acids, bases, and ligands that interact with the mineral surface, catalyzing the release of ions to solution (Fig. 2), and promoting formation of secondary mineral phases. Microorganisms also have more indirect effects on silicate weathering reactions. Microbial compounds such as extracellular polysaccharides bind soil particles together, increasing water retention at the mineral surfaces, thereby increasing time for hydrolysis.

The full range of ways in which microbes impact silicate mineral dissolution and soil formation is unclear. There has been much debate over the potential magnitude of these effects, with estimates ranging from negligible to a factor of two to several orders of magnitude. The magnitude of the effect of microbial activity on mineral alteration rates probably spans this range,

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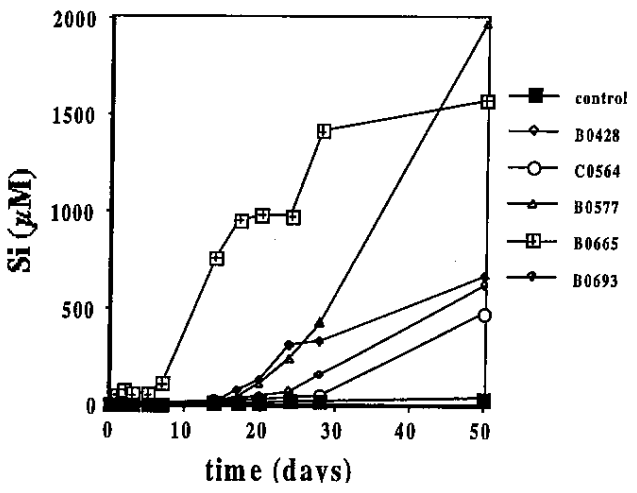

Fig. 2: Si release from feldspar in glucose metabolizing microbial cultures (B0428, C0564, B0577, B0665, B0693) and an abiotic control. Data from Barker et al. 1998 (in press).

depending upon the geochemical conditions, nature of the microbial population, and activities of individual species.

Although its clear that microbes and higher plants mediate silicate weathering reactions by accelerating the rate of destruction and formation of mineral phases, its not known if this is something they do intentionally. For example, it is unclear whether environmental stresses trigger the production of dissolution enhancing compounds, or if these are simply metabolic byproducts. All organisms need elements such as Fe, K, Mg that can be derived from silicate mineral weathering. Laboratory studies of silicate mineral weathering have demonstrated that microbes limited by Mg and K produce organic ligands and accelerate biotite dissolution (Paris et al., 1996). Controlled field experiments show bacteria preferentially colonizing and etching K-rich mineral phases (Bennett et al., 1996). Under anoxic conditions, bacteria can utilize ferric iron as an electron acceptor, catalyzing the dissolution of ferric iron-silicate mineral phases. Lithotrophs can also use reduced iron as an energy source, and live off of reduced Fe-silicate mineral phases (Stevens and McKinley, 1995)

There are approximately a billion bacteria and a million fungi cells per gram of soil. Most of these organisms are attached to surfaces, where they can interact directly with silicate minerals. While the extraordinary diversity of microbial species in soils has been established in a few DNA-based studies (e.g., Bintrim et al.,1996), their individual and collective effects are not yet well understood. Even less is known of microbial diversity and metabolism in the early stages of weathering and in the deeper subsurface. Below the soil zone, total cell numbers are lower, on the order of 10^5 to 10^8 cells per gram, and organic content is lower. However, microbes still impact mineral weathering reactions, although heterotrophs (organisms that derive energy by oxidation of organic carbon compounds) may be less important. Lithotrophic bacteria found several kilometers below the Earth's surface live by metabolizing reduced compounds from basalts (Stevens and McKinley, 1995), and these may also be important in dissolution and precipitation in partly weathered rocks and sediments. Much remains to be learned about microbial distributions and microbially-mediated reactions in the subsurface.

ii) Example of microbial control of the sulfur (and iron) cycle

Perhaps the most dramatic example of microbial impact on geochemistry is the effect of microorganisms on the sulfur cycle. Sulfur occurs in valence states from +6 to -2 in nature, with -2, -1, 0, +2, and +6 being the most common inorganic oxidation states. In oxygenated environments, reduced sulfur compounds can be oxidized by microbes, resulting in the release of sulfate to the environment. This oxidation is frequently coupled with CO2 reduction by chemolithotrophs - those organisms that derive energy from inorganic chemical sources.

The biogeochemical sulfur cycle is of enormous economic and environmental significance. Microbial sulfur oxidation occurs when sulfides are exposed at the Earth's surface through mining activities; this process is primarily responsible for environmental pollution known as acid mine drainage. However, microorganisms are also used to dissolve sulfide minerals in order to recover metals from low-grade ores at relatively low cost, making many more ore bodies economically lucrative. These processes greatly increase sulfate concentrations in river systems. While the magnitudes of global sulfur fluxes are not yet certain, current estimates indicate sulfate inputs to the oceans are in excess of the total sinks by about 10^{13} g S/yr. Almost half of the sulfate input into the ocean occurs from river runoff. It is estimated that current river transport of sulfate at >200 x 10^{12} g S/yr, is roughly double that of pre-industrial conditions (Brimblecombe et al. 1989).

Microbial catalysis of pyrite oxidation and the subsequent formation of acidic water has been recognized for almost a century. It has been estimated that microorganisms increase the rate of oxidation of Fe^{2+} by about a factor 10^6 (Singer and Stumm, 1970). Members of the genus *Thiobacillus* were the first, and have remained the predominant sulfur-oxidizing isolates (species identified by culturing) from acid mine drainage environments. A considerable amount is known about the energy generation scheme in *Thiobacillus ferrooxidans* , and the impact of this organism on Fe oxidation rates, and thus on pyrite dissolution, has been studied widely (see review by Nordstrom and Southam, 1997). However, culture-based studies provide a very incomplete picture of microbial populations and thus of the impact of microorganisms on sulfide oxidation.

