# THE GEOCHEMICAL NEWS

Newsletter of The Geochemical Society

in cooperation with The European Association of Geochemistry

NUMBER 113 ISSN 0016-7010 OCTOBER 2002

## Iron and Fire

*The Hydrothermal Onset of Life*

## Microelectrodes

*In Situ Environmental Sensors*

# 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), the ***Reviews in Mineralogy and Geochemistry Series*** (jointly with the Mineralogical Society of America), the journal ***Geochimica et Cosmochimica Acta*** (jointly with the Meteoritical Society), and co-publishes the electronic journal $G^3$ (jointly with the American Geophysical Union: AGU); grants the ***V.M. Goldschmidt***, ***F.W. Clarke*** and ***Clair C. Patterson Awards***, and, jointly with the European Association of Geochemistry (EAG), the Geochemistry Fellows title; sponsors the V.M. Goldschmidt Conference, held in North America in odd years and elsewhere in even years, jointly with the EAG; and co-sponsors the Geological Society of America annual meeting and the AGU spring meeting. The Society honors our first President, F. Earl Ingerson, and our first Goldschmidt Medalist, Paul W. Gast, with the ***Ingerson*** and ***Gast Lectures***, held annually at the GSA Meeting and the V.M. Goldschmidt Conference, respectively. 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.

# THE GEOCHEMICAL NEWS
## October 2002

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The Geochemical News © Copyright 2002, The Geochemical Society (ISSN 0016-7010). GN is published quarterly (Jan, April, July, Oct).

**POSTMASTER:** Send address changes to The Geochemical Society, Dept of Earth and Planetary Sciences, Washington University, One Brookings Drive, St.Louis, MO 63130-4899, USA.

## From the President:

### The 2002 Goldschmidt Conference – "From Stars to Life"

Here in Switzerland, the euphoria produced by a highly successful Goldschmidt Conference is gradually fading in the golden light of autumn. With approximately 1700 participants, this Conference was undoubtedly the most well attended to date. The overall success of a conference, however, is not just in the number of participants but has much to do with the quality of presentations, the variety of themes and the possibilities for interaction. Davos received excellent marks in all of these categories. It was simply a "high" to be among so many geochemists, to hear the latest accomplishments in our diverse sub-fields, and to learn that established concepts are being re-evaluated and new ones are emerging. The publication of the abstracts as a special issue of *Geochimica et Cosmochimica Acta* was an appreciated new initiative this year, providing the participants with a substantial volume containing 1750 abstracts in a solidly bound format. Details of the Conference highlights will appear in an upcoming issue of GN. Finally, I would like to take this opportunity to thank Alex Halliday and all of his co-organizers in Japan. Scheduling a Goldschmidt Conference beyond the borders of the USA or Europe is a major step towards becoming truly international in scope. The Conference will be held at Kurashiki-Sakuyo University, which is located just outside the well-preserved, historical town of Kurashiki, a local trading center in western Japan during the Edo period (17th to 19th centuries). This venue will provide geochemists and cosmochemists the opportunity to exchange ideas on a wide range of topics at the frontiers of geochemistry in a unique cultural setting. The first circular for the Conference was printed in July 2002 and more information can be obtained from the Conference web site at www.ics-inc.co.jp/gold2003/. A call for special sessions has been announced, with a deadline for session proposals to be submitted by October 31, 2002.

### Board of Directors Meeting in Davos

On the Saturday prior to the Goldschmidt Conference, the Board of Directors of the Geochemical Society met for an extended business session in the Davos Congress Center. The meeting minutes, as compiled by Jeremy Fein, are published in this issue of GN. The agenda was full and the meeting lasted until 7 pm. Besides the scheduled reports, topics of discussion included new initiatives to be taken by the GS and the direction of future Goldschmidt Conferences.

Of particular interest were the figures on GS membership, which was at 1523 as of 31 July 2002, but it should be boosted to about 2,100 with the addition of 350 professional memberships and 200 student memberships submitted with the Goldschmidt registration. Membership has not been this high in the last 20 years and is perhaps a reflection of the success of the Goldschmidt Conferences, attracting new members to the Society. Also, it reflects the intensive membership drive conducted each fall by the GS business office manager, Seth Davis, reminding us all to renew. The 2003 membership drive will begin earlier this on October 1st 2002. It would be wonderful to see the membership continue to grow, a goal which was discussed by the BoD. Frank Podosek's Executive Editor's report on the health of *Geochimica et Cosmochimica Acta* with manuscript submittal remaining at a high level after a smooth transition to the electronic processing of manuscripts was, as usual, excellent news. Additionally, a set of guidelines for the publication of future Goldschmidt Conference abstracts has been formulated.

The GS Treasurer, Becky Lange, reported that the financial state of the Geochemical Society continues to be good, even considering the economic downturn experienced worldwide in recent months. With our endowment secure and continued earnings from our investments, we are in a position to consider further how to use our income to best promote geochemistry. Two years ago, we started the Meetings Assistance Program, to which GS members can apply for $2,000 grants to help fund their geochemically related meetings. We also give $10,000 each year to help support student travel to Goldschmidt Conferences. But, considering the national representation in Davos, the BoD discussed possibilities for additional support to make the Goldschmidt Conferences more accessible to the international community beyond North America and Europe. Also, the BoD considered a sponsorship program to enable Geochemical Society members to sponsor membership for geochemists in developing countries at a reduced rate. Different proposals to accomplish this goal are currently under discussion.

At this juncture between the Goldschmidt Conferences in Davos and Kurashiki, the BoD contemplated the direction of future meetings. The Goldschmidt Conference is now recognized as the premier annual meeting for geochemistry. The organizers of the 2004 Goldschmidt in Copenhagen, as well as the selection of future venues, must take into consideration the growing size of the Conference. Will the trend towards ever increasing attendance at Goldschmidt Conferences continue, or has it reached a plateau around which attendance will stabilize at a specific number, more or less? Further questions that stimulated discussion at the BoD meeting, inspired in part by Alex Halliday's report on the Davos Goldschmidt and penetrating questions from BoD member, Eric Oelkers, included: How do we translate the growing success of the Goldschmidt Conferences into a longer-term asset for the field of geochemistry? How can we better promote the field of geochemistry beyond our relatively small scientific community, increasing its visibility and "political" strength internationally? And, how can we better nurture future geochemists, promoting career-development and scientific creativity? Obviously, answers to these questions are not simple, and how we publicize geochemistry in the future will occupy us for some time to come as the field continues to grow. Overall, the general feeling emanating from Davos was that it is an exciting time to be a geochemist!

With best wishes,

Judith A. McKenzie
GS President

## *EDITOR'S CORNER...*

In a recent issue of *New Scientist* magazine, a two-page spread was devoted to highlights of a conference that previous week, focused on research into artifiicial intelligence. Only a few presentations were cited, but those two pages probably focused more public attention, by a few orders of magnitude, on the presenters' work - and by extension the work of everyone else in that field - than all their refereed publications combined. *New Scientist* has a worldwide circulation, and is read not only by scientists but by students, government officials, funding agents, and thousands of others outside the science professions.

Did *New Scientist* cover our recent - and highly successful - 2002 V. M. Goldschmidt Conference in Davos, Switzerland? No. Why not? Nearly every issue of *New Scientist* is filled with current events and news from the environmental, planetary, earth and life sciences. Many of these stories are strongly geochemical, or touch on problems that we as geochemists address regularly. One would expect that the current importance of issues as diverse as global climate change, organic and metallic chemical pollution, life on other worlds, and the struggle for energy resources should be right up our alley. Other conferences covered by this and other magazines include those of the American Chemical Society, the American Society of Microbiology, and the American Geophysical Union, to name just a few of the major science clubs in this hemisphere. So why is geochemistry invisible?

Part of the problem is our history; evolving as a distinct field of science from diverse sectors of the geological, chemical, and biological disciplines. So, we often get lumped into one of these other fields. But Judith McKenzie is correct to note that the significance of geochemistry as a separate field is expanding dramatically and is unlikely to fade soon.

Still, a recent survey of incoming graduate students in my own department (a Chemistry dept) shows that none of them had ever previously *heard* of geochemistry. This points up a serious problem with the disciplinary educational model, but beyond that it shows that we have a long way to go in communicating what we do to the voting public. As science funding dries up, and geochemistry funding in particular erodes, our duty as advocates of our own research grows more critical. What do we do? Advertise. Volunteer as a congressional expert, giving advice to policymakers on scientific issues. Write review articles for the popular scientific press. Get onto National Public Radio. Write your local newspaper about your work, or write an op-ed piece advocating a scientific viewpoint. And we need to get the press to our meetings. A few more citations in *New Scientist*, or *Scientific American*, or even *Discover*, will help to shed a bit more light on what we do all day. Remember, if the public thinks it is interesting, the politicians will eventually respond. And then maybe our grant proposals will start to give better odds than your average lottery ticket.

Until next issue...

*Johnson R. Haas*
*Carla Koretsky*
*Editors*

COVER:

A black smoker hydrothermal vent at the Mid-Atlantic Ridge. Photo credit: P. Rona, OAR/National Undersea Research Program (NURP), National Oceanographic and Atmosheric Administration.

## Call for Nominations for 2003 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. Up to 10 new Fellows will be elected each year. 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.

**Submission by attached files to email is strongly encouraged, although signed originals of documents must also be submitted by conventional mail.**

***Nominations should be sent no later than November 15, 2002 to***

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2534 C.C. Little Building
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Tel. 734-763-4590
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***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, James R. O'Neil, George Parks, James C.G Walker, David Walker, E. Bruce Watson, Bernard J. Wood, Jan Veizer, Ernst Zinner

**1999** Hubert L. Barnes, Gordon E. Brown, C. Wayne Burnham, William S. Fyfe, Nobumichi Shimizu

**2000** Harry Elderfield, Gunter Faure, Fred A. Frey, Gilbert Hanson, Frank J. Millero, Francois M. Morel, Minoru Ozima, Douglas Rumble II, Terry M. Seward, G. Alan Zindler

**2001** A. Halliday, C.J. Hawkesworth, W.J. Jenkins, B.B. Joergensen, I. Tolstikhin, R. Wollast

**2002** D. Des Marais, M. Drake, I. Friedman, C. Martens, P. Meyers, G. Sposito, and J. Wasson

***Please take the time to honor your deserving friends and colleagues! It is up to you, as members of The Geochemical Society or the European Association for Geochemistry, to ensure that the roll of Fellows is representative of the entire geochemical community!***

## Geochemical Society Business Office News

First off, I'd like to thank everyone who took the time to stop by my exhibit at the Davos Goldschmidt Conference and introduced themselves to me. It was a real honor and a privilege to meet all of you and listen to your input about the Society and its direction. Second, I would like to welcome all of those members who joined through the Davos Goldschmidt registration. There may be some confusion as to what you have signed up for, so I will clarify:

- All memberships processed in 2002 are for the 2002 calendar year including memberships collected at the Goldschmidt Conference.

- The information obtained with your registration was only your name and your e-mail address. Because of this, we were not able to send you a printed version of this newsletter (Geochemical News #113). A version of this newsletter is available on-line at: **http://gs.wustl.edu/archives/#NewsLett**. If you would like a printed version mailed to you please contact the business office. An e-mailed version of this announcement will also be sent to you.

With that said, I would like to end by announcing that once again it is time for the Geochemical Society to start its annual membership drive. Here is a reminder of some of the benefits of membership. (Remember that Professional membership is only $25 (USD) and student and senior memberships are only $5 (USD)).

Subscription to the Quarterly Newsletter *Geochemical News*. Four issues a year of news, interviews, articles, event calendars and more.

Savings on Conference Registrations - Members receive discounted rates to a number of conventions such as:
- V.M. Goldschmidt (non-member: up to $450, member: up to $350. Save up to $100)
- Fall AGU (non-member: up to $400, member: up to $340. Save up to $60)
- Annual GSA (non-member: up to $450, member: up to $360, Save up to $90) just to name a few.

Savings on Publications - Members discounted rates on:
- Geochemical Society Special Publications
- 25% on most MSA titles (including RiM&G, Mineralogical Society Series and more)
- Optional personal subscription to *Geochimica et Cosmochimica Acta* ($130/year for Professionals, $50 for students/seniors). Including on-line access to GCA through Science Direct.

And knowledge that your contribution to the Geochemical Society is internationally promoting geochemistry through such programs as:
- The V.M. Goldschmidt Conference
- *Geochemical News*
- GS Special Publication Series
- Medals (Goldschmidt, Clarke, Patterson, Treibs, and OGD Best Paper)
- *G3* – Electronic Journal (www.g-cubed.org) (with AGU)
- RiM&G volumes (with MSA)
- Editorship of GCA (with MS)
- Short Courses
- Guest Lecture Series
- Geochemistry Fellows Award (with EAG)
- Student Travel Grants

A renewal form is available elsewhere in this newsletter. Please take a moment to renew your support to your Society.

Many thanks,

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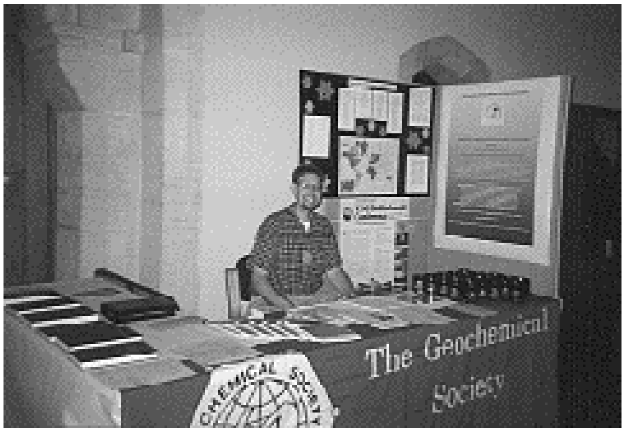

# FROM GEOCHEMISTRY TO BIOCHEMISTRY

## *Chemiosmotic coupling and transition element clusters in the onset of life and photosynthesis*

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### Initial Conditions

Convection currents within the Earth dissipate heat, eventually delivering hydrothermal fluids to the cold sink of the ocean. Strong chemical disequilibrium is focused at points of submarine exhalation. This is where metabolism came into its own, dissipating this supply of chemical energy to electron sinks. Metabolism quickens, by many orders of magnitude, oxidation and reduction reactions on our planet. And just as convection involves juxtaposed molecules behaving in concert as they transfer heat to a lower temperature sink, so too, orderly and commensurate flows through a semi-permeable membrane of electrons, protons and small uncharged molecules but not anions and cations, ensures that metabolic reactions fall into step in the kind of neighbourly co-operation that leads to the rapid dissipation of up to a volt or so of renewable photoelectrochemical energy. Genetically regulated metabolism and convection are coupled on our planet and must have always been so, right back to life's origin (Russell and Hall 1997).

### The Emergence of Life

Although the spectacular Black Smokers have been hailed as the likely forge of life, we argue that its hatchery was a humble submarine seepage in the ocean deep (Fig. 1). Here the precipitation of an inorganic semi-permeable membrane

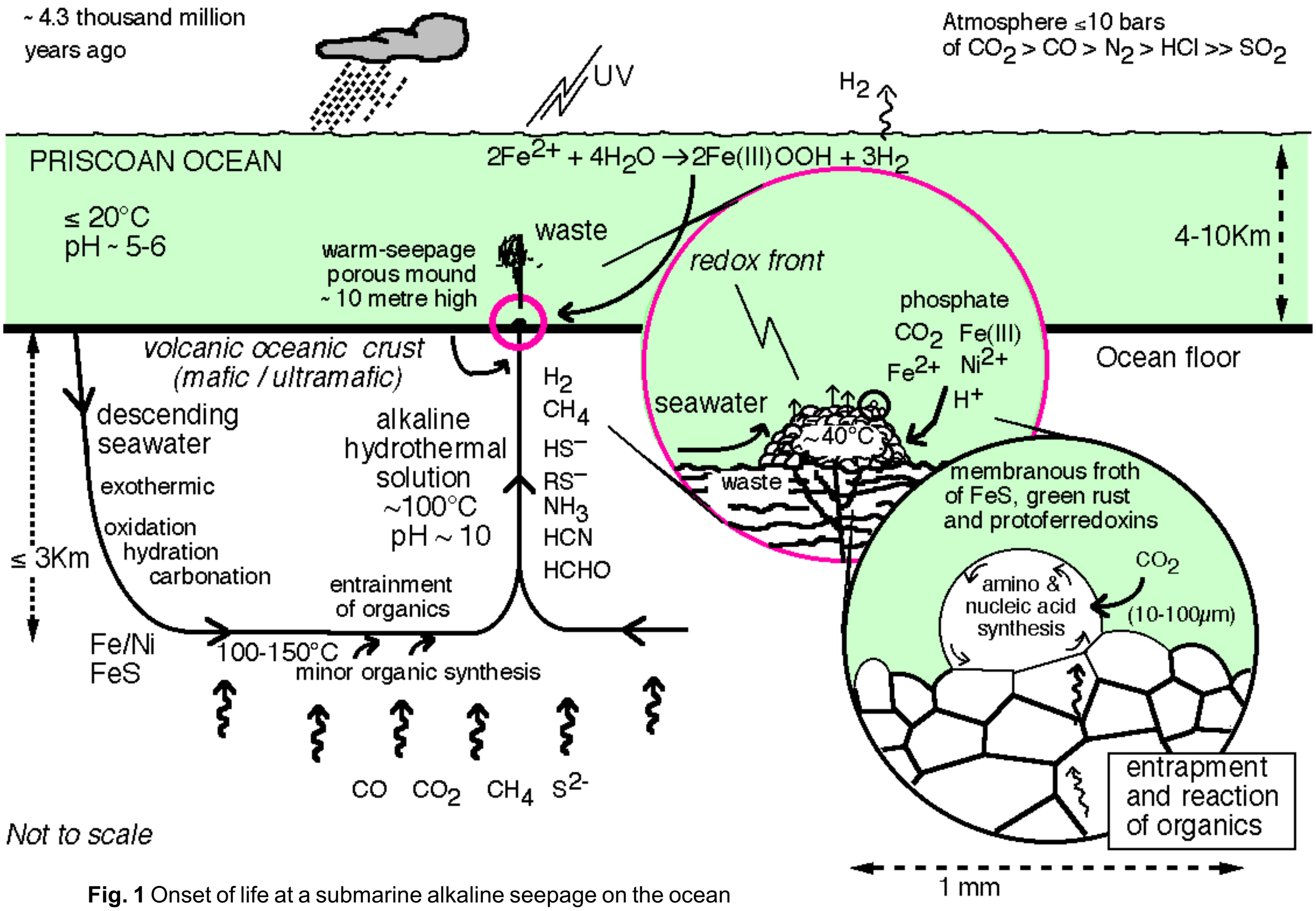

**Fig. 1** Onset of life at a submarine alkaline seepage on the ocean floor (Russell et al. 2002).

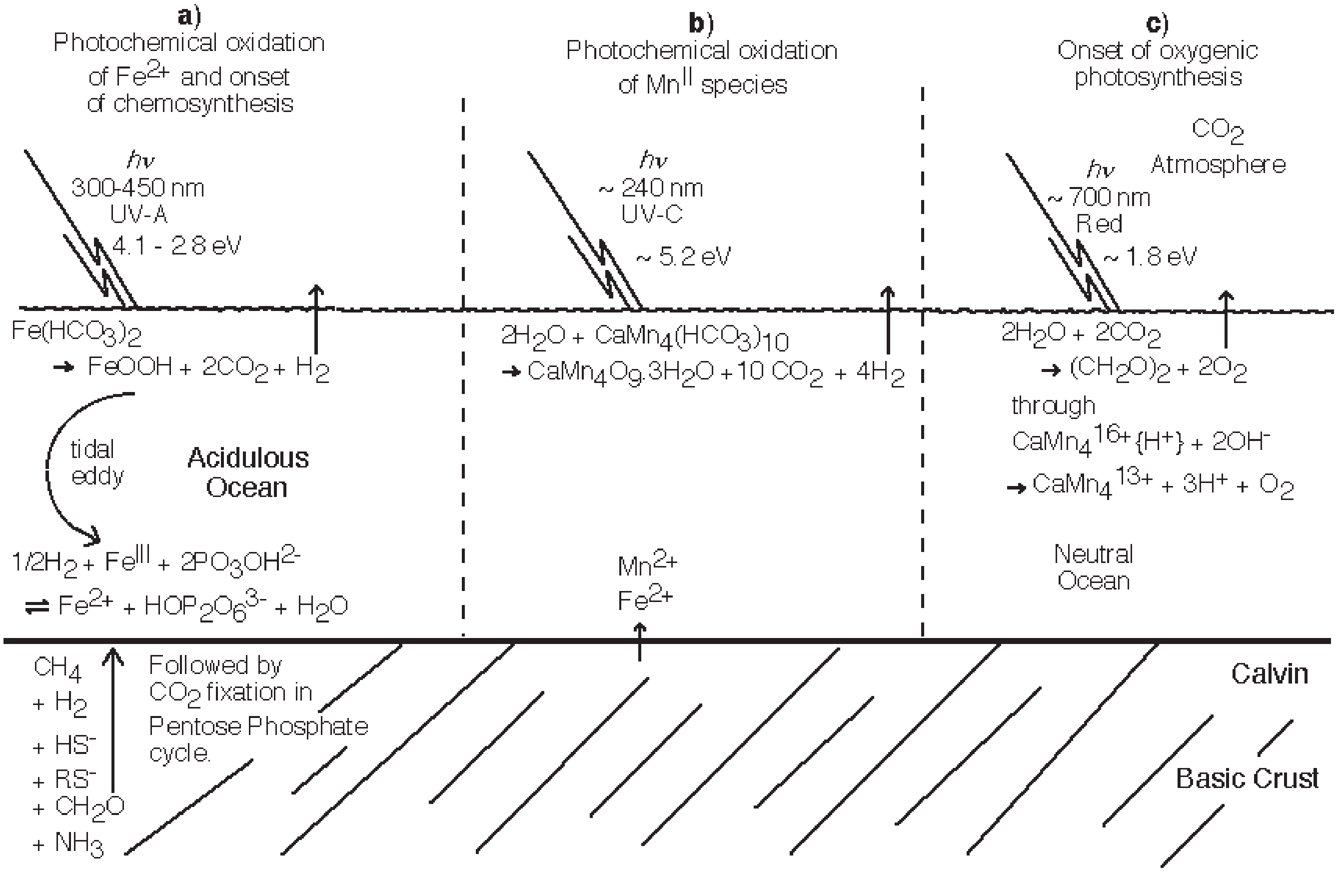

**Fig. 2** Solar radiation produces **a**) photolytic $Fe^{III}$ which potentiates chemosynthetic life; **b**) photolytic $CaMn_4O_9.3H_2O$ clusters, precursor to the water oxidising complex (or the mineral ranciÈite); **c**) oxygenic photosynthesis through reduction of $Mn_4^{IV}$.

prevented immediate titration of an alkaline hydrothermal fluid with an ocean made acidulous (pH ~5.5) by an atmosphere rich in carbon dioxide. A particular advantage of alkaline hydrothermal solutions is that they would have the propensity to dissolve organic acids and bases, including the nucleic acid bases. Alkaline conditions also favour phosphate chemistry which must have been a feature of early metabolic cycles and genetic translation.

But very high temperature springs did have a role to play in the emergence of life, that of supplying transition elements to the Priscoan ocean. The chemical energy dissipated by the first metabolist resulted from the tension between hydrothermal hydrogen and photolytic ferric iron in this acidulous ocean. The Earth was a giant photoelectrochemical cell — the ocean was the fluid matrix to a dispersed positive electrode, $\gamma\text{-}Fe^{III}OOH$, generated by UVC on $Fe^{2+}$ supplied through 400° C submarine springs (Fig. 2a):

$$2Fe^{2+} + 2H^{+} + h\nu \longrightarrow 2Fe^{III} + H_2\uparrow \quad (1)$$

Hydrothermal hydrogen comprised the negative electrode at the warm seepage sites. The serpentinization of olivine and pyroxene in the crust during hydrothermal convection not only introduces hydrogen, it also has the effect of increasing the pH of 100° C hydrothermal solutions to about 10 (cf. Kelley et al. 2001; Marteinsson et al. 2001):

$$12Ca_{0.25}Mg_{1.5}Fe_{0.25}Si_2O_6 + 16H_2O \longrightarrow$$

$$6Mg_3Si_2O_5(OH)_4 + 12SiO_2 +$$

$$Fe_3O_4 + 3Ca^{2+} + 6OH^- + H_2\uparrow \quad (2)$$

Life emerged in the mixing zone at ~40° C (Russell et al. 2003).

### The First Membrane

According to Williams (1961, p. 3) ‘it may well be that the achievement of a separation of activated reagents in space plus restricted diffusion provides the fundamental distinction between biological chemistry and test-tube chemistry’. If so it follows that the membrane is the most conserved of all biological structures. But what was it made of? A semipermeable *inorganic* membrane can be made to precipitate at a pH front in the lab (or play room). The best known example is that of the silica gel comprising a chemical garden where growth is induced through *osmotic* pressure. In the conditions obtaining on the early Earth various membranes may have been generated at alkaline seeps (Russell et al. 2003). On occasions when bisulfide activities were high, reaction with ferrous iron in the ocean would have led to the precipitation of an iron sulfide membrane, predominantly of mackinawite [$(Fe{>>}Ni)_{1+x}S$], perhaps **diagenetically** within a hydrothermal clay matrix. Such a membrane would also have encouraged a different kind of feedback, viz. a *chemiosmotic* pressure. Chemiosmotic pressure signals the change from mere mineral precipitation to informed, and thereby evolving encapsulated feedback cycles capable of exploiting commensurate chemical tensions elsewhere on the planet.

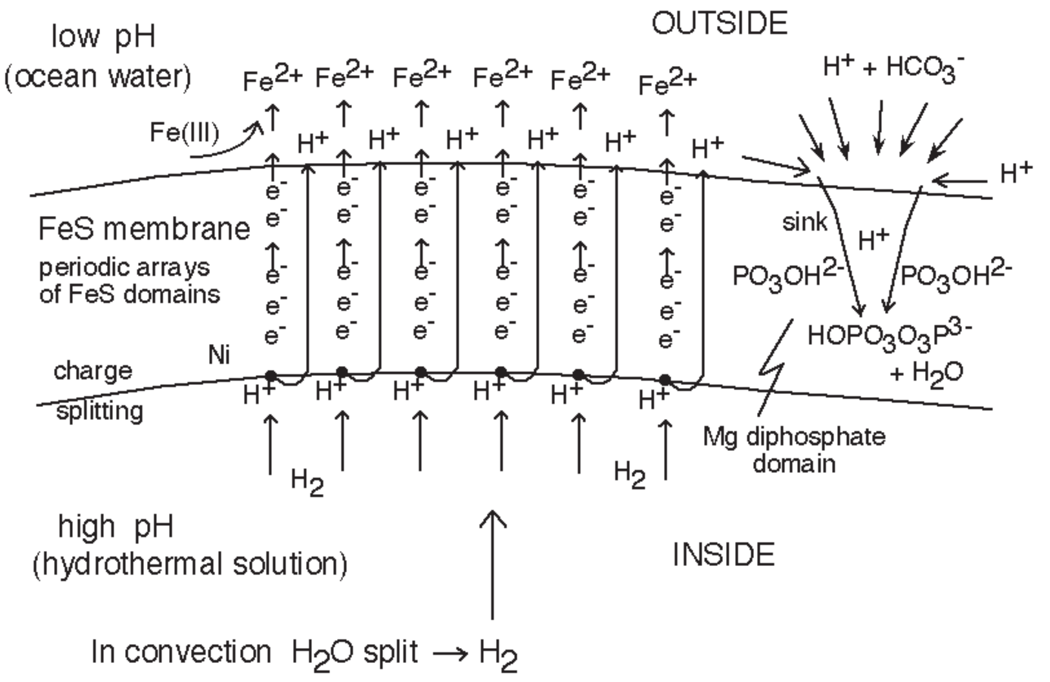

**Fig. 3** Emergence of chemiosmosis driven by reduction of $Fe^{III}$ on the exterior of the FeS membrane. Electrons are conducted through mackinawite nanocrystallites from $H_2$ on the interior. Protons track electrons through aqueous films to conserve charge balance. Elsewhere the double layers of sulfur atoms bestow an insulating capacity upon mackinawite. The membrane potential is augmented by protons in the acidulous ocean — an ambient pmf. Returning protons condense monophosphate.