T. ferrooxidans is only one of a much larger group of Fe and S oxidizing bacteria and archaea found in low pH environments. DNA-based population studies indicate that *Leptospirillum ferrooxidans* (Norris, 1983; Schrenk et al. 1998), for example, may be equally or more important in some acidic environments. At some sites, higher temperatures associated with oxidizing ore bodies (due to exothermic oxidation reactions) may explain the predominance of species other than *T. ferrooxidans* (e.g., Schrenk et al. 1998). The variation in Fe and S oxidizing populations should not be surprising, as individual species tend to be optimized for a range of geochemical conditions that is small

compared to the range of conditions encountered in acid-generating environments.

Typically, the impact of microorganisms cannot be evaluated based on an individual species, but rather, the effect is the result of a consortia. Even at very low pH, communities consist of Archaea, Bacteria, and Eukaryotes, with diverse heterotrophic and lithotrophic metabolisms (Schrenk et al. 1998, Edwards et al. 1998, 1999). Symbiotic effects are probably widespread. Cooperative action of Fe- and S-oxidizing species has been suggested, and the role of heterotrophs in removal of organic byproducts toxic to lithotrophs has been noted. It is thus essential to determine the diversity of microbes responsible for redox reactions, organic degradation, nitrogen fixation, etc. It is also critical to evaluate the distribution of species as a function of geochemical conditions in order to understand their roles. This is well illustrated using the example of *T. ferrooxidans*. When this species is associated with pyrite surfaces, it is reasonable to infer that it plays a significant role in sulfuric acid generation by catalysis of pyrite dissolution through acceleration of ferrous iron oxidation. However, *T. ferrooxidans* may be confined to peripheral regions surrounding sulfide-rich deposits (Schrenk et al. 1998). In the later case, this species actually plays an environmentally beneficial role, because energy generation from aqueous Fe^{2+} oxidation induces formation of ferric iron solids, accompanied by coprecipitation of dissolved metals.

iii) Further examples of microbial controls on iron distribution

All organisms need iron, if only in small quantities. Dissolved iron was presumably abundant when life appeared (due to relatively reduced conditions). In the post-oxygen atmosphere world, iron availability must have become problematic. For this reason, microorganisms and higher organisms (e.g., plants) produce complexing molecules (e.g., catechol and hydroxamate siderophores) that have the ability to bind and solubilize iron (Stone, 1997). These molecules are also able to increase rates of mineral dissolution (Hersman et al. 1995). Iron is also an important terminal electron acceptor (e.g., for respiration and fermentation) in anoxic environments and an electron donor (e.g., in energy generation by organisms in acidic environments). There also are many Fe biomineralization reactions. For example, greigite and magnetite are precipitated intracellularly for microbial navigation (e.g., in magnetotactic bacteria). In combination, solubilization, energy generation, and biomineralization reactions dramatically influence iron geochemistry near the Earth's surface.

iv) Methane and the global climate

Methane-producing prokaryotes (methanogens, belonging to the archael domain) live under anoxic conditions, including hot subterranean environments, anoxic sediments, wetlands, rice paddies, as well as in the guts of macroorganisms such as cows. Though methane represents a tiny fraction of the total organic carbon in the biosphere, it is a greenhouse gas and changes in its concentration in the atmosphere can dramatically impact global climate. Atmospheric methane concentration nearly doubled during the last glacial to interglacial period, from approximately 400 to 700 ppb (Schlesinger, 1997 and references therein). Concentrations have doubled again since the start of the industrial period due primarily to anthropogenic alteration of microbial methane producing habitats.

v) Microbes and the nitrogen cycle

Although nitrogen is the predominant atmospheric gas, all cells require nitrogen in the form of ammonia or nitrate. Nitrogen fixation (reduction of N2 to ammonia) is dependent upon an enzyme (nitrogenase) that is only found in a subset of prokaryotes. The organisms responsible may be free-living, but commonly live in symbiosis with plant root tissues, leaves, or surrounding soil, or in the digestive tract of animals (Ehrlich, 1996). Other organisms derive energy from oxidizing ammonia or nitrite and yet others catalyze the reduction of nitrate to N2 (Nealson and Stahl, 1997). The identities and the activities of these species are critical questions because of the pivotal role of nitrogen in the ecology of microbial communities and thus, microbe-mediated geochemistry.

vi) Phosphorus availability and fixation

All organisms require phosphorus, which is often the growth-limiting nutrient. Phosphorus is a key element in biological energy transformation reactions (ATP, ADP), structural compounds (phospholipids, teichoic acids) and for storing genetic information (DNA, RNA). In the modern environment, the predominant source of P may be organophosphate compounds or insoluble mineral phosphates (Fig. 3), with only a small fraction of the total P available as biologically active orthophosphate. Microbes produce phosphatases that enzymatically degrade organic phosphate compounds before the P can be taken up by cells (Ehrlich, 1996). It has been demonstrated that microorganisms accelerate rates of dissolution of phosphorus-bearing minerals such as apatite, aluminum phosphates, and iron phosphates by release of acids, chelators, and via reductive dissolution (e.g., Banik and Dey, 1983; Babu-Khan et al. 1995). Phosphate biomineralization is widespread at low temperature. Alternatively, microbial processes are also involved, both directly and indirectly,

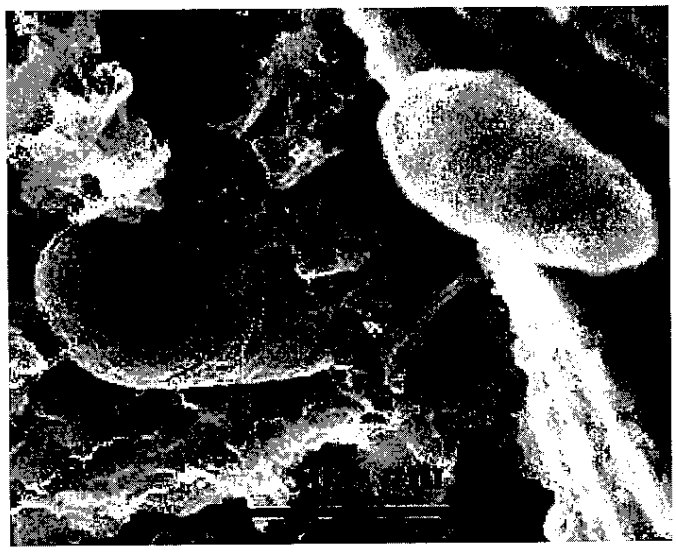

Fig. 3: Microorganisms associated with apatite and secondary products in weathered granite (Taunton et al. in prep.).