**Osmosis and Chemiosmosis Compared**

Osmosis works to equilibrate contrasting water activities across a semipermeable colloidal gel envelope or membrane. Water molecules permeate the membrane which is distended by osmotic pressure to form the colourful spires that constitute the gardens. The "fuel" is generally a crystal hydrate of a strong acid and weak base such as $CoCl_2.6H_2O$, introduced into a relatively dilute solution of sodium silicate. The crystal remains separated from the so-called "water glass" by a spontaneously precipitated silica membrane which bears a bloom of cobalt. The initial reaction, notionally equilibrated with respect to water activity is:

$$CoCl_2.6H_2O + [Na_2SiO_3 + 8H_2O] \rightarrow$$

$$[6H_2O + 2HCl]_{inside} +$$

$$[\text{“}CoSiO_3\text{”}]_{barrier} + [6H_2O + 2NaOH]_{outside} \quad (3)$$

The membrane continues to develop by the reaction:

$$[2H^+ + 2Cl^-]_{inside} + [2Na^+ + Si(OH)_4^{2-}]_{outside} \rightarrow$$

$$2Na^+ + 2Cl^- + H_2O + SiO_2.H_2O \quad (4)$$

While osmosis works towards the equilibration of water activities across a *semipermeable* membrane, chemiosmosis works to equilibrate proton activities across a membrane that is also a *semiconductor*. A proton gradient would clearly result from the interfacing of the alkaline hydrothermal fluid (pH ~10) with the acidulous ocean (pH ~5.5). But there is another factor of fundamental significance — redox. We suggest that hydrothermal hydrogen was the first fuel, split to electrons and protons on the interior of the FeS membrane, probably at a nickel site (Fig. 3):

$$^1/_2H_2 + Fe^{III} \rightarrow H^+ + Fe^{2+} \quad (5)$$

Electrons would be conducted along the metallic-iron layer of mackinawite (Fe-Fe is 2.6≈), hopping from one crystallite to the next through the membrane toward the external photolytic $Fe^{III}$ receptor (Fig. 2,3). At the same time the protons would be driven by rotational/translational diffusion of water molecules adhering to the mackinawite faces, through the membrane to maintain charge balance (Russell et al. 1994,2003). Once on the exterior the protons were abandoned by electrons, which satisfied the electrophilic ferric iron acceptor. Concentrated thus the protons exerted a further pressure across the membrane directed toward the still alkaline interior (Fig. 3). Characterized as proticity by Mitchell (1967) the hydrogen ions re-invade the membrane where they dimerized inorganic phosphate, derived from the ocean, by a process of 'hydrodehydration':

$$H^+ + MgPO_3OH + PO_3OH^{2-} \rightarrow MgP_2O_6OH^- + H_2O \quad (6)$$

These two separated reactions (5 and 6) are linked electrically through the membrane, simplified as:

$$^1/_2H_2 + Fe^{III} + 2PO_3OH^{2-} + H^+_{[out]} \rightarrow$$

$$Fe^{2+} + HOP_2O_6^{3-} + H_2O + H^+_{[in]} \quad (7)$$

The total protonmotive force is considered thus:

$$\Delta p = \Delta\psi + \Delta E_{pH} \quad (8)$$

where $\Delta_p$ is the overall 'protonic' potential composed of the sum of the electric potential $\Delta\psi$ and that potential due to ambient pH, i.e., $\Delta E_{pH}$. The overall electrochemical energy available in such a system is best appreciated in a Pourbaix diagram (Fig. 4). We caution that complications, leakage, and kinetic barriers in the far-from-equilibrium conditions pertaining across a membrane are such as to preclude exact calculation of the protonmotive force. Nevertheless we can gauge from Figure 4 that the potential available on the early Earth well exceeds the critical value for metabolism considered to be the ~250mV (or ~ -11.5 kcal per mole) required to generate pyrophosphate (PPi) from inorganic monophosphate (Pi) or adenosine triphosphate (ATP) from adenosine diphosphate (ADP) and Pi. To borrow a phrase from Mitchell (1967), "oxidoreduction (is) coupled to hydrodehydration".

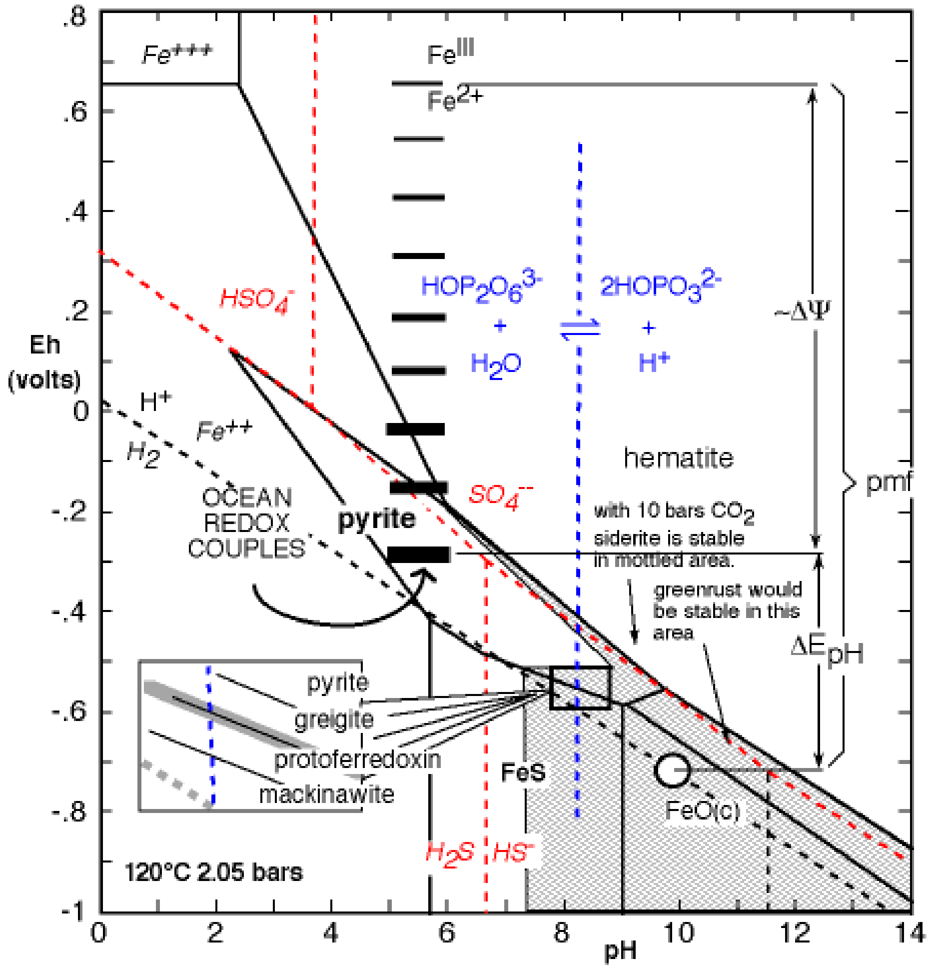

Fig. 4 Pourbaix diagram to illustrate the mixing of the alkaline hydrothermal solution (circle) and acidulous seawater with a sequence (bars) of notional redox couples extending to Fe3+/Fe2+. Stabilities of relevant minerals at activities of H2S(aq) = 10-3, and Fe2+ = 10-6 (using Geochemists Workbench) are given and, inset, notional phase relations of protoferredoxin. The protonmotive force (pmf) of ~700mV theoretically exceeds the critical value (250mV) required to generate pyrophosphate (PPi) (cf. Zachara et al. 2002, fig. 2). Note that the pH boundary of Pi/PPi intersects the region (square box) of the membranous precipitate.

## The First Metabolic Cycle and Pathway

At the alkaline seepage just prior to the onset of metabolism we can imagine the nucleation of mineral clusters (many of them hydrates) and their polymerization to form inorganic crystallites. In contrast, partially reduced carbon molecules such as formaldehyde generated in the Priscoan ocean crust by reaction of hydrogen and carbon monoxide and entrained in the alkaline fluid till they stuck to mackinawite (Rickard et al. 2001), could only polymerize to unstable "carbohydrates". Phosphorylated, carbohydrates such as ribulose bisphosphate would also adhere to (be selected by) the FeS crystallites. Uncooperative molecules would remain in the solution and be passed to the ocean as waste. Reacting to fix further formaldehyde the still more unstable fructose monophosphate is formed. If polyphosphate is available this molecule cleaves to glyceraldehyde phosphate in stage one of a precursor to the Pentose Phosphate Cycle before repolymerizing (Quayle and Ferenci 1978, fig. 3):

$$CH_2OH.CO.(HCOH)_3CH_2OPO_3^{2-} + HP_2O_7^{3-} \rightarrow 2CHO.CHOH.CH_2OPO_3^{2-} + H_2PO_4^- \quad (9)$$

In the neutral to exergonic evolved metabolic cycle ribulose monophosphate can also assimilate carbon dioxide in the presence of activated hydrogen (Quayle and Ferenci 1978):

$$CH_2OH.CO(HCOH)_2CH_2OPO_3^{2-} + 2H^* + CO_2 \rightarrow COOH(HCOH)_4.CH_2OPO_3^{2-} \quad (10)$$

Carbon may also have been fixed in the iron>>nickel sulfide membrane from the oxides by a precursor to the Acetyl-CoA Pathway involving activated hydrogen and a thiol (Huber and Wächtershäuser 1997; Martin and Russell 2003):

$$2CO_2 + CH_3SH + 8[H] \rightarrow CH_3COSCH_3 + 3H_2O \quad (11)$$

We suggest that the chaos of these autocatalytic feedback cycles can be ordered both in terms of product and stereochemistry by the active surfaces of clays in the hydrothermal mound as well as of the mackinawite comprising the membrane. Thus a controlled "formose" reaction was transmuted in the presence of inorganic pyrophosphate derived from the ocean to the Pentose Phosphate Cycle, precursor to the Calvin Cycle of ribose synthesis. HCN condensates by contrast are relatively stable at $C_5$ (e.g., adenine $[HCN]_5$) or may be hydrolysed to $C_4$ (e.g., uracil $C_4N_2H_2O_2$). Nevertheless, apart from adenine, the nucleic acid bases are difficult to synthesise in hydrothermal conditions, a fact that runs counter to the RNA World hypothesis. Phosphorylated bases will react with nucleosides to make nucleotides. Organophosphates are strongly adsorbed on sulfides. We assume that phosphorylations could generate limited amounts of RNA from the ribose and the nucleosides. RNA could achieve lengths of up to ten bases on the surface of the mackinawite. Distortion at greater lengths renders the polymer unstable. Adsorbed thus RNA would conform to three triplets, i.e., three potential codons, on a surface (Mellersh 1993; Mellersh and Wilkinson 2000).

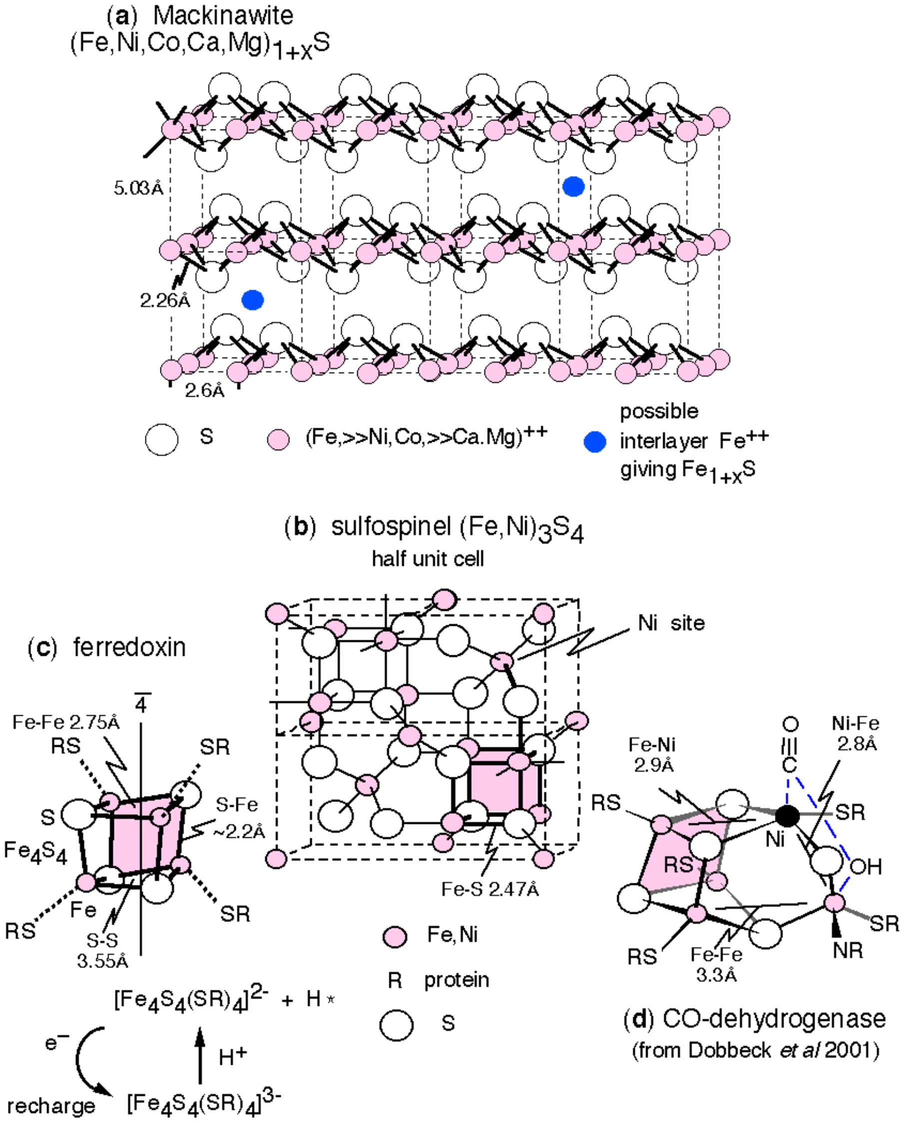

**Fig. 5** Structural relatedness of **a**) mackinawite $Fe_{1+x}S$; **b**) greigite $Fe_5NiS_8$; **c**) the thiocubane $[Fe_4S_4]$ unit in protoferredoxins and ferredoxins; **d**) the $[Fe_4NiS_5]$ open cuboidal complex in CO-dehydrogenase. Affine sulfur sublattices, cubic close-packed in **a** & **b**, are distorted in **c** & **d**. The presence or absence of $Fe^{III/3+}$ and organic ligands dictates which of these entities form.

### Clusters, Catalysts and Enzymes

The amino acids glycine, alanine, aspartate, serine, glutamate, isoleucine, lysine, proline, valine and leucine are produced at 150° C in the presence of hydrothermal hydrogen, though in sharply descending order of yield [glycine yield ~2% with respect to KCN + $NH_4Cl$ + HCHO with excess $CO_2$ + $H_2$; conditions comparable to those obtaining at the seepage (Hennet et al. 1992)]. It so happens that the most stable RNA triplets form the codons for just these simple abiotic amino acids (Trifonov 2000). We suggest that once these amino acids nestle into the RNA triplet clefts they polymerize in the oscillating pH conditions in the membrane by acid-base catalysis (Russell et al. 2003). Released from their RNA moulds, the regulated amino acid trimers can cast around for other ligands. The most common will be $[Fe_4S_4]^{+/2+}$ cubane clusters that otherwise would have been interred in the mineral greigite (as $[SNiS][Fe_4S_4][SFeS]$) (Vaughan and Craig 1978) (Fig. 5). Chelated thus, e.g., $(gly)_3[Fe_4S_4](ala)_3$, the complex would have the capacity to store and transfer electrons. Alternatively $ser_2cys[SNiS][Fe_4S_4]ala_3$ would have the power to hydrogenate and dehydrogenate organic acids and alcohols (Russell et al. 2003). Perhaps greigite, as well as mackinawite, acted as an abiotic hydrogenase in the inorganic membrane. These same "abiotic" amino acids — glycine, alanine, aspartate and valine — also exclusively comprise the active site motifs of enzymes that generate pyrophosphate (PPi), the likely first central energy carrier (Baltscheffsky et al. 1999).

The chelation of "ready made" $[Fe_4S_4]^{2+}$ cubane clusters with amino acid trimers helps explain a central problem in the emergence of life, that of the organic takeover of the membrane. The first microbes were probably encapsulated in a proteinaceous envelope (Wächtershäuser 1998). Lipids were later (next section). Not only would protoferredoxins afford a greater control to electron transfer across the proteinaceous membrane, but, as ties from one protopeptide to another, they would serve also to stabilize it, a role significant in heterodimeric proteins to this day.

### The First Lipid Membranes

Lipids comprise the impermeable and insulating spacing between membrane bound enzymes in all prokaryotes. But Archaea and Bacteria possess completely different lipids (Kandler 1998). Archaebacterial lipids consist of isoprenoids and various derivatives connected to stereospecifically-numbered-glycerol-1-phosphate by an ether bond. Eubacterial lipids consist of fatty

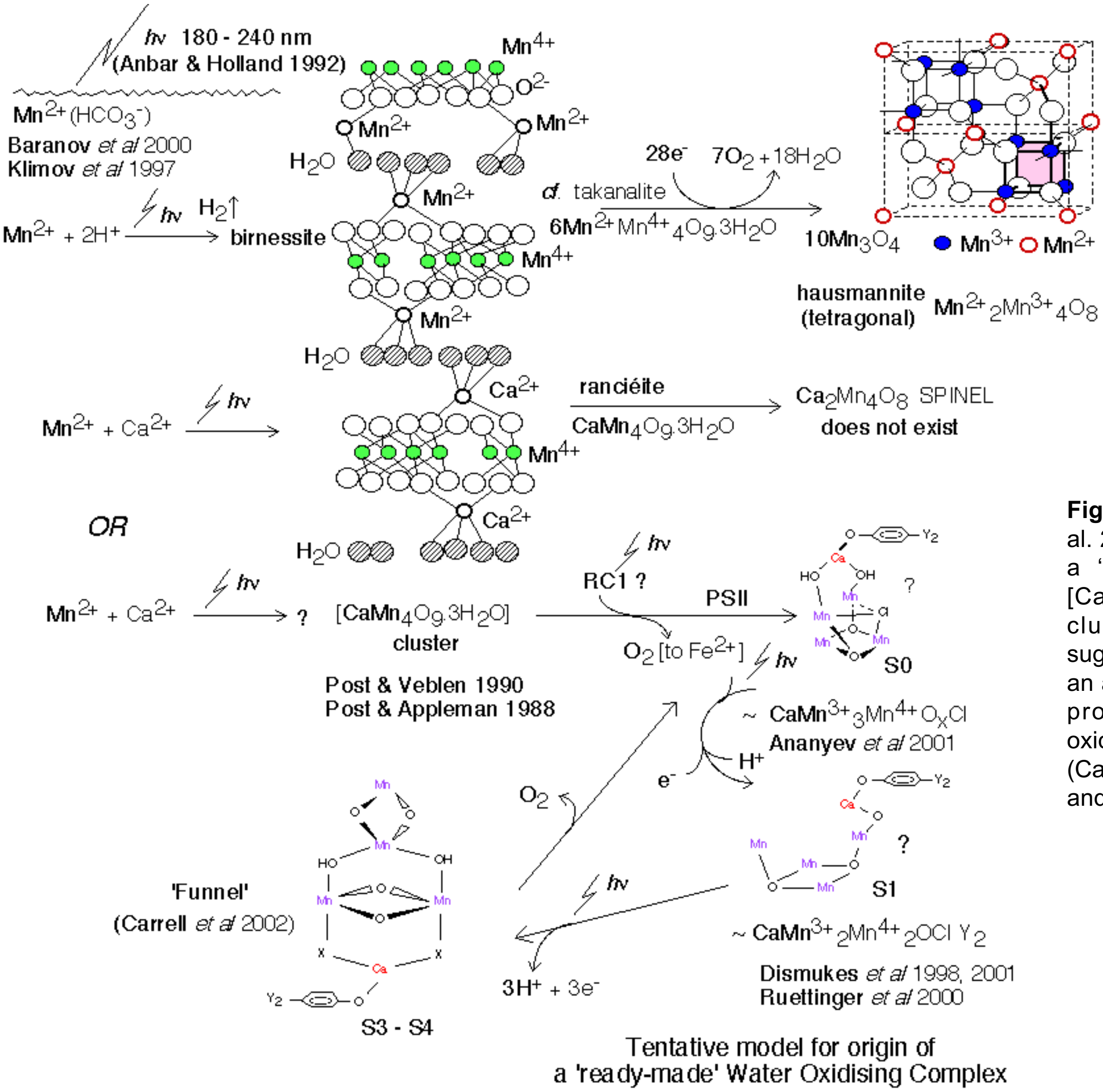

**Fig. 6** Model (Russell et al. 2003) for the origin of a 'preformed' abiotic $[CaMn_4O_9.3H_2O]$ core cluster which, we suggest, was enrolled in an antecedent of RCII to produce the water-oxidising complex in PSII (Carrell et al. 2002; Sauer and Yachandra 2002).

acids connected to *sn*-glycerol-3-phosphate by an ester bond. The biochemical pathways to their respective syntheses also differ markedly. Moreover the Bacterial cell wall consists of murine whereas that of the Archaea is pseudomurine. Although there is overlap in the redox reactions involving inorganic donors and acceptors that both domains exploit in order to sustain ATP synthesis, those used by the hardier Archaea are the more restricted (Amend and Shock 2001). These differences have been interpreted as relicts of a phase of differentiation driven by stereochemical "immiscibility", perhaps as higher temperature regions of the hydrothermal mound were accessed after divergence from the universal ancestor, though prior to the emergence of free-living chemoautotrophs (Martin and Russell 2003).

### Oxygenic Photosynthesis

That the early active centres to enzymes were pre-existing entities which required no genetic design is echoed in one other extraordinary evolutionary jump, that to oxygenic photosynthesis. While the onset of life changed the nature of our planet, the invention of oxygenic photosynthesis changed its face (Dismukes et al. 2001). Oxygenic photosynthesis is the most demanding of macro-evolutionary developments, requiring the processing of four protons and four electrons in order to photo-oxidize water (Fig. 2,6):

$$2H_2O + h\nu \rightarrow O_2 + 4H^+ + 4e^- \quad (12)$$

The active water oxidizing complex (WOC) in what is known as photosystem II (PSII) catalyzing this reaction is invariably a $CaMn_4$ centre in all cyanobacteria and plants (Blankenship 2002). We suggest that the introduction of the $CaMn_4$ catalytic core is such an extraordinary biological innovation that a "ready-made" cluster must have been co-opted whole by a (mutant?) protein (Russell et al. 2003). This suggestion recalls our idea that an [4Fe-4S] cubane cluster could have been sequestered by peptides into a ferredoxin where it provided a "preformed" electron transfer site for the first metabolist. Both the [4Fe-4S] cubane and the $CaMn_4$ complex allow for loss and, in the case of the iron sulfide, gain of (delocalized) electrons, from $Fe^{2.5+}$ and $Mn^{2.75+}$ respectively. Sequestering of the $[Fe_4S_4]$ cubane with peptide both protects and allows the integrity of the structure to survive, with minor distortion, the addition or subtraction of a single electron.

During the extraction and accumulation of the four electrons and protons from water, the conformational changes of the $CaMn_4$ structure (ligated to the tyrosine Yz in PSII) are much more extreme than the minor flexions of $[Fe_4S_4]^{+/2+}$, and are not yet fully characterized (Fig. 5,6):

$$[Mn_4^{13+} \sim Yz] \leftrightarrow [Mn_4^{16+} \sim Yz^+] + 4e^- \quad (13)$$

The original sequestering site of the $CaMn_4$ complex may have been where tyrosine and amines were already present in an ancestral reaction centre. We now revisit the experimental and geochemical evidence that favours such a speculation.

Hot springs would have discharged Fe and Mn to the ocean in the early Archaean just as they do today. Because Fe is less soluble at higher pH, it would have precipitated around the springs, partly as iron oxyhydroxides and partly as iron sulfides. The more soluble $Mn^{2+}$, on gaining the ocean surface, would be photo-oxidized at extremely short wavelength beyond UV-C (Anbar and Holland 1992) to colloidal clusters of $[CaMn_4O_9.3H_2O]$ (Fig. 6). This putative cluster also represents a nucleus for the mineral ranciéite (Russell et al. 2003). Thus a $CaMn_4$ species may have been the free cluster sequestered by a mutant reaction centre (cf. Sauer and Yachandra 2002). A comparison between the mineral and the oxygen-evolving polymorphic complex is instructive. Calcium is ligated to three water molecules in ranciéite (Fig. 6) and the atom may also act as the water donor site in the water oxidizing complex, releasing it to the fully-accumulated positive charge state four of the tetra-manganese cluster. It is as a Lewis acid that calcium activates water oxidation.

Calcium has several other possible roles: that of conducting electrons to tyrosine during oxidation of the complex; preventing dissolution on reduction to state zero, or, because of its low charge concentration, in preventing the formation and locking of $[Mn_4O_4]^{4+}$ as a cubane (as in the spinel hausmannite $[(Mn^{2+})_2(Mn^{3+})_4O_8]$, Fig. 6) during the reduction of the oxidised phase in the precursor to PSII-WOC.

## Proposal

How can the alkaline hydrothermal hypothesis be tested? It must be said that experimental work on the origin of life has not fulfilled early expectations. Experiential, rather than experimental knowledge has been the more useful, i.e., that gleaned from pertinent geochemical, geological, geophysical and biochemical discoveries. Experimentalists have tended to design experiments that, even if successful in themselves, have ignored likely initial conditions. And interpretations and extrapolations of reactions from experiments with few reactants, usually run to equilibrium, fail to address the effects of the electrical and protonic potentials that drove early life to emerge, perhaps through a semiconducting, semipermeable inorganic membrane. We suggest that experiments using a reactor nexus which takes account of chemiosmosis at the final stages of moderate temperature aqueous geochemical interaction are required, experiments that may have to resort to the oft disparaged “cook and look” approach (Russell et al. 2003).

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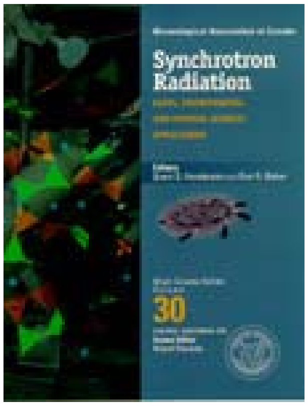
# Book Review

## Synchrotron Radiation: Earth, Environmental and Material Sciences Applications

*Grant S. Henderson and Don R. Baker, eds.*
*Short Course Series 30, Mineralogical Association of Canada. Price: US $40, CDN $40.*



The advent of increasingly more powerful synchrotron instruments is stimulating a revolution in the Earth Sciences. Relatively readily available synchrotron radiation has impacted applications such as X-ray diffraction (XRD), X-ray absorption spectroscopy (XAS), X-ray fluorescence (XRF), and X-ray photoelectron spectroscopy (XPS). The importance of synchrotron radiation to Earth Sciences is evident by the publication of two volumes on the subject in the same year - the MAC volume which appeared in May 2002 as part of a short course in Saskatoon, Saskatchewan, and a Reviews in Mineralogy and Geochemistry (RiMG) volume that will appear as part of a short course (Applications of Synchrotron Radiation in Low-Temperature Geochemistry and Environmental Science) to be given in Monterey, California in December 2002.

The MAC volume consists of seven chapters, covering a wide range of topics. The first chapter, by T.K. Sham, is an overview of the properties of synchrotron radiation and also gives a brief history of the development of synchrotron instruments. The author also describes how synchrotron radiation is produced. I found this chapter to be quite terse and additional reading would be required to fully understand the details of what is covered. Nevertheless, it is a useful starting point for those wishing to understand some of the basics. The second chapter is primarily a description of the Canadian Light Source (CLS) by G.M. Bancroft and E.L. Hallin. The CLS is not yet fully operational, and this chapter is essentially a progress report. Thus, this chapter is likely to become obsolete in the not-too-distant future. However, there is some information in this chapter that will be of long-term use. J.S. Tee provides a brief review of powder and single crystal diffraction using synchrotron radiation and D.T. Jiang does the same for X-ray absorption fine structure spectroscopy. Chapter 5, by D.R. Baker, discusses the synchrotron X-ray microprobe. There is some material in this chapter on EXAFS and XANES that is repetitious of material in the chapter by Jiang, but such repetition doesn't hurt when dealing with such relatively complex subjects. My favorite chapter in the book is that by H.W. Nesbitt on XPS. This was the most clearly written and detailed of all the chapters. The book is rounded out by a useful chapter on the application of synchrotron radiation to the study of amorphous materials by G.S. Henderson.

In general, this book provides a lot of useful information for the potential synchrotron user in the earth sciences. The book is by no means comprehensive, but does provide an important starting point with references for delving deeper into the various subjects. The volume looks to be complementary to the upcoming RiMG volume on synchrotron radiation, and many people will want to own both volumes. The paperback book is attractive with a reasonable size font, and the price is quite affordable. The only drawback to the volume is that many of the figures are of low resolution and hence fuzzy. Few of the figures are so low resolution as to inhibit understanding, but they do detract from the volume aesthetically. Nevertheless, this is a volume worth owning.

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Department of Geosciences
University of Idaho

# OBITUARIES

## George Phair

Dr. George Phair, a retired research geologist with the U.S. Geological Survey in Reston, Virginia, died of cancer at Suburban Hospital on August 5. Dr. Phair, a long-time resident of Potomac, Maryland, was 83.

Dr. Phair was born in 1918 in Washington, D.C. and grew up in Lyndhurst, New Jersey. He received Bachelor of Science degrees in geology and chemistry from Hamilton College in 1940 and a Master of Science degree in structural geology from Rutgers University in 1942. He received Master of Arts and Doctorate degrees in geology and geochemistry in 1947 and 1949 from Princeton University.

During World War II, he worked as a chemist at the Carnegie Institution of Washington's Geophysical Laboratory, where his experimental work on gun design and propellants led to development of a new erosion-resistant alloy that was used as a liner in 50-caliber machine guns. At high rates of fire, the patented material increased the life of machine-gun barrels tenfold.

In 1949, Dr. Phair joined the U.S. Geological Survey, where he remained a research geologist until his retirement in 1984. He led field and laboratory investigations on uranium and thorium and concentrated his studies in Colorado. His research, with Harry Levine, on leaching characteristics of uranium, radium, and thorium from uranium ore contributed to successful exploration of the Algoma uranium district in Canada, which has one of the largest uranium reserves in North America.

His election to Fellow in many professional societies was recognition of his contributions to the field of earth science. Dr. Phair was a Fellow of the Geological Society of America, Mineralogical Society of America, American Association for the Advancement of Science, and the Washington Academy of Science. He was an archivist for the Mineralogical Society of America, a life member of Sigma Xi, and a charter member of the Geochemical Society.