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in the sequestering of phosphate into sediments.

Concluding comments

The goal of this article is to stimulate further interest in the close association between microbes, mineral formation, mineral dissolution. The published literature has clearly demonstrated that microorganisms have played key roles in geological evolution and that they continue to dramatically affect element cycles today. In addition to basic scientific inquiry, there are additional reasons for careful attention to this topic. The modern world faces problems due to environmental pollution by metals and organic molecules, loss of soil by erosion, degradation of soil fertility due to agricultural practices, and long term safe storage of nuclear waste. Microbes can both contribute to these problems and be part of their solutions. For example, bioremediation of organic contaminants by natural or introduced populations of microbes may be a cost-effective way to clean up soil, sediment, and water. Extraction of toxic metals from solution and fixation in insoluble precipitates (see review by Gadd, 1993) may reduce aqueous metal loads (Nelson et al. 1996) and play an important role in reclamation of polluted sites. Organisms may be employed to modify metal toxicity by altering their speciation (e.g., by oxidation, reduction, methylation, dealkylation; Gadd 1992). Microbes play critical roles in soil formation. In a new millennium, welcomed by discovery of water on the moon and marked by renewed excitement about exploration of space, microbe-mineral interactions are positioned to make key contributions. If we are to be freed from the need to export soil into space, we need to know how to turn rocks into soil (and perhaps air). Microbes are expert at this task. These are but a few examples. There has been a revolution in microbiological techniques, and the methods are now sufficiently routine to deploy as part of geochemical studies. It is time to vigorously embrace these technologies and to build new paradigms for geochemical processes.

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Unsung Heroes of the Geochemical Society

Since its founding in 1955, the Geochemical Society has relied on the outstanding volunteer efforts of hundreds of distinguished scientists who have served admirably on its various committees. The Clarke, Goldschmidt, Nominations, Patterson, and Program committees are staffed from a list of candidates formulated by the Vice President of the Society, and approved by the Board of Directors. These committee members serve a three year term, and a chair is selected each year from among the experienced members. Other committees are staffed somewhat differently, as described below.

The Geochemical Society is rapidly evolving from a largely North American organization, to a truly international society, and this international emphasis is becoming increasingly seen in the makeup of our committees. In the staffing process, great consideration is also given to promoting balance and diversity, in terms of geochemical subdiscipline, gender, race, career stage, and institutional affiliation, among other factors. Strict guidelines are established to eliminate any possibility of conflict of interest in the recommendations of the committees.

Most of our past committee members have found this experience both stimulating and beneficial to their careers. Those invited to serve, and approved by the GS Board or relevant governing body, have a real opportunity to make an impact on the field of geochemistry. Interested persons may contact our Vice President, Michael F. Hochella, Jr. (Dept. Geological Sciences, Virginia Polytechnic Institute, Blacksburg, Virginia, 24061 USA, email – hochella@vt.edu) for further details.

Here is a brief description, in alphabetical order, of the duties of each of our committees. Space does not permit the listing of all past committee members, and indeed, record of their service is dissolving in the mists of time. Listed below are the members of the 1997/98 and 1998/99 committees. Please let them know that their work is appreciated!

The **F.W. Clarke Award** recognizes a single outstanding contribution by a recently-graduated scientist in the general field of geochemistry. The committee selects a candidate and an alternate from a list of nominees submitted by the geochemical community. Nominations come as a result of ads in *Geochimica et Cosmochimica Acta*, the GS Homepage, and *The Geochemical News*, and the committee members also solicit nominations. Often several rounds of voting are needed to arrive at a final recommendation. Dr. Munir Humayun of the University of Chicago will receive the 1998 Clarke Medal at the Goldschmidt Conference in Toulouse, France, August 30 – September 3, 1998.

F.W. Clarke Award Committee

John H. Jones[a]	Laura Crossey
Samuel Traina[b]	Patricia M. Dove
Barb Dutrow[1]	Donald B. Dingwell[2]
R. Keith O'Nions[1]	Stanley R. Hart[2]

The **V.M Goldschmidt Award** Committee, using a process similar to that described above for the Clarke Committee, selects a candidate and alternate to receive the Society's highest award and accompanying honorarium, for lifetime achievement in the broad discipline of geochemical sciences. Dr. Werner Stumm of ETH/Zürich will receive the 1998 award in Toulouse.

V.M. Goldschmidt Award Committee

Kristin Vala Ragnarsdottir[a,1]	Chris Hawkesworth
Gerald Wasserburg	Miriam Kastner[b]
Heinrich Holland[2]	Charles Langmuir[1]
Alan T. Stone[2]	Cindy Lee

The **Nominations** Committee selects candidates to replace the Society's officers and directors, as their terms expire. The committee's recommendations are first approved by the current Board (16 directors, including the 9 officers and 7 non-officer directors), and then this slate is presented to the entire membership. Members may make additional nominations before the slate is finally approved, but the Nominations Committee has done such a stellar job in the past that a vote of the entire membership is rarely needed.

Nominations Committee

Roberta Rudnick[a,1]	Dean Presnall
Eric Oelkers[b]	Bernhard Wehrli
Cindy Lee[1]	Marilyn Fogel[2]
Jonathan Patchett	E. Bruce Watson[2]

The **Clair C. Patterson Award** is a new medal that will be given in recognition of a major contribution in environmental geochemistry. The award honors the many achievements of the late Clair C. Patterson, especially his work concerning lead contamination from anthropogenic vs natural sources. The current intention is to bestow the award every other year, at the Goldschmidt Conference, and the inaugural 1998 medalist is Dr. Michael Bender of Princeton University.

C. C. Patterson Award Committee

Alex N. Halliday[a]	Malcolm McCulloch
Joel D. Blum	Judith McKenzie
Edward A. Boyle	Leon T. Silver

The **Program** Committee is charged with promoting the organization of GS-sponsored symposia, theme sessions, and special conferences. Traditionally, this committee has focussed most of its efforts on the spring AGU and fall GSA annual meetings, which the Society co-sponsors. A major task of the committee is the organization of volunteered abstracts in geochemical subject areas into coherent technical sessions, and helping AGU and GSA schedule them to avoid massive overlap with concurrent sessions at the meetings. The committee also schedules the Society's Ingerson Lecture at GSA. This year's lecturer in Toronto will be Dr. Susan W. Kieffer of Kieffer and Woo, Inc. Due to the complexity of this committee's function, the chair often serves for more than one year.