Horticulture was one of Dr. Phair's life-long interests. A job with a horticulture company while in college developed into a strong avocation throughout his professional career and retirement and resulted in publications in professional journals on shade and rock-garden plants. Dr. Phair was an active member of the North American Rock Garden Society and helped organize national meetings on the topic in his retirement.

He is survived by his wife, Cecil Alice Phair; a son, Raymond Weston Phair, of Potomac, Maryland; a daughter, Susan Marie Kelley of Midlothian, Virginia; three grandsons, Matthew Kelley, Christopher Kelley, and Bryan Kelley; and a brother, Harry Weston Phair of New Jersey.

Contributions to his memory may be made to the Potomac Presbyterian Church Memorial Garden Fund, 10301 River Road, Potomac, Maryland 20854.

## John I. Hedges

died unexpectedly on July 26, 2002 while on sabbatical in Munich, Germany. John was a fellow of the Geochemical Society, and received the Organic Geochemical Division's Alfred E. Treibs Award in 2000 (Hedges, 2001) for his many outstanding contributions in organic geochemistry. John majored in chemistry at Capital University in Columbus, Ohio and received his PhD in 1975 from the University of Texas, working with Pat Parker. John spent his postdoctoral years with Tom Hoering at Carnegie Institution's Geophysical Lab. From there, he went to the University of Washington's Department of Oceanography where he has been ever since.

John Hedges' research spanned many areas of oceanography and organic geochemistry. He was particularly interested in terrestrial influences on the ocean. He developed methods for lignin analysis, introducing one of the most unambiguous tracers of terrestrial input to the ocean that exists. John was also interested in cutins, tannins, carbohydrates and amino acids, and worked on the analytical chemistry, sources, and fates of all these compound classes. John was involved with several projects quantifying river inputs of organic matter to the ocean, as well as particle fluxes within the ocean. He worked to help set a standard for the measurement of dissolved organic carbon and to help determine its chemical composition. John mentored many students and post-docs and was aided throughout his time in Seattle by Michael Peterson. Some of John's recent interests were in understanding the global significance of black carbon, using NMR spectroscopy for investigating the organic composition and fate of marine materials, and determining how inorganic matter affects preservation and sinking of organic matter.

John leaves his wife Joyce and two daughters, Angelique and Elizabeth, and many, many friends and colleagues. A Memorial Fund is being set up at the School of Oceanography of University of Washington to help support student travel to scientific meetings and to sponsor a John Hedges Seminar Series. Contributions may be made to the School of Oceanography, ATTN: Laurie Bryan, School of Oceanography, Box 357940, Seattle, WA 98195-7940.

Hedges, J. I. 2001. Acceptance of the 2000 Alfred E. Treibs Award. Geochim. Cosmochim. Acta 65 (6); 1001-1002.

# Voltammetric Solid-State (Micro)electrodes:

## A powerful tool for studying biogeochemistry processes in real time

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### Introduction

Electrochemical techniques have often been used to study the environment. Many measurements are performed on samples that had been returned to the lab, but in the last couple of decades there has been much interest in making real time measurements with these techniques. In this paper, I describe our group's use of solid-state voltammetric solid-state electrodes to measure a suite of important redox chemical species in a variety of environments, but first review some principles of electrochemistry.

The major methods using electrodes (including microelectrodes) in environmental chemical analysis are of three general types (1) conductimetric, (2) potentiometric and (3) amperometric / voltammetric. Conductimetric electrodes are used to measure salinity and are incorporated into a variety of designs commercially and will not be further discussed. Examples of the potentiometric type are pH and sulfide as the Ag$_2$S electrode (e.g., Revsbech et al, 1983) and pH and pCO$_2$ (Cai and Reimers, 1993), and of the amperometric type are O$_2$ and N$_2$O (Revsbech et al, 1980; 1988). In the potentiometric type, potential is measured at near zero current passing through an electrochemical cell consisting of the working electrode and a reference electrode, and the potential is proportional to the concentration of the analyte. In amperometric types (based on voltammetry), current is measured at a fixed potential between the working and reference electrodes, and the current is proportional to the concentration of the analyte. Initial environmental research has centered on the use of microelectrodes for a single species in microbial ecology (e.g., Revsbech and Jorgensen, 1986) and in deep-sea sediments (e.g., Reimers et al 1986) although two to three separate microelectrodes housed together in one unit have been reported (Revsbech and Jorgensen, 1986; Visscher et al (1991). In our voltammetric work, current is measured while scanning the entire voltage range of the solid-state electrode (I vs E curves), which allows the measurement of more than one species at a given time in the same space (Brendel and Luther, 1995); this is analogous to absorbance versus wavelength curves in spectroscopy. Measured electrode currents for peaks during voltage scans are proportional to the concentration(s) of the analyte(s). An advantage of voltammetry with full voltage scan over amperometry at one fixed potential is that voltammetry provides a better measure of background or zero current. Voltammetry is thus a non-selective method that can measure many chemical species. In Voltammetry, a working electrode (Au/Hg) and a reference electrode (e.g., Ag/AgCl) are used to apply voltage while a counter electrode (Pt) is used to measure current so that no current passes through the reference electrode.

### Need for voltammetric sensors

In the late 1980's, intense interest arose to study anaerobic oxidation processes of sulfide with Fe and Mn oxide minerals from both biotic and abiotic mechanisms (e.g., Aller and Rude, 1988; Burdige and Nealson, 1986) and the bacterial reduction of Fe and Mn oxides during organic matter decomposition (Lovley, 1991; Nealson and Myers, 1992) and bacterial oxidation of Fe$^{2+}$ and Mn$^{2+}$ (e.g.; Tebo, 1991). It was clear that another sensor was needed to measure these metals in conjunction with other chemical species in real time. Until our development of the solid-state Au/Hg (micro)electrode (Brendel and Luther, 1995), it was not possible to measure metals and redox species such as O$_2$ and H$_2$S simultaneously. Using a single (micro)electrode we could determine multiple species including the metals, Fe and Mn, which are important in sedimentary processes on the same (sub)millimeter scale as O and at larger scales (meter) in lakes, estuaries (e.g., Chesapeake Bay); major basins (e.g., Black Sea) and hydrothermal vents. Our single Au/Hg

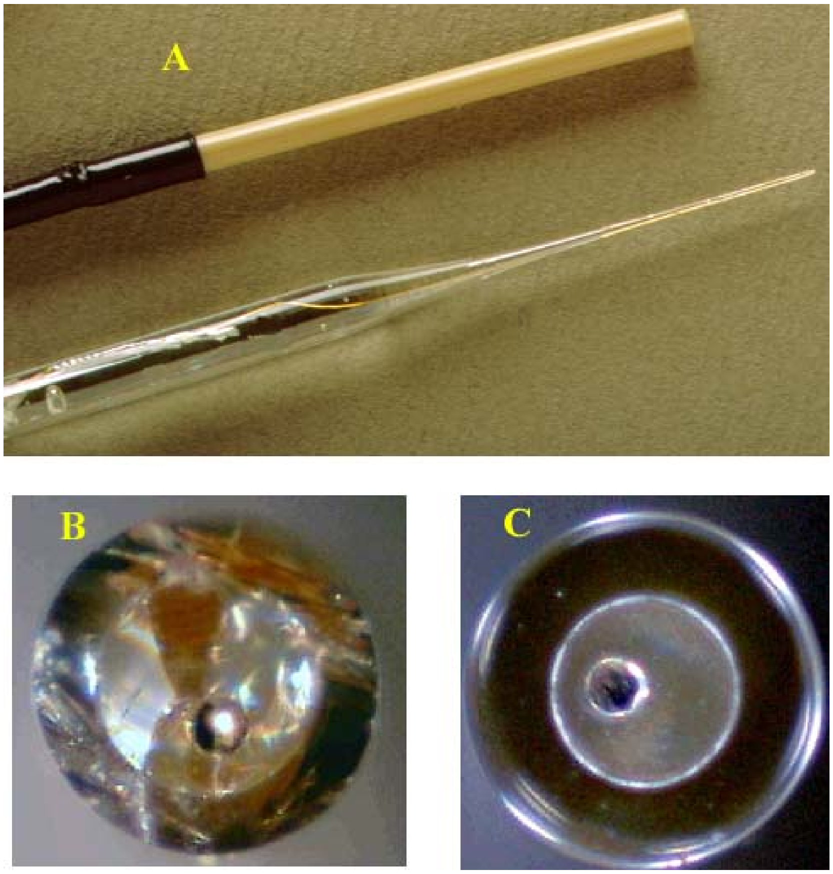
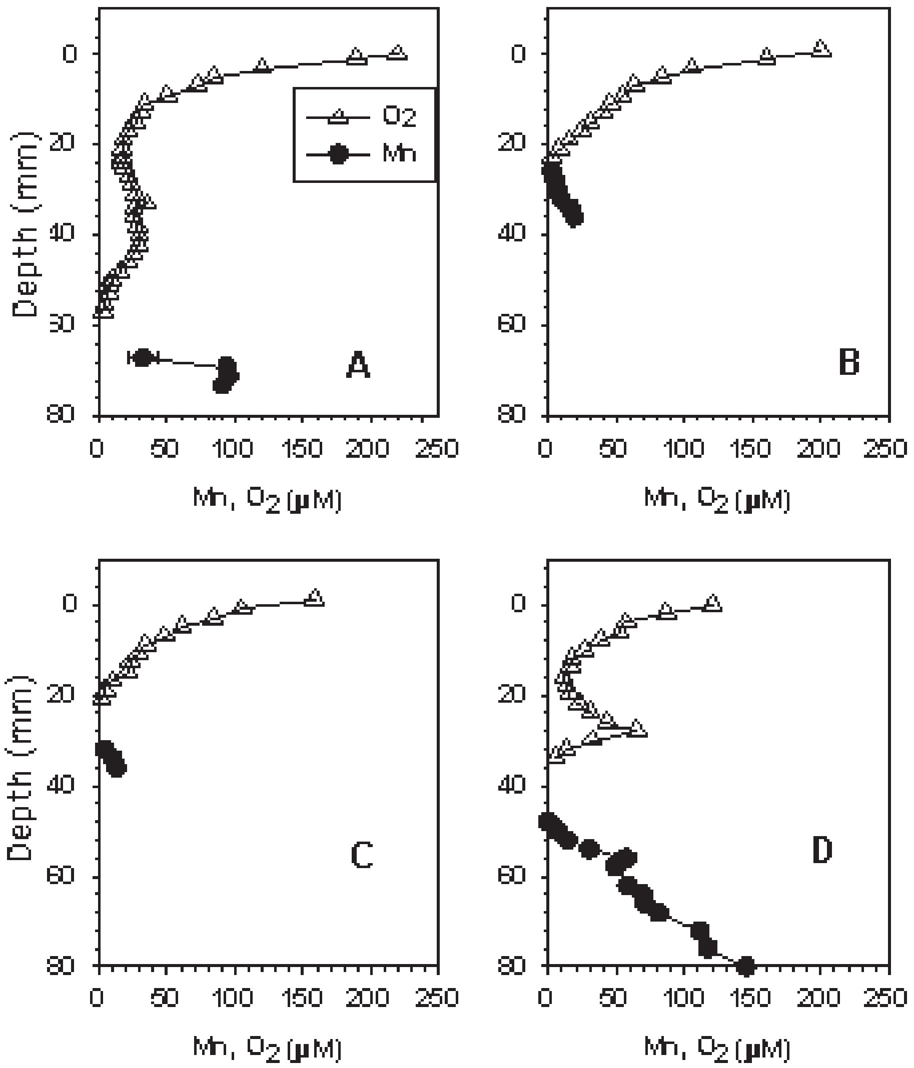
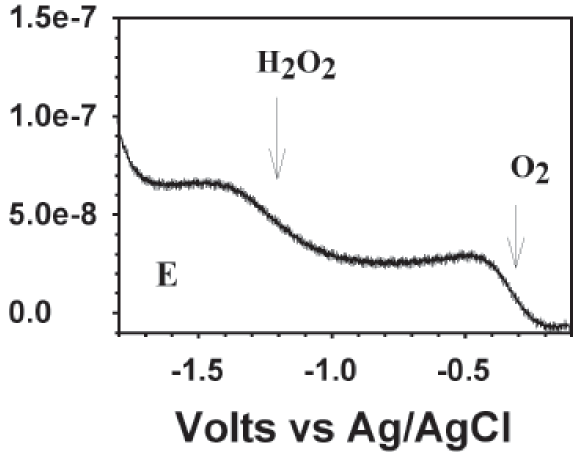


**Figure 1.** (A) A glass encased and PEEK electrode – the Au wire is soldered to the conductor wire and fixed with a non-conductive epoxy. (B) The tip of a 100 mm diameter Au electrode in glass after initial construction but before sanding and polishing. (C) After final polishing with 0.25 mm polish and prior to plating with Hg solution.



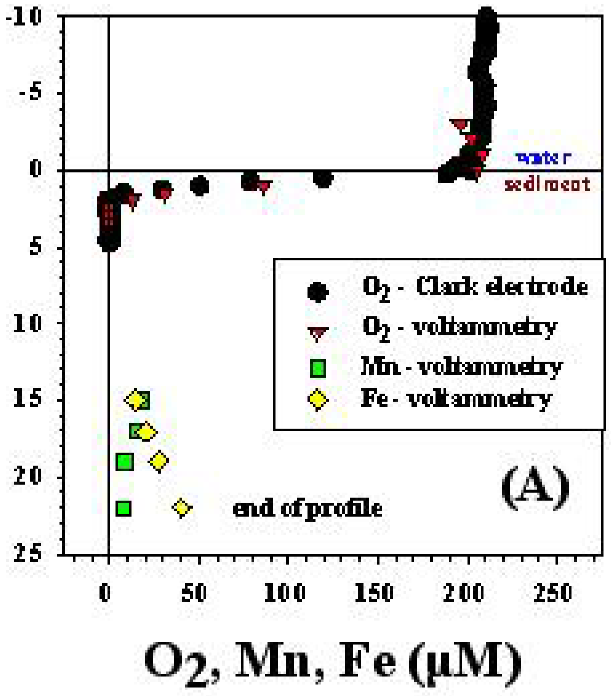
**Left: Figure 2 (A-D).** Four plots of $O_2$ and $Mn^{2+}$ from continental margin sites. Plots A,C and D show no overlap but plot B does (this is a rarity in most marine sediments). Plot D shows an increase in $O_2$ at depth and indicates that a worm burrow was intersected. Several profiles coupled to make three-dimensional plots reveal the extent of the burrow (Luther et al, 1998).

**Below: Figure 2 (E).** linear sweep voltammogram for $O_2$ at the sediment-water interface (scan rate is 200 mV $s^{-1}$ from positive to negative V and data is not smoothed); the arrows indicate the half-wave potential ($E_{1/2}$) for the reduction of oxygen to peroxide and peroxide to water, respectively.



electrode has the capability of determining all the key soluble redox species except for nitrate and ammonia. Table 1 shows the chemical species that have been analyzed to date in the environment. The solid-state Au/Hg voltammetric microelectrode can measure rapidly, at the same time, and with (sub)millimeter spatial resolution, five of the principal redox species involved in early diagenesis ($O_2$, $Mn^{2+}$, $Fe^{2+}$, $HS^-$, and $I^-$) as well as FeS and Fe(III) species. $I^-$ is a proxy for nitrate reduction because bacterial iodate and nitrate oxidation of organic mater have similar free energies (Luther et al, 1998). This tool can be used to measure the distribution of these redox components in natural waters and in the porewaters of marine and freshwater sediments as well as temporal changes at any given location or depth. **Figure 1A** shows two designs – one in glass for sediment work and another in the durable polymer PEEK (polyethyletherketone) for water column and hydrothermal vent work. Details of construction can be found in Luther et al (1999; 2001). **Figure 1B** shows a glass electrode after fabrication, sanding and final polishing. In all our work, the electrodes provide reproducible data because of the application of *in situ* conditioning potentials to clean the electrode electrochemically after each voltage scan.

In our early work, cores were brought back to the lab or to the shipboard laboratory. However, due to the strong interest in making real time measurements to better document biogeochemical processes, we have now deployed the solid-state electrodes in a variety of environments with the aid of industrial cooperation



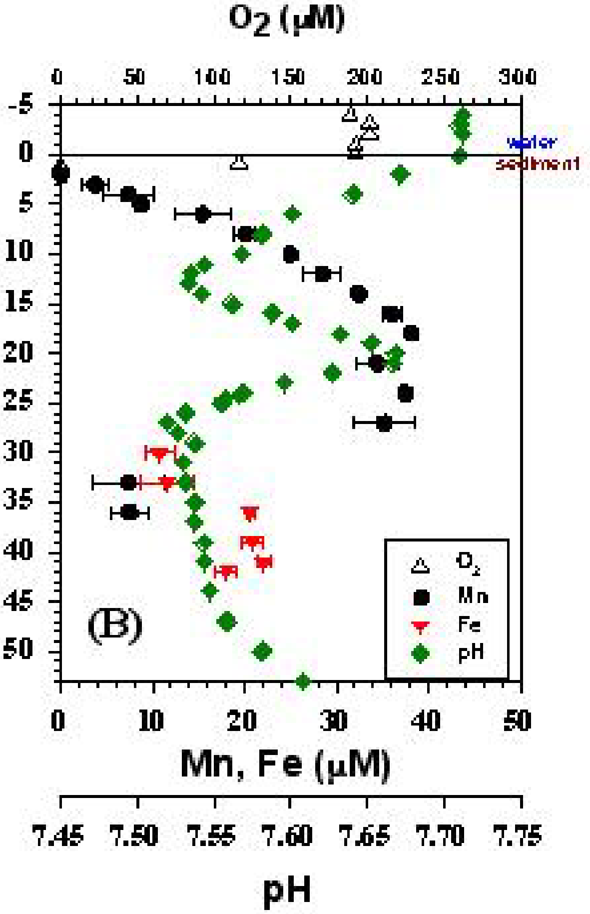


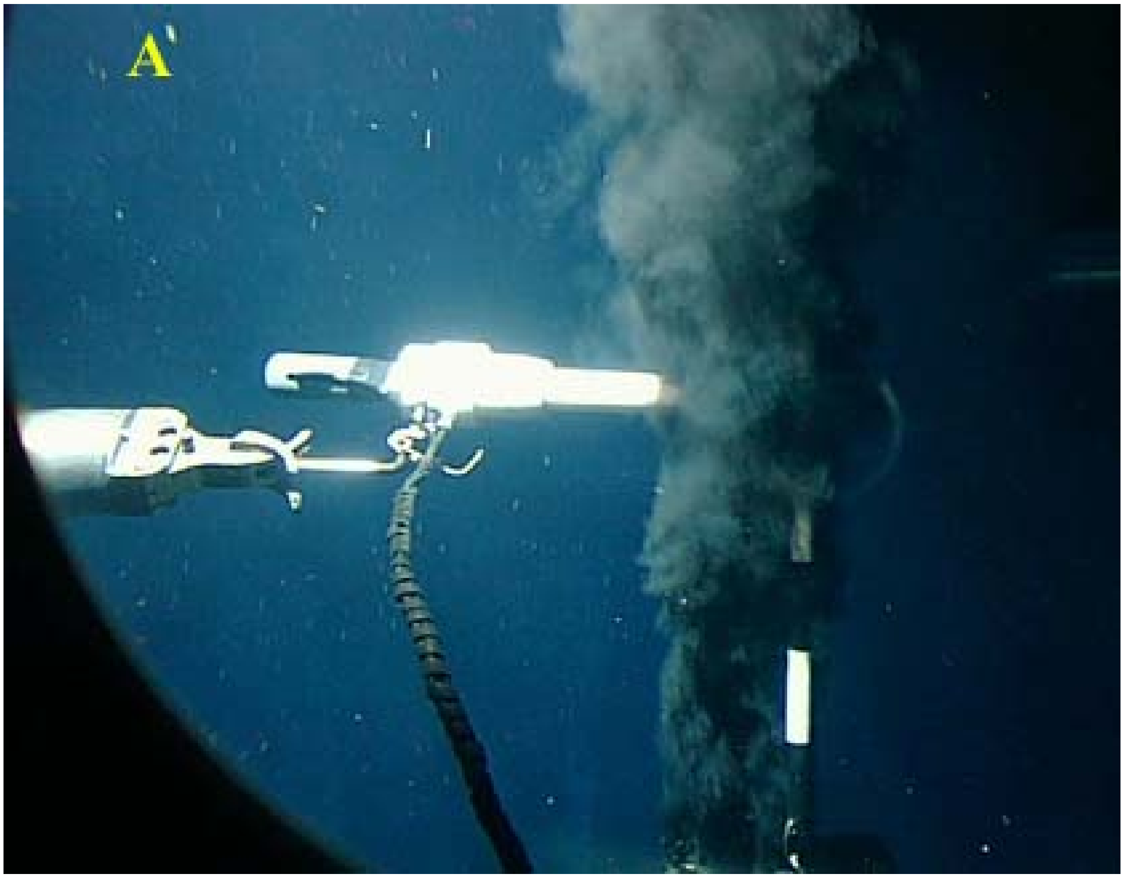
**Figure 3.** (A) Distribution of dissolved $O_2$, Mn and Fe in porewaters from Raritan Bay New Jersey. $O_2$ and Mn do not overlap and the agreement between the voltammetric sensor and the Clark $O_2$ sensor is excellent. (B) Profile with pH data from C. Reimers. $O_2$ is not detected at 2 mm depth and Mn is first detected at 3 mm. The maximum in pH occurs with the $Mn^{2+}$ maximum. (C) ROV ready to deploy the electrodes.

(Analytical Instrument Systems, Inc.). *In situ* studies range from sediment studies in lakes, bays and estuaries to water column studies in the Black Sea to hydrothermal vent studies that document the chemistry that constrains life in extreme environments. Recent local work documents the chemistry in inland bays that leads to fish kills.

## Results and Discussion

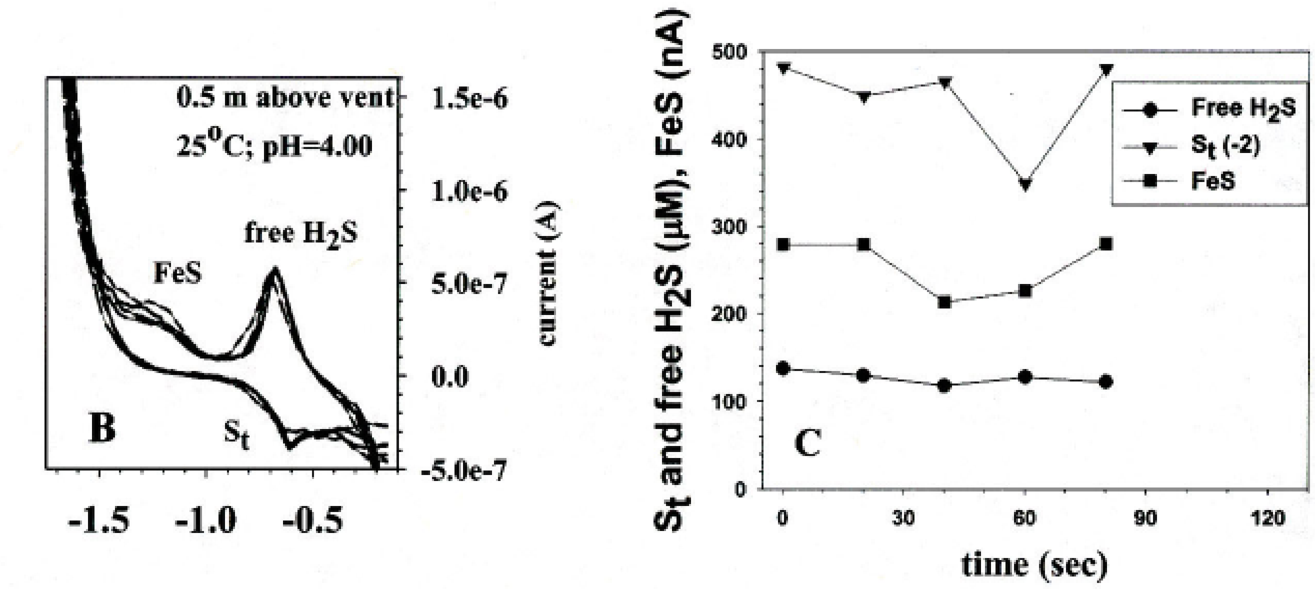
### Sediments

Our early salt marsh (Brendel and Luther, 1995; Luther, 1995; Luther et al, 1996) work showed the importance of the Au/Hg electrode in measuring dissolved $Mn^{2+}$, $Fe^{2+}$ and $Fe^{3+}$ in addition to $O_2$ and $H_2S$, but work with our colleague, Dr. Bjørn Sundby, in the St. Lawrence estuary and continental margin sites (Luther et al, 1997, 1998; Anschutz et al, 2001) clearly documented the importance of Mn and Fe dynamics in the sedimentary environment. In this work, we showed that $O_2$ rarely overlaps with $Mn^{2+}$ in most sedimentary environments (**Figure 2**). Their overlap had been always assumed because direct measurement of all redox species without sampling artifacts was not an easy task by traditional methods. Thus, another oxidant is required to oxidize $Mn^{2+}$ and our results showed



**Left: Figure 4. (A)** Positioning of the electrodes 0.5 m above a black smoker chimney.

**Below: Figure 4.** (B) Cyclic voltammograms (1 V/s scan rate; scan direction is from positive to negative and back to positive) show the measurement of free $H_2S$, FeS clusters and total sulfide (sum of free $H_2S$ and FeS). (C) Time course of the measurements. A conditioning step of 15 sec at –1.0 V was used to clean the surface of the Au/Hg electrode.



that nitrate and iodate are excellent candidates linking the Mn and N cycles to the formation of $N_2$ (see also Boudreau et al, 1998). Interestingly, overlap of $O_2$ with $Mn^{2+}$ does occur frequently in lakes (Cai et al, 2002).

Further sediment work in flumes (Huettel et al, 1998), in mesocosms (Luther et al, 1998) and in real time (Luther et al, 1999) including using ROV's (Remotely Operated Vehicle) showed that soluble $Fe^{3+}$ (Luther et al,, 1996; Taillefert et al, 2000, 2002) and FeS clusters (Theberge and Luther, 1997; Rickard et al, 1999; Rozan et al, 2002) are formed in sediments. The signal for $Fe^{3+}$ is typically broad but comparison of this signal with several laboratory prepared Fe(III) organic complexes indicates that the porewater signal represents Fe(III) organic complexes. On ageing, the Fe(III) signal shifts from about –0.4 V to more negative potentials. The Fe(III) signal is not observed when sulfide is present in porewaters and known Fe(III) complexes are shown to react with sulfide in a matter of minutes.

The solid state microelectrode has also been used *in situ* to measure pore water profiles of dissolved $O_2$, Mn, Fe, and sulfide in nearshore

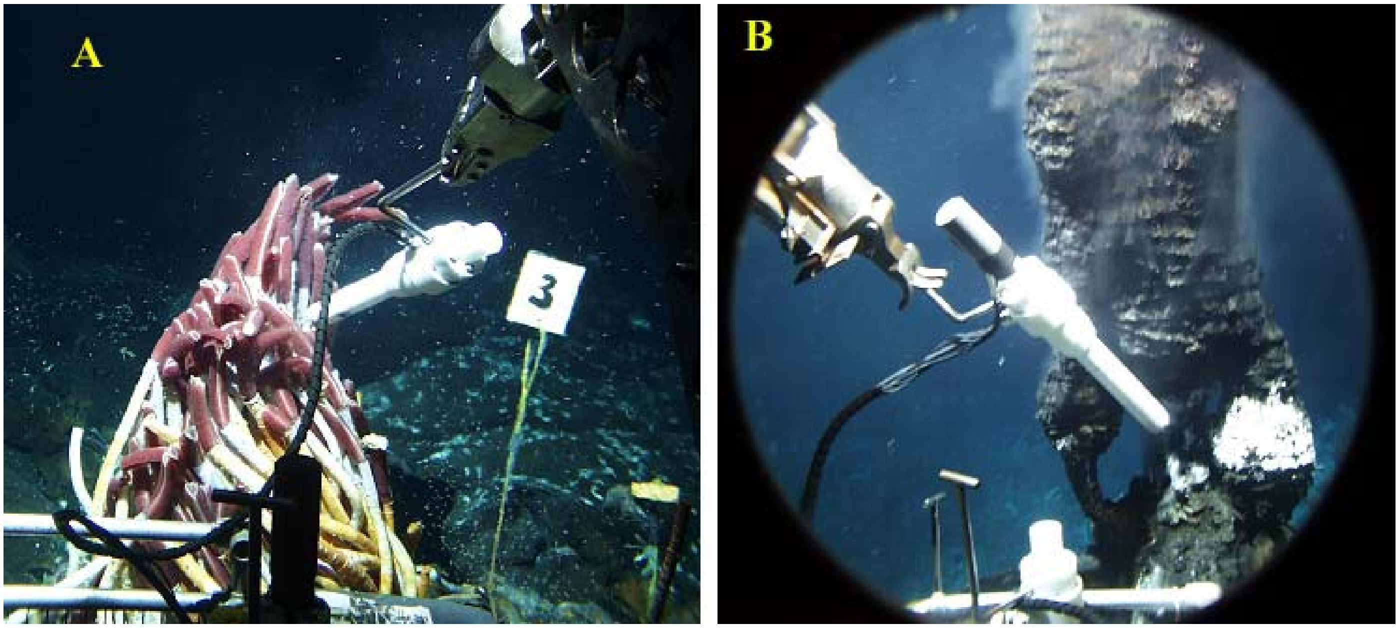


**Figure 5.** Deployment of electrodes near (A) *Riftia pachyptila* and (B) a beehive vent structure.

sediments. The voltammetric sensor is positioned and manipulated with microprofiling instrumentation mounted on a small ROV. The electrode is connected to the shipboard voltammetric analyzer with a 30 m cable, which had receiver transmitter transducers on each end to preserve the signal quality along the cable. The sensor was thus controlled and monitored in real time from the research vessel anchored at the study site. Single analyte $O_2$, pH and resistivity microsensors provided by Dr. Clare Reimers were inserted into the sediment next to the voltammetric sensor. Excellent agreement was found between the Clark amperometric $O_2$ electrode and the Au/Hg voltammetric electrode (**Fig. 3A)**. Again the profiles (e.g., **Fig. 3B**) show no detectable overlap of $O_2$ and $Mn^{2+}$ in the sediments similar to observations on cores from the continental margin sites of Canada. A subsurface $Mn^{2+}$ peak was observed at about 2 cm and coincided with a subsurface pH maximum as expected based on equation (1). The Au/Hg electrode and pH data can be explained by organic matter decomposition with alternative electron acceptors and by secondary reactions involving the products from organic matter decomposition. Similar data are observed in the upper few sediments of lakes (Cai et al, 2002), but pH and $Mn^{2+}$ do not decrease after the Mn/pH maximum.