Program Committee

Bill McDonough[a,b]
Rebecca Lange[1]
Everett L. Shock[1]
Rosemary Capo
Louis Derry
R. Lawrence Edwards
Richard Walker
Susan L.S. Stipp[2]
David Burdige[2]

The **Alfred E. Treibs Award** is bestowed by the GS's Organic Geochemistry Division (OGD) in recognition of lifetime achievement in organic geochemistry. This committee is appointed by the OGD officers and councilors. The award is normally presented in odd years at the Gordon Research Conference on organic geochemistry.

A.E. Treibs Award Committee

John W. Farrington (Chair)
Robert Alexander
Marilyn Fogel
Susan M. Heinrichs
Keith A. Kvenvolden

In addition to these regular committees, appointed by the officers and directors of the Geochemical Society and its Organic Geochemistry Division, two very important committees are active in helping the society function.

The **Geochemistry Fellows** Selection Committee members are appointed for two-year terms, jointly by the GS Board and EAG Council, based upon the recommendations of the Goldschmidt Forum (the Presidents and Vice Presidents of the two Societies). This committee solicits nominations, and selects candidates for recognition of a long period of substantial contributions to geochemistry. It is noteworthy that membership in either society is not a criterion in the selection process. This is also true of the other awards of the Geochemical Society.

Geochemistry Fellows Selection Committee

John M. Hayes[a,1]
Albrecht W. Hofmann[1]
Teresa S. Bowers[1]
Donald J. DePaolo
Peter Fritz
Terry M. Seward[b]
Alexandra Navrotsky[2]
Charles H. Langmuir[2]
Bernard J. Wood[2]

Last, but certainly not least, is the Joint Publications Committee, whose task is to recommend candidates for Executive Editor of *Geochimica et Cosmochimica Acta* to the governing bodies of the Geochemical Society and the Meteoritical Society which co-sponsor the journal, to represent the two societies in the establishment of contracts with the publisher (Elsevier Science Ltd.), to make recommendations to the Executive Editor based upon input from the societies and the readership, and to serve as arbitrator between authors and the Editorial Advisory Board.

Joint Publications Committee

Frank Podosek (Chair)
Larry Grossman
Richard M. Mitterer
Everett L. Shock
Garrison Sposito
Grenville Turner

[Key - [a]1997/98 Chair; [b]1998/99 Chair; [1]outgoing member; [2]incoming member]

9th V.M. Goldschmidt Conference
Harvard University, Cambridge, MA, U. S. A.
August 22-27, 1999

Contact:

Stein B. Jacobsen
Department of Earth and Planetary Sciences
Harvard University
Cambridge MA 02138
Phone: 617-495-5233
Fax: 617-496-4387
E-mail: goldschmidt@eps.harvard.edu

Program Committee:

Harvard: C. Agee, H. Holland, S. Jacobsen, W. McDonough, R. Rudnick, D. Schrag, M. VanBaalen. *MIT*: S. Bowring, F. Frey. *Gradient Corp.*: T. Bowers. *BU*: R. Murray. *WHOI*: J. Hayes, N. Shimizu.

The Geochemical Society 1999 Awards Nominations

V.M. Goldschmidt Award

The V.M. Goldschmidt Award shall be made for major achievements in geochemistry or cosmochemistry, consisting of either a single outstanding contribution, or a series of publications that have had great influence on the field. The award will normally be given annually at the V.M. Goldschmidt Conference. Current members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society.

Past Recipients: P.W. Gast (1972), R.M. Garrels (1973), H.E. Suess (1974), H.C. Urey (1975), H.P. Eugster (1976), S. Epstein (1977), G.J. Wasserburg (1978), H. Craig (1979), C.C. Patterson (1980), R.N. Clayton (1981), K.B. Krauskopf (1982), S.S. Goldich (1983), A.O. Nier (1984), J.B. Thompson (1985), C.J. Allégre (1986), W.S. Broecker (1987), H.C. Helgeson (1988), K.K. Turekian (1989), E. Anders (1990), A.E. Ringwood (1991), S.R. Hart (1992), S.R. Taylor (1993), H.D. Holland (1994), R. Berner (1995), A.W. Hofmann (1996), D. Lal (1997), W. Stumm (1998)

Nominations should specify the name, address, and chief fields of specialization of the nominee, and be accompanied by a curriculum vitae and bibliography of the nominee, limited to two pages each, and up to three supporting letters. Nominations should also be accompanied by a letter from the nominator giving name, address, phone number, signature, and a brief summary of why the candidate is suitable for the award.

Nominations for the 1999 V.M. Goldschmidt Award should be submitted before October 1, 1998, to:

Dr. Miriam Kastner
Scripps Inst. Oceanography, 0212
9500 Gilman Drive
La Jolla, California 92093, USA

Tel: 1-619-534-2065
Fax: 1-619-534-0784
E: mkastner@ucsd.edu

F. W. Clarke Award

The F.W. Clarke Award shall normally be made annually at the V.M. Goldschmidt Conference to an early-career scientist for a single outstanding contribution to geochemistry or cosmo-chemistry, published either as a single paper or a series of papers on a single topic. Candidates must have held a recognized doctorate or its equivalent for no more than six (6) years, or be not more than thirty-five (35) years of age, whichever anniversary date is later in the year of the nomination deadline. Current members of the Board of Directors and past recipients of the award are ineligible for nomination. The Clarke and Patterson medals cannot be awarded for the same accomplishment. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society.

Past Recipients: D.A. Papanastassiou (1972), H. Ohmoto (1973), L. Grossman (1974), D. Walker (1975), J.R. Wood (1976), B. Mysen (1977), D.J. DePaolo (1978), A.C. Lasaga (1979), R.W. Potter (1980), J.F. Minster (1981), P.J. Patchett (1982), E.B. Watson (1983), A. Mackenzie (1984), E.M. Stolper (1985), M.D. Kurz (1986), E. Takahashi (1987), F.M. Phillips (1988), R.J. Walker (1990), D. Sherman (1991), E. Klein (1992), Y Zhang (1993), C. Agee (1994), R. Lange (1995), P.M. Dove (1996), J. Blundy (1997), M. Humayun (1998)

Nominations should specify the name, address, and chief fields of specialization of the nominee, and be accompanied by a copy of the paper(s) for which the nominee is being considered for the award, and up to three supporting letters. Nominations should also be accompanied by a letter from the nominator giving name, address, phone number, and signature, together with a brief statement explaining the significance of the nominee's work. This letter should also specify the nominee's date of birth and final degree received, the degree advisor's name, the year granted, and the name of the granting institution.

Nominations for the 1999 F.W. Clarke Award should be submitted before October 1, 1998, to:

Dr. Samuel Traina
School of Natural Resources
Ohio State University
210 Kottman Hall, 2021 Coffey Road
Columbus, Ohio 43210, USA

Tel: 1-614-292-9037
Fax: 1-614-292-7432
Email: traina.1@osu.edu

Alfred E. Treibs Award

The Organic Geochemistry Division (OGD) of the Society bestows this award, for major achievements in organic geochemistry. A separate nominations call will be announced, and inquiries may be made to OGD Secretary Steven A. Macko, Dept. Environmental Science, University of Virginia, Charlottesville, Virginia 22903, USA (Phone: 1-804-924-6849; Fax: 1-804-982-2137; Email: sam8f@virginia.edu).

Clair C. Patterson Award

This is a new award of the Geochemical Society, for a recent innovative breakthrough in environmental geochemistry of fundamental significance, published in a peer-reviewed journal. Nominations are still open for the 1998 award, which will normally be made biennially at the V.M. Goldschmidt Conference. The award has no age or career stage restrictions, but the Clarke and Patterson medals cannot be awarded for the same accomplishment. Members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination.

Nominations should include the name, address, and chief fields of specialization of the nominee, and be accompanied by a curriculum vita of not more than two pages, a list of no more than 10 peer-reviewed publications relevant to the accomplish-ment being recognized, and up to three support letters. Nominators should include a letter of not more than two pages, giving name, address, phone number, signature, and a brief description of the nominee's contribution to environmental geochemistry.

Nominations for the 1998 Clair C. Patterson Award should be submitted before May 1, 1998, to:

Dr. Alex N. Halliday
Department of Geological Sciences
The University of Michigan
2534 C. C. Little Building
Ann Arbor, MI 48109-1063, USA

Tel: 1-313-936-3601
Fax: 1-313-763-4690
E: anh@umich.edu

Call for Nominations for 1999 Joint EAG-GS Geochemistry Fellows

The European Association for Geochemistry (EAG) and the Geochemical Society (GS) established in 1996 the honorary title of Geochemistry Fellow, to be bestowed upon outstanding scientists who have, over some years, made a major contribution to the field of geochemistry. Existing and new Urey, Goldschmidt and Treibs Medal winners become Fellows automatically. Approximately 15 new Fellows will be elected each year, representing about 0.5% of the combined membership. However, membership in either organization is not a factor in consideration of Fellows candidates. Current members of the Fellows Selection Committee, the GS Board of Directors, and the EAG Council are ineligible for nomination. Any member of either organization may nominate Fellows by right.

Nominations should include the name, address, telephone number and email address of the nominee, a citation of no more than two pages describing the contributions the individual has made to geochemistry, and up to three letters of support from members of either society. The nomination should also include the nominator's name, address, telephone number, and signature.

Nominations should be sent no later than October 1, 1998 to:

Dr. Terry M. Seward
Institut für Mineralogie und Petrographie
ETH-Zentrum
CH-8092, Zürich
Switzerland

Tel. 41-1-632-2227
Fax: 41-1-632-1088
Email: tseward@erdw.ethz.ch

Geochemistry Fellows (excluding Urey, Goldschmidt, and Treibs Medalists)
1996 William Compston, Willi Dansgaard, John Edmond, John M. Hayes, Marc Javoy, Ho-Kwang Mao, Stephen Moorbath, John Reynolds, Jean-Guy Schilling, Nick Shackleton, Mitsunobu Tatsumoto, Werner Stumm, George Tilton, Grenville Turner, Heinrich Wänke, William White
1997 Philip Abelson, Jan Bottinga, Ian Carmichael, Donald J. DePaolo, Bruno J. Giletti, Tom Krogh, Ikuo Kushiro, Gunter W. Lugmair, Fred T. Mackenzie, Alexandra Navrotsky, Michael O'Hara, Keith O'Nions, Denis M. Shaw, Edward M. Stolper, George W. Wetherill, Derek York
1998 Thomas J. Ahrens, Francis Albarede, Michael L. Bender, Edward A. Boyle, Eric M. Galimov, John I. Hedges, Miriam Kastner, Yehoshua Kolodny, Charles H. Langmuir, Antonio C. Lasaga, James R. O'Neil, George Parks, James C.G Walker, David Walker, E. Bruce Watson, Bernard J. Wood, Jan Veizer, Ernst Zinner

Second GERM Workshop held in La Jolla, California, March 11-13, 1998

Hubert Staudigel
Institute For Geophysics and Planetary Physics
Scripps Institution of Oceanography
University of California at San Diego - 0225
La Jolla CA 92093-0225

Bill McDonough
Earth and Planetary Sciences
Harvard University
20 Oxford St
Cambridge, MA 02138

Henry Shaw
Geosciences and Environmental Technology, L-201
Lawrence Livermore National Laboratory
Livermore, CA 94551

The Geochemical Earth Reference Model ("GERM") Initiative is a grass-roots effort within the geochemical community aimed at establishing globally relevant geochemical databases that will ultimately lead to a "geochemical reference model" for the Earth. This reference model will include a complete set of chemical data for all major geochemical reservoirs, and the fluxes between them. The GERM effort was initiated during a workshop in Lyon, France in March 1996. This workshop led to a special volume of *Chemical Geology* (Albarede, *et al.* 1998) and the development of a regularly updated website (http://www-ep.es.llnl.gov/germ/germ-home.html) that includes a wide spectrum of useful geochemical data and other information (see also Staudigel *et al.*, 1998).