$$236\ MnO_2 + C_{106}H_{263}O_{110}N_{16}P + 364\ H^+ \longrightarrow$$
$$8\ N_2 + 106\ HCO_3^- + HPO_4^{2-} + 236\ Mn^{2+} + 636\ H_2O \quad (1)$$

### Microbial cultures, mats and biofilms

Direct insertion of the Au/Hg electrode into cultures (Farrenkopf et al, 1997; Dollhopf et al, 2000) documented the conversion of iodate to iodide, Mn(IV) to Mn(II) and Fe(III) to Fe(II) during the oxidation of organic matter. Increasing the crystalline nature of the electron acceptor's phase slows down the rate of reduction. More recently, we have documented the change of sulfur chemistry in salt marsh microbial mats (Glazer et al, 2002; Luther et al, 2001) and showed that soluble soluble elemental sulfur, $S_2O_3^{2-}$ and polysulfides ($S_x^{2-}$) form in discrete layers of (sub)millimeter thickness. The detection of $S_x^{2-}$ is readily observed as two peaks [one more positive for S(-2) and the other more negative for the (x-1) S(0) atoms; Table 1; Rozan et al, 2000]. The electrochemical data in microbial mats correlate well with the data obtained from molecular biology and other methods including microscopy (Glazer et al, 2002). In a study of biofilm corrosion in seawater, a 25 mm solid-state electrode was used to study the chemistry in biofilms (Xu et al, 1998). The biofilm had a thickness of 125 mm and the computer manipulator had a resolution of better than 5 mm. The chemistry of the biofilm showed similar profiles as those above for sediments.

### Water column data including hydrothermal vents

More recently we have applied the technology to the study of the water column by mounting the electrodes on a CTD (Luther et al, 2002a) or by pumping water through a flow cell (Luther et al, 2002b) and by deployment off of the Deep Sea submersible *Alvin* (Luther et al, 2001, 2002b; Nuzzio et al, 2002). **Figure 4a** shows the deployment of the electrodes from *Alvin*. The electrodes are housed in a white wand containing a metal handle for the submersible's manipulators to position. **Figure 4b,c** show the actual voltammetric scans and the reduced data obtained while deploying the electrodes 0.5 meter above a black smoker at the East Pacific Rise ($9^0$ 50'). The reproducibility is excellent. The one data point was affected by electrical noise from the submersible. We are aware of no other method that can provide data in such a turbid environment because 30 cm of the tip of the wand cannot be seen in the black smoke. Other data collected with the Au/Hg electrode showed that the tubeworm, *Riftia pachyptila*, resides in waters that are rich in $H_2S$ whereas the polychaete, *Alvinella pompejana*, lives in waters rich in FeS clusters with little or no free $H_2S$. Because *Riftia* has an endosymbiont that performs chemosynthesis that requires $H_2S$ and *Alvinella* does not, our data indicate that chemical speciation drives hydrothermal vent ecology.

### Conclusions

The voltammetric method with solid-state electrodes is suitable for the study of chemistry of a wide variety of environmental systems in real time, but requires that the analyst be well versed in the principles of electrochemistry including voltammetry. We have trained several colleagues in the U.S and overseas who are now using the techniques in these and other ways. Voltammetry is a powerful technique because it provides chemical speciation data (e.g.; oxidation state and different elemental compounds/ions) as well as quantitative data. Because (micro)organisms occupy environmental niches due to the system's chemistry, it is necessary to know the speciation. Voltammetric methods allow us to study how chemistry drives biology and how biology can affect chemistry for its own benefit. We have recently applied the electrodes to study microbial mats in Yellowstone National Park, polluted sites and water column stratification in lakes, estuaries, Inland Bays, the Chesapeake Bay and the Black Sea. We hope to pursue the use of these electrodes off of moored systems.

### Acknowledgements

We thank the National Oceanic and Atmospheric Administration and the National Science Foundation for support of this work. The advancement of this work could not have been done without Dr. Donald Nuzzio of Analytical Instrument Systems, Inc. who ably designed the electronics for real time measurements. We thank our good colleagues Drs. Bjørn Sundby, David Rickard, Ken Nealson, Clare Reimers, Dave Lovalvo, Wei-Jun Cai, Gert deLange, Bruce Williamson, Craig Cary and Steve Dexter for their assistance and encouragement in several areas. A host of students and postdoctoral students who are referenced in this paper have contributed to the development and application of this technology. Paul Brendel and Steve Theberge received their Ph.D. degrees in analytical chemistry from the University of Delaware's department of chemistry and biochemistry under my guidance, and their work shows the kind of excellent collaboration that can occur between diverse and distant (135 km.) university departments.

**Table 1:** Electrode reactions at the Au/Hg electrode vs the saturated calomel electrode (SCE). All data were obtained with a 100-µm diameter electrode ($A = 7.85 \times 10^{-3}$ mm$^2$). $O_2$ data were collected by Linear Sweep Voltammetry at 200 mV s$^{-1}$; all others were collected by Square Wave Voltammetry at 200 mV s$^{-1}$. Potentials can vary with scan rate and concentration; e.g., on increasing concentration, the sulfide signal becomes more negative. Detection limit can be enhanced with faster scan rates (Bond, 1980).

When applying potential from a positive to negative scan direction, sulfide and S(0) react in a two step process (1- adsorption onto the Hg surface; 2 - reduction of the HgS film) and polysulfides react in a three step process (1- adsorption onto the Hg surface; 2 - reduction of the $HgS_x$ film; 3 - reduction of the S(0) in the polysulfide). Increasing the scan rate separates electrode reactions 4b and 4c into two peaks because eq. 4c is an irreversible process (increasing scan rate shifts this signal; Bond, 1980). MDL=Minimum detection limit.

| | | $E_p$ ($E_{1/2}$) (V) | MDL (µM) |
|---|---|---|---|
| 1a) | $O_2 + 2 H^+ + 2 e^-$ --> $H_2O_2$ | -0.30 | 5 |
| 1b) | $H_2O_2 + 2 H^+ + 2 e^-$ --> $H_2O$ | -1.2 | 5 |
| 2a) | $HS^- + Hg$ --> $HgS + H^+ + 2 e^-$ | adsorption onto Hg <-0.60 | |
| 2b) | $HgS + H^+ + 2 e^-$ <--> $HS^- + Hg$ | ~ -0.60 | <0.1 |
| 3a) | $S(0) + Hg$ --> $HgS$ | adsorption onto Hg <-0.60 | |
| 3b) | $HgS + H^+ + 2 e^-$ <--> $HS^- + Hg$ | ~ -0.60 | <0.1 |
| 4a) | $Hg + S_x^{2-}$ --> $HgS_x + 2 e^-$ | adsorption onto Hg <-0.60 | |
| 4b) | $HgS_x + 2 e^-$ <--> $Hg + S_x^{2-}$ | ~ -0.60 | <0.1 |
| 4c) | $S_x^{2-} + x H^+ + (2x-2) e^-$ --> $x HS^-$ | ~ -0.60 | <0.1 |
| 5) | $2 RSH$ <--> $Hg(SR)_2 + 2 H^+ + 2 e^-$ | typically more positive than $H_2S/HS^-$ | |
| 6) | $2 S_2O_3^{2-} + Hg$ <--> $Hg(S_2O_3)_2^{2-} + 2e^-$ | -0.15 | 10 |
| 7) | $S_4O_6^{2-} + 2 e^-$ --> $2 S_2O_3^{2-}$ | -0.45 | 15 |
| 8) | $FeS + 2 e^- + H^+$ ---> $Fe(Hg) + HS^-$ | -1.1 | molecular species |
| 9) | $Fe^{2+} + Hg + 2 e^-$ <--> $Fe(Hg)$ | -1.43 | 10 |
| 10) | $Fe^{3+} + e^-$ <--> $Fe^{2+}$ | -0.2 to -0.9 V | molecular species |
| 11) | $Mn^{2+} + Hg + 2 e^-$ <--> $Mn(Hg)$ | -1.55 | 5 |
| 12) | $Cu^{2+} + Hg + 2 e^-$ <--> $Cu(Hg)$ | -0.18 | <0.1 |
| 13) | $Pb^{2+} + Hg + 2 e^-$ <--> $Pb(Hg)$ | -0.41 | <0.1 |
| 14) | $Cd^{2+} + Hg + 2 e^-$ <--> $Cd(Hg)$ | -0.58 | <0.1 |
| 15) | $Zn^{2+} + Hg + 2 e^-$ <--> $Zn(Hg)$ | -1.02 | <0.1 |

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# Opportunities in Geochemistry for Post-2003 Drilling: Preparing for the Integrated Ocean Drilling Program (IODP)

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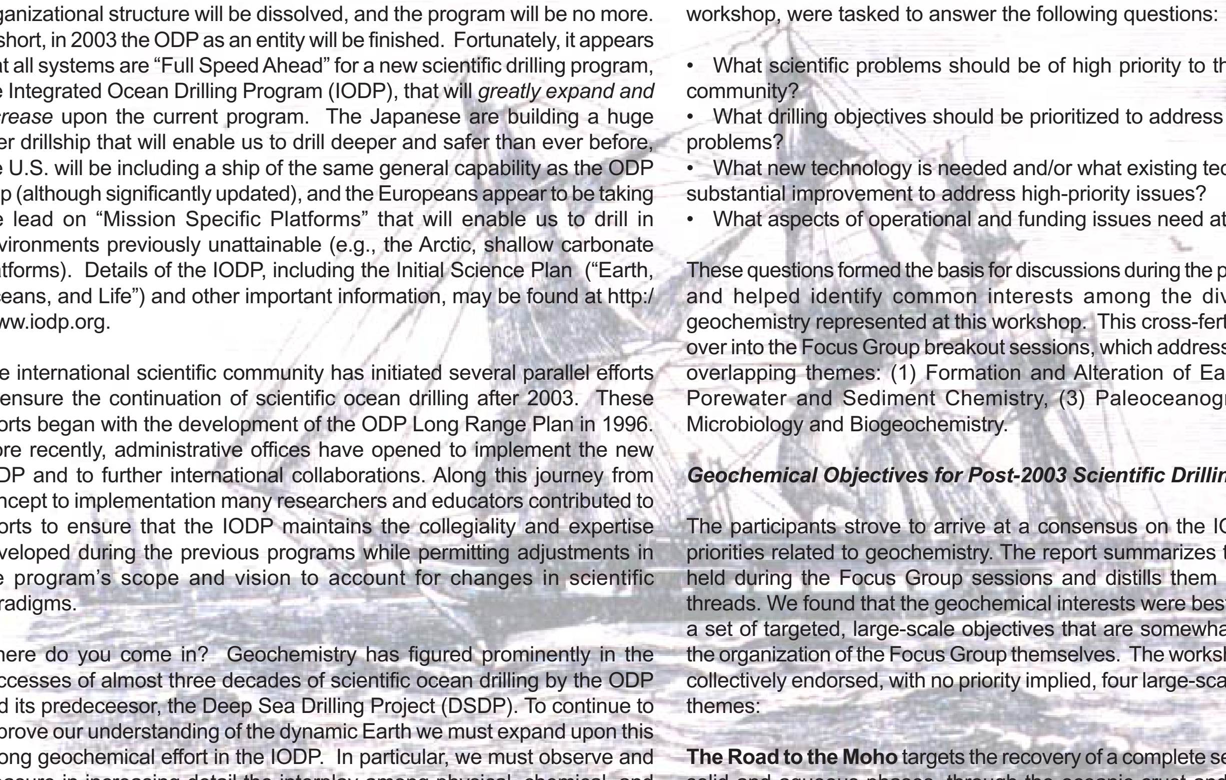
***Introduction***



As you are perhaps aware, the Ocean Drilling Program (ODP) will end on October 1, 2003. Scientific drilling operations will stop, the current organizational structure will be dissolved, and the program will be no more. In short, in 2003 the ODP as an entity will be finished. Fortunately, it appears that all systems are "Full Speed Ahead" for a new scientific drilling program, the Integrated Ocean Drilling Program (IODP), that will *greatly expand and increase* upon the current program. The Japanese are building a huge riser drillship that will enable us to drill deeper and safer than ever before, the U.S. will be including a ship of the same general capability as the ODP ship (although significantly updated), and the Europeans appear to be taking the lead on "Mission Specific Platforms" that will enable us to drill in environments previously unattainable (e.g., the Arctic, shallow carbonate platforms). Details of the IODP, including the Initial Science Plan ("Earth, Oceans, and Life") and other important information, may be found at http://www.iodp.org.

The international scientific community has initiated several parallel efforts to ensure the continuation of scientific ocean drilling after 2003. These efforts began with the development of the ODP Long Range Plan in 1996. More recently, administrative offices have opened to implement the new IODP and to further international collaborations. Along this journey from concept to implementation many researchers and educators contributed to efforts to ensure that the IODP maintains the collegiality and expertise developed during the previous programs while permitting adjustments in the program's scope and vision to account for changes in scientific paradigms.

Where do you come in? Geochemistry has figured prominently in the successes of almost three decades of scientific ocean drilling by the ODP and its predeceesor, the Deep Sea Drilling Project (DSDP). To continue to improve our understanding of the dynamic Earth we must expand upon this strong geochemical effort in the IODP. In particular, we must observe and measure in increasing detail the interplay among physical, chemical, and biological processes. This need is growing as Earth's population demands increased access to natural resources, protection from changes in Earth's hydrosphere, and advance notice of major changes in Earth's surface resulting from either natural or anthropogenic forcings.