The aim of the second GERM workshop, held in La Jolla, CA and hosted by the Scripps Institute of Oceanography (SIO) was to foster a multi-disciplinary discussion about the earth as a complex geochemical system. Discussions at the La Jolla workshop successfully integrated geophysics with a wide range of geochemical subdisciplines, including cosmochemistry, and the chemistry of the atmosphere, hydrosphere, and lithosphere. The workshop format was based on keynote presentations followed by extensive discussions that were moderated by discussion leaders (participants and their functions are listed at the end of this note). In addition, smaller "breakout" sessions were held on specific topics relating to the actual development of the web-based GERM. In some sessions a number of groups were established to promote further studies and sharing of samples in order to foster a better understanding of specific reservoirs and fluxes (*e.g.*, the arc environment).

Discussions on oceanic crustal data pointed up the need to consider the composition of fresh oceanic crust, as it is extracted from the mantle, as well as the altered oceanic crust that is subducted at arcs. Altered oceanic crust provides the input into island arcs where some of its inventory is extracted to form arc volcanoes and some of it is injected into the mantle where it may provide material for the source regions of some ocean island basalts. Differences between altered and fresh oceanic crust provide an estimate for chemical fluxes between seawater and oceanic crust.

Debate related to the continental crust focussed on whether there is a secular evolution in its composition and the "basalt paradox": why the crust does not have a basaltic bulk composition even though these appear to be the primary magmatic additions to the crust. Possible solutions to this paradox include weathering of primary basalt, returning Mg (± Ca and Fe) to the mantle through the oceanic ridge systems, delamination of mafic and ultramafic cumulates from the base of the crust or non-basaltic primary magmatic additions (e.g., Archean tonalites and trondhjemites). In addition, the dominant tectonic setting of crustal growth was variably attributed to plumes (due to the apparent episodic nature of crust formation) or arcs (based on the bulk chemistry of the crust).

Discussions of the chemistry of the oceans and the atmosphere mostly focussed on their long-term evolution over the entire history of the earth, and the relationships between seawater isotopic composition and climate.

These scientific discussions led up to a series of working group sessions that focussed on how GERM can help improve our understanding of the earth. In particular the workshop emphasized the need for:

- more community participation;
- involvement with other globally relevant initiatives and programs (such as ODP, REM, Margins, RIDGE, JGOFS);
- peer review of materials placed on the GERM web site;
- establishment of well structured data bases using common formats insofar as possible; and
- using GERM as an umbrella organization for fostering and coordinating a variety of community efforts.

Specific progress on some of these issues included an agreement to set up a joint office for GERM and the geophysical Reference Earth Model (REM) at Scripps Institution of Oceanography in fall 1998 (Staudigel and Masters) and to establish contacts with the MARGINS initiative (Bebout). Considerable progress was made toward the coordination of the GERM database effort with other ongoing efforts to compile databases for specific reser-

voirs. Along these lines, C.H. Langmuir (Lamont), A. Hofmann (Max Planck Institute) and C. Hawksworth (Open University), will be compiling geochemical data for MORB, Ocean Islands, and Island Arcs, respectively.

The GERM workshop succeeded in bringing together expertise from very diverse fields of earth science, with the common focus of improving our understanding of the make-up of the planet and the processes that control its interactions. Much progress was made on advancing the GERM initiative, but it is very obvious that this effort needs the continued support by the geochemical community. In return, the effort offers the community the opportunity a basis for identifying key issues that need resolution, a convenient resource for data compilations and abstractions, and a forum for bringing together earth scientists with different backgrounds to work on common geochemical problems.

Conference Participants and their functions (KN Keynote Speaker, DL Discussion Leader, CON Convenor. PO poster presentation, GE GERM editor, GSt Steering Committee)

Albarede, F. (CON, GSt, PO, albarede@geologie.ens-lyon.fr)
Anderson, D. (DL, GSt., PO dla@seismo.gps.caltech.edu)
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Bebout, G. (GE PO geb0@lehigh.edu)
Bohrson, W. (bohrson@magic.geol.ucsb.edu)
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Vervoort, J. (PO, vervoort@geo.arizona.edu)
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Acknowledgements

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References

Albarede, F., Blicher-Toft, J., Staudigel, H. and White, W.M. (eds), 1998, Geochemical Earth Reference Model (GERM), Special Issue of *Chemical Geology*, Vol 145, p 1563-491.

Staudigel, H., Albarede, F., Blicher-Toft, J., Edmond, J., McDonough, W., Jacobsen, S. B., Keeling, R., Langmuir, C. H., Nielsen, R. L., Plank, T., Rudnick, R., Shaw, H. F., Shirey, S., Veizer, J. and White, W.M., 1998, Geochemical Earth Reference Model (GERM): description of the Initiative., *Chemical Geology*, 145: 153-160.

Meetings Calendar

June 29-July 15, 1998: 8th International Platinum Symposium (IAGOD/CODMUR), Johannesburg, South Africa. Contact: Dr. C. A. Lee, P.O. Box 68108, Bryanstown, South Africa. Tel: + 27 1127 373 2580; Fax: + 27 1127 836 0371; Email: clee@amplats.co.za

June 29-July 2, 1998: 15th Caribbean Geological Conference, Kingston, Jamaica. Contact:: Trevor Jackson, 15th Caribbean Geological Conference, c/o Dept. of Geography & Geology, University of the West Indies, Kingston 7, Jamaica. Fax 809-977-6029.