As part of the overall planning effort for the IODP, fifty-two geochemists from the international community, with a diverse set of interests, met in a workshop to develop a blueprint for geochemical studies during the IODP and to articulate a collective vision of geochemistry's role in the next decade of scientific ocean drilling. Representatives from the U.S. National Science Foundation (NSF), the JOI/U.S. Science Advisory Committee (JOI/USSAC), and the ODP/IODP scientific advisory structures also participated in these discussions. The two-day workshop was held at the Boston University Corporate Education Center in Tyngsboro, Massachusetts, which provided a retreat-like setting for the exchange of ideas. The workshop was motivated by the need to identify common interests among diverse subsets of geochemists and to go beyond the scientific planning described in the IODP Initial Science Plan.

The workshop report was recently mailed to the Geochemical Society's membership, in addition to the ODP and IODP advisory structure, a variety of other scientists, and relevant personnel in US and international funding agencies. It may be found on-line as well, both at the Geochemical Society's site as well as that of the Joint Oceanographic Institutions (www.joi-odp.org). Workshop results provide a framework for geochemists and other geoscientists to define new drilling proposals, measurement techniques, and other associated initiatives that will contribute to a successful future deep-drilling program. An explicit workshop goal was to strengthen ties to other members of the geochemical community by involving individuals who have had only limited interactions with DSDP/ODP. Thus, a wide range of scientific fields were represented by the workshop attendees. In addition, written comments were solicited from persons who were unable to attend, however, we recognize that not all of the goals, ideas, and needs of broad spectrum of geochemical research are incorporated into this workshop report. Nonetheless, the discussions, recommendations, and conclusions presented herein articulate a common vision for geochemical research in the next decade of scientific ocean drilling and provide this group's view of how to maintain the highest standards for chemical study in the IODP.

Each of the attendees, and other individuals that were unable to attend this workshop, were tasked to answer the following questions:

- What scientific problems should be of high priority to the geochemical community?
- What drilling objectives should be prioritized to address these scientific problems?
- What new technology is needed and/or what existing technology needs substantial improvement to address high-priority issues?
- What aspects of operational and funding issues need attention?

These questions formed the basis for discussions during the plenary sessions and helped identify common interests among the diverse fields of geochemistry represented at this workshop. This cross-fertilization carried over into the Focus Group breakout sessions, which addressed four broadly overlapping themes: (1) Formation and Alteration of Earth's Crust, (2) Porewater and Sediment Chemistry, (3) Paleoceanography, and (4) Microbiology and Biogeochemistry.

***Geochemical Objectives for Post-2003 Scientific Drilling***

The participants strove to arrive at a consensus on the IODP's scientific priorities related to geochemistry. The report summarizes the discussions held during the Focus Group sessions and distills them along common threads. We found that the geochemical interests were best organized into a set of targeted, large-scale objectives that are somewhat different from the organization of the Focus Group themselves. The workshop participants collectively endorsed, with no priority implied, four large-scale geochemical themes:

**The Road to the Moho** targets the recovery of a complete section, including solid and aqueous phases, through the oceanic crust and into the upper mantle. The journey of "The Road to…" is as important as the destination of "…the Moho," as a wealth of information will be gained by fully characterizing oceanic and transitional [continental] crust.

**Continental Margins as Biogeochemical Reactors** targets the critical interface between land and sea, with all associated gradients in aqueous and solid phase chemistry, organic geochemical sources and sinks, microbiological communities, and the cycling among the four important carbon reservoirs (continents, seawater, marine sediments, and atmosphere). The highly variable nature of continental margins (e.g., passive vs. active, continental vs. oceanic island arcs, volcanic vs. non-volcanic provinces) leads to a variety of "reactor" operating conditions.

**Global Biogeochemistry Through Time** targets the geochemical links among the hydrosphere, atmosphere, lithosphere, and biosphere, and addresses forcings and responses at all time scales. Specific research goals beyond the existing focus on paleo-temperature and paleo-$CO_2$ studies, such as the importance of biomarkers in reconstructing ocean history, need to be increasingly emphasized. The geochemical budgets and large-scale cycling of many elements are unconstrained.

**Linking Microbiology and Biogeochemistry** targets the intimate relationship between microbial activity and geochemical properties, and

***(continued, see 'IODP' on page 27)***

# Minutes of the Board of Directors Meeting: Davos, Switzerland, 17 Aug 02

The meeting was convened at the Congress Center in Davos, and came to order at 9:10 am.

**Present:** Judith McKenzie (President), Tim Drever (Vice President), Jeremy Fein (Secretary), Ken Peters (OGD Chair), Frank Podosek (GCA Editor), Scott Wood (Special Publications Editor), Albrecht Hofmann (Director), Eric Oelkers (Director), Erwin Suess (Director), Francis Albarede (President of EAG), Seth Davis (GS Business Manager), Johnson Haas and Carla Koretsky (Geochemical News co-editors), Alex Halliday (2002 Goldschmidt Organizing Committee member), Yukihiro Matsuhisa and Jun-ichi Matsuda (2003 Goldschmidt Organizing Committee members), Susan Stipp and Bjorn Jamtveit (2004 Goldschmidt Organizing Committee members), Mickey Gunter (Proposed 2005 Goldschmidt Organizing Committee member), Lynn Walter (Past Chair, Patterson Award Committee), Rod Ewing (President of MSA), Friso Veenstra (Elsevier Product Manager).

**President's Report:** Judith McKenzie made introductory remarks, and reported that the health of the Geochemical Society is strong, reflecting the overall strength of geochemistry as a whole. Highlights from the past year include the identification of a strong group of medal recipients, and a new group of committee members to help carry out the Geochemical Society's programs and mission.

**Vice President's Report:** Tim Drever reported that his primary activities involved the identification and nomination of replacements for openings in GS committees. A concern was raised that the Program Committee did not include enough 'hard rock' geochemists. Drever reported that every effort was made to provide balance to the committee according to scientific discipline, but due to a large number of people who declined to serve on the committee, some disciplines, specifically high-temperature geochemistry, are not well represented. To remedy the situation for this year, Daniele Cherniak at Rensselaer Polytechnic Institute has agreed to serve as an informal additional member of the committee. Drever suggested that in the future the Vice President should solicit input from other members of the Board of Directors to help identify candidates for these positions.

**Nominations Committee Report:** Judith McKenzie reported that due to a mis-communication, the previous Nominations Committee did not provide nominations for the two out-going GS Directors or for the out-going Treasurer. McKenzie has contacted Becky Lange, and Lange has agreed to serve for a second two-year term as Treasurer if elected. Jan Veizer, the new chair of the Nominations Committee, will be charged with identifying two nominees for the open Director positions as soon as possible. The changeover date of July 1 for committee membership was identified as one source of difficulty, and a number of different options were discussed.

**International Secretary's Report:** Because of a scheduling conflict, Eiichi Takahashi could not attend the Board meeting. A description of activities was submitted by Takahasi for distribution at the meeting, and is summarized below:

**Goldschmidt 2003:** Details will be reported by Dr. Matsuhisa (President of the organizing committee for GS2003) at Davos Meeting – see below. The university campus is a 10 min walk from the station of the Shinkansen and is linked by local train (2 stations) with the historical town of Kurashiki where most people will stay. The City of Kurashiki is a well known historical preserved town of the Edo period, and there are a range of museums and civil events. Field trips during the meeting will include a half-day trip to Himeji castle (world heritage, Shirasagijyo in Himeji city) and Korakuen (one of the best Japanese gardens in Okayama city). All lecture rooms (80, 150, 300 seats) are clean and modern, equipped with intelligent PC projector plus OHP. Up to 10 lecture rooms plus sites for poster and exhibition areas will be located in the same building. There are two good concert halls that can be used for special lectures and ceremonies.

At the same time as Goldschmidt 2003 is held, the Sakuyo University and the city of Kurashiki are hosting the 5th Tchaikovsky Contest for young musicians (annually held in one city in the world). The Contest starts two weeks earlier than Goldschmidt, so that only the final contests will overlap with the Goldschmidt 2003 week. There will be few conflicts except housing and we may have some fringe benefits such as small concerts at the Sakuyo University Campus for Goldschmidt participants.

**Geochemical Society Short Course for Isotope Geochemistry**: On Oct. 7th to 10th of 2001, a lectures series (short course) for young scientists on isotope geochemistry was held at Hayama, Kanagawa prefecture, Japan. The short course was planned by E.Takahashi, and Prof. Takafumi Hirata (both at Titech, Tokyo Institute of Technology) acted as the organizer. The short course was sponsored by the Geochemical Society and the Geochemical Society of Japan and the company Seki-Technotron. Prof. K. O'Nion of Oxford University and Prof. R.N. Clayton of University of Chicago gave invited lectures. The participants (in total 51) consisted of approximately half graduate students and the other half scientists from various universities and research labs in Japan. Prof. R. Nesbit (Southampton) also attended as a special guest speaker. We extend our special thanks to Professors R.N. Clayton and K. O'Nions who flew to Japan despite the very difficult travel conditions after Sept. 11.

**Treasurer's Report:** Because of a scheduling conflict, Rebecca Lange could not attend the Board meeting. The Treasurer's Report is summarized below:

The amount of money in our checking accounts going into the year 2002 suggests that our financial health is good. We unexpectedly made money ($38,062.20) on the Goldschmidt meeting in May, 2001. Two of the Bank United CD accounts matured in 6/00, and because of the difficult stock market climate, these were renewed. In 2001, $15 K was transferred from the Reserve Special Fund to the Medals Special Fund (to pay for medal purchases in 2002 and to leave a positive balance in the Medals Fund). These Special Funds are abstractions (the money is in our checking and investment accounts), but very real and important ones for tax purposes. Advance payments to Elsevier for 2001 GCA subscriptions were made in 2002; similarly, royalties for GCA from Elsevier are expected in 2002. Typically, advances are made, but this was not done in 2001. The subscription payments and royalties roughly balance out, and so this deferment to 2002 does not make a big difference to the accounting for 2001. The full Treasurer's Report with financial details was distributed to all Board of Directors.

**Secretary's Report:** Jeremy Fein summarized the actions that were taken by the GS Board since its last annual meeting. These are listed below:

1) Approved the nomination of Dr. John Hayes for the 2002 Goldschmidt Medal.
2) Approved the nomination of Dr. Harry Elderfield for the 2002 Patterson Medal.
3) Approved the nomination of Dr. Ruth Blake for the 2002 Clarke Medal.
4) Approved the nomination of Dr. David Des Marais, Dr. Mike Drake, Dr. Irving Friedman, Dr. Cristopher Martens, Dr. Phil Meyers, Dr. Garrison Sposito, and Dr. John Wasson to be named as Geochemistry Fellows at the 2002 Goldschmidt Conference.
5) Approved the nominations of replacements for outgoing Geochemical Society Committee members as put forth by Vice President Drever.
6) Approved the reappointment of Frank Podosek as Executive Editor of *Geochimica et Cosmochimica Acta* for a new three year term.

**GS Business Office Report:** Seth Davis reported on the following items:

*Current Membership:* As of July 31, 2002 the society has 1,523 members. Memberships are down slightly from last year. A factor for this could be attributed to potential new membership and renewals taking advantage of the automatic membership registration feature offered with the Davos Goldschmidt Conference. Paul Beattie has estimated that about 350 professional memberships and 200 student memberships were submitted with conference registrations. If applied to 2002 totals that would boost membership to nearly 2,100 members. Member demographics are given in Appendix I.

*2002, 2003 Membership Drives:* The 2002 membership drive started on November 15th, the same as for 2001. This caused considerable pressure on the renewal process as nearly 2/3 of memberships were processed within a 6 week period. It is in the best interest of the Society to start as early as possible for the 2003 drive. The by-laws recommend starting three months before the end of the year, and October 1st seems like an ideal time to start as it would be in conjunction with the release of the October 2002 issue of Geochemical News (#113). Subscription information is given in Appendix II.

*Publication:* In March 2002, the remaining stock of Special Publication books (volumes 1 – 6) located at Cadmus's Lancaster Press in Maryland, USA was relocated to a storage facility at Washington University's Tyson Research Center. The storage facility is a bomb-proof underground ammunitions warehouse built in the 1940's. Washington University acquired these bunkers in 1963 and the nearly 2000 acres of surrounding woods for wildlife conservation and research. Being underground, the facility maintains a fairly cool and steady temperature, and there are de-humidifiers present to keep everything dry. It seems to be an excellent location for these books. April 2002 marked the release of Special Publication Volume 7, printed by the University of Idaho Press. Stock of these books is also located at Tyson. Publication statistics are compiled in Appendix III.

**GCA Executive Editor's Report:** Frank Podosek reported on the following items:

### Editorial Office Staff

As noted in the prior Editor's Report, an office staffing level of 2.0 full-time people has simply been inadequate to handle the normal workload, and half-measures such as temporary help or a graduate student intern have turned out to be impractical. I have requested increase of the staff level to 3.0 full time people, and Elsevier has recently agreed to support the office at this level. The third staff member came on board July 1, at which time the staff consisted of Linda Trower, Cayce French and Bridget Healy.

Unfortunately, a complex situation has developed, such that Cayce French is no longer employed in this office and Bridget Healy is on leave; her return is dubious. Pending replacement of Cayce's position, Karen Pollard (formerly employed in this office) is helping out on a part-time basis. Some tasks that are non-time-critical are being postponed, and Linda and Karen are keeping the office running without falling too far behind. Other temporary help is available if needed. Although the situation is difficult, I am confident that inconvenience to journal clientele will be minimal.

### Manuscript Statistics

A tabulation of manuscript processing statistics (submissions by type, acceptance rates, processing times, etc., is shown in Appendix V.

### Electronic Access, Proofs, Supplements

As previously proposed, beginning this year individual member subscribers have access to the electronic version of GCA on Elsevier's website, independently of institutional access. The access includes several years' past volumes as well as the current volume. The access is valid during the current calendar year, and it is a password system, and therefore portable (i.e. a member may access it from anywhere). At least for this year, electronic access is free, compliments of Elsevier, automatically granted to every member who subscribes to GCA at the normal rate. Subscribers are advised of their electronic access privileges, and provided with password and instructions, in an e-mail from the GS business office.

Also as previously proposed, all GCA authors are given temporary (three-month) access to the electronic version of GCA on Elsevier's website, independently of institutional access, personal subscription, or society membership. This assures authors of the opportunity to download the published versions of their own manuscripts. (A downloaded manuscript file can serve as a source for reprints.) Since most authors are not society members it may also be hoped that familiarization with the journal will encourage authors to consider joining one or both of the sponsoring societies.

In addition, effective this year, authors can obtain their proofs, and submit corrections, electronically. Proof files are posted (password-protected) on a website maintained by Cadmus, the company which contracts with Elsevier for production services, including printing, for GCA. Authors are notified of proof availability by an e-mail message generated by Cadmus. Electronic proofing is not mandatory; Cadmus will provide traditional hardcopy (and accept hardcopy corrections) upon request. The principal perceived benefits of electronic