July 4-11, 1998: Processes of Crustal Differentiation (Geological Society of America), Verbania, Italy. Contact: Tracy Rushmer, Dept. Of Geology, University of Vermont, Burlington, VT 05405 USA. Tel: 802-656-8136; Fax: 802-656-0045; Email: trushmer@zoo.uvm.edu

July 5-10, 1998: 18th International Congress on Glass, San Francisco, CA USA. Contact: American Ceramic Society. Tel. 614-794-5890; http://www.acers.org/

July 6-10, 1998: Australian Geological Convention, Townsville, Australia. Contact: Debbie Buckley, School of Earth Sciences, James Cook University, Townsville QLD 4811, Australia. Tel: +61 077 81 5047; Fax: +61 077 25 1501; Email: jcu.edu.au; http://www.jcu.au/dept/Earth/l/AGC14.html

July 7-14, 1998: Coupled Ocean-Atmosphere Response Experiment '98 (COARE98), Boulder, CO USA. Contact: B. Jackson, University Corporation for Atmospheric Research/Joint Office for Science Support Program Support Group, P.O. Box 3000, Boulder, CO 80307-3000 USA. Tel: 303-497-8663; Fax: 303-497-8633; Email: bjackson@ucar.edu; http://www.joss.ucar.edu/joss_psg/project/coare98/

July 8-10, 1998: Geological Society of South Africa Geocongress '98, Pretoria, South Africa. Contact: Congress Secretary, Tel: 27-12-8411167, fax 27-12-8411221; Email: eaucamp@geoscience.org.za; http://www.geoscience.org.za/geocongress

July 11-17, 1998: IAVCEI International Volcanological Congress '98, Rondebosch, South Africa. Contact: Secretariat, IAVCEI 1998, Dept. Of Geological Sciences, University of Cape Town, Rondebosch, South Africa. Fax: + 27 21 650 3783; Email: ivc98@geology.uct.ac.za; http://www.uct.ac.za/depts/geolsci/ivc98/

July 21-24, 1998: 1998 Western Pacific Geophysics Meeting, Taipei, Taiwan. Contact: Tel: 800-966-2481 or 202-462-6900; http://www.agu.org (Click on Meetings, Click on 1998 Western Pacific Geophysics Meeting).

July 26-30, 1998: Society for Organic Petrology 15th Annual Meeting, Halifax, Nova Scotia. Contact: P. K. Mukhopadhyay, Global Geoenergy Res., Box 9469, Station A, Halifax, NS B3K 5S3, Canada. Tel: 902-453-0061; Email: avery@agc.bio. ns.ca; http://agc.bio.ns.ca/tsophalifax98.

Aug. 5-8, 1998: Eighth International Symposium on Solubility Phenomena, Niigata, Japan. Contact: Kiyoshi Sawada, General Secretary of the 8th ISSP, Dept. Of Chemistry, Faculty of Science, Niigata University, Niigata 950-21, Japan. Tel: + 81 25 262 6265; Fax: + 81 25 262 6116; Email: issp@sc.niigata-u.ac.jp

Aug. 9-12, 1998: 4th International Symposium on Environmental Geotechnology and Global Sustainable Development, Boston, MA USA. (Abstract deadline: Nov. 15, 1997). Contact: H. I. Inyang, Center for Environmental Engineering and Science Technologies, James B. Francis College of Engineering, University of Massachusetts-Lowell, One University Avenue, Lowell, MA 01854 USA. Tel: 508-934-2285; Fax: 508-934-3092; Email: inyangh@woods.uml.edu

Aug. 9-14, 1998: International Mineralogical Association: IMA '98, 17th General Meeting, Toronto, Canada. Contact: Professor A. J. Naldrett, Dept. Of Geology, University of Toronto, Canada M5S 3B1. Tel: 461-978-3030; Fax: 416-978-3938; Email: ima98@quartz.geology.utoronto.ca; http://www.geology.utoronto.ca/ima98

Aug. 10-16, 1998: International Ophiolite Symposium and Field Excursion; Generation and Emplacement of Ophiolites Through Time, Oulu, Finland. Contact: Jouni Vuollo, Dept. Of Geology, University of Oulu, FIN-90570 Oulu, Finland; Fax: + 358-81-5531484; Email: vuollo@sveka.oulu.fi or Eero Hanski, Geological Survey of Finland, P.O. Box 77, FIN-96101 Rovaniemi, Finland. Fax: + 358-60-3297289; Email: eero.hanski@gsf.fi

Aug. 15-20, 1998: Sixth International Congress on History of Oceanography, Qingdao, China. (Abstract deadline: Nov. 30, 1997). Contact: G.-K. Tan, First Institute of Oceanography, SOA, 3A Hongdao Branch Road, Qingdao 266003, P. R. China. Tel: + 86-532-2883127; Fax: + 86-532-2879562; Email: fiokjc@ns.qd.sd.cn

Aug. 17-20, 1998: The Second International Conference on Climate and Water, Espoo, Finland. Contact: N. Helenius, Helsinki University of Technology, Water Res. Eng., Tietotie 1, FIN-02150 Espoo, Finland. Tel: + 358 9 275 3835; Fax: + 358 9 451 3827; Email: nheleniu@ahti.hut.fi; http://ahti.hut.fi/wr/caw2

Aug. 19-25, 1998: Global Atmospheric Chemistry and Climate, Seattle, WA USA. Contact: Patricia Quinn, CACGP/ICAG Meeting - 1998, NOAA/PMEL OCRD, Bldg. 3, 7600 Sand Point Wa NE, Seattle, WA 98115 USA. Fax: 206-526-6744; Email: quinn@pmel.noaa.gov

August 20-26, 1998: 9th International Conf. on Geochronology, Cosmochronology & Isotope Chemistry (ICOG-9), Beijing, China. Abstract Deadline: Mar. 1, 1998. Contact: ICOG-9 Secretariat, Chinese Academy of Geological Sciences, Baiwanzhuang Road 26 , Beijing 100037, P.R. China. Tel: +86-(10)-6831-1545 and +86-(10)-6832-6456; Fax: 86-(10)-6831-1545; e-mail: liudunyi@public.bta.net.cn; http://www.cags.net.cn

August 23-27, 1998: American Chemical Society National Meeting, Boston, Massachusetts. Contact: Sally Pecor, ACS News Service, 1155 16th St., N.W., Washington, DC 20036, Tel: 202- 872-4451; Fax 202-872-4370; Email: s_pecor@acs.org.

Aug. 30-Sep. 3, 1998: 8th Annual V.M. Goldschmidt Conference, Toulouse, France. Contact: 8th Annual V.M. Goldschmidt Conference Laboratorie de Geochimie, 38, rue des 36 Pons, 31400 Toulouse France. Tel: +33-561-55-65-18 or +33-561-55-87-85; Fax: +33-561-52-05-44 e-mail: goldconf@lucid.ups-tlse.fr; http://www.obs-mip.fr/omp/umr5563/goldconf98.html *(see page 9)*

Aug. 30-Sep. 4, 1998: Clay Mineralogy and Petrology Conference and Workshop, Brno, Czech Republic, by International Geological Correlation Programme Project No. 405. Contact: Petr Sulovsky, Dept. Of Mineralogy, Petrology, and Geochemistry, Faculty of Science, Masaryk University, Kotlarska 2, CZ 611 37 Brno, Czech Republic. Fax: + 420 541211214; Email: clays@sci.muni.cz

Sept. 7- 9, 1998: Microscopic Properties and Processes in Minerals, NATO Advanced Study Institute, Lucca, Italy. Contact: Prof. Catlow Royal Institution, Albemarle St., London W1X 4BS England. http://www.esc.cam.ac.uk/nato/

Sept. 12-18, 1998: European Union, Università di Siena -Vrije Universiteit Amsterdam - Universitetet i Oslo, SOCRATES - Intensive Programme, Modern Trends in Fluid-Phase Petrology. Contact: Maria-Luce Frezzotti, Dipartimento Scienze Terra, Via delle Cerchia n.3, 53100 Siena, Italy. Tel: +39 577 298915; Fax: +39 577 298815; Email: frezzotti@dst.unisi.it

September 21-25, 1998: First National Meeting of Earth Sciences/Primera Reunion Nacional de Ciencias de la Tierra, Mexico City, Mexico
Abstract deadline: April 30, 1998. Contact: Jessica Ortega, 541-08-79. Abstract sent to: Luca Ferrari Pedraglio, Instituto de Geologia, UNAM, Circuito exterior, Ciudad Universitaria, Coyoacan, 04510; Mexico, D.F. or email to: luca@servidor.unam.mx -or- sgm@geol sun.igeolcu.unam.mx

Sep. 21-25, 1998: GQ '98: International Conference and Special Workshops on Groundwater Quality: Remediation and Protection, Tubingen, Germany. Contact: Conference Secretariat GQ '98, c/o Lehrstuhl fur Angewandte Geologie, Sigwartstrasse 10, D-72076 Tubingen, Germany. Tel: + 49-7071-2974692; Fax: + 49-7071-5059; Email: mike.herbert@uni-tuebingen.de

Oct. 6-10, 1998: GEO-BERLIN '98, A joint meeting of Deutsche Geologische Gesellschaft, Deutsche Mineralogische Gesellschaft, and other geoscientific societies, Berlin, Germany, Abstract Deadline: Mar. 1, 1998, Contact: Frau Kaiser, Tel: (+49)-30-314-21457; Fax: (+49)-30-314-24087; Email: kaiser@wtb.zuv.tu-berlin.de

Oct. 26-29, 1998: 1998 GSA Annual Meeting, Toronto, Canada. Abstract Deadline (electronic via www) July 13, 1998. Contact: GSA, 3300 Penrose Place, Boulder, CO 80301 USA. Tel: 303-447-2020; Fax: 303-447-1133; http://www.geosociety.org/meetings/index.htm

November 8-9, 1998: National Academy of Sciences Colloquium on "Geology, Mineralogy and Human Welfare", Beckman Center, Irvine, California. Information and Registration: Edward Patte, National Academy of Sciences, NAS-146, 2101 Constitution Avenue, NW, Washington DC 20418. Tel: (202) 334-2445; Fax: (202) 334-2153; E-mail: epatte@nas.edu; For further information see: http://www2.nas.edu/abstract/20fa.html.

November 9-13, 1998: Mexican Geophysical Union Annual Meeting/La Reunion de UGM, Puerto Vallarta, Mexico. Abstract Deadline: August 31, 1998. Contact: Victor Frias, 74-45-01 (ask for UGM); email: ugm@cicese.mx; http:\\www.ugm.org.mx

Dec. 1-3, 1998: The Origin of the Earth and Moon, Geochemical Society Topical Conference, Monterey, CA USA. Contact: LPI; 3600 Bay Area Blvd.; Houston, TX USA. Email: simmons@lpi.jsc.nasa.gov

Dec. 6-10, 1998: Fall AGU Meeting, San Francisco, CA USA. Abstract Deadline: August 27, 1998. Contact: AGU Meetings Dept., 2000 Florida Ave. NW, Washington, DC 20009 USA. Tel: 800-966-2481 or 202-462-6910, ext. 215; Fax: 202-328-0566; Email: meetinginfo@kosmos.agu.org (Subject: 1998 Fall Meeting)

May 26-28, 1999: Geological Association of Canada-Mineralogical Association of Canada Joint Annual Meeting, Sudbury, Ontario. Contact: P. Copper, Dept. of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, Canada, Tel: 705- 675-1151, ext. 2267; Fax 705-675-4898; Email: gacmac99@nickel.laurentian.ca.

July 11-16, 1999: Meteoritical Society 62nd Annual Meeting, Johannesburg, South Africa. Contact: W. U. Reimold, Dept. of Geology, University of the Witwatersrand, Private Bag 3, P.O. Wits 2050, Johannesburg, South Africa. Tel: 27 11 716 2946; Fax: 27 11 339 1697 Email: 065wur@cosmos.wits.ac.za.

July 19-30, 1999: IUGG '99: The 22nd General Asembly of the International Union of Geodesy and Geophysics, The University of Birmingham, UK, Abstract Deadline: January 15, 1999. Will include programs of the International Associations of Volcanology and Chemistry of the Earth's Interior (IAVCEI), Seismology and Physics of the Earth's Interior (IASPEI), Meteorology and Atmospheric Sciences (IAMAS), Physical Sciences of the Ocean (IAPSO), Geomagnetism and Aeronomy (IAGA), Hydrological Sciences (IAHS), and Geodesy (IAG).To receive the Second Circular (May/June, 1998), Contact: IUGG99, School of Earth Sciences, The University of Birmingham, Edgbaston, Birmingham BIS 2TT, UK; Fax: 44121414 4942; Email: IUGG99@bham.acMk.; http://www.bham.ac.uk/IUGG99/

Sept. 12-15, 1999: Third International Workshop on Orogenic Lherzolites and Mantle Processes, Pavia, Italy. http://www_crystal.unipv.it

Oct. 25-28, 1999: GSA Annual Meeting, Denver, CO USA, Contact: Becky Martin, GSA Meetings Department, Box 9140 Boulder, CO 80301-9140 USA. Tel: +1-303-447-2020, ext. 164; Fax: +1-303-447-1133.

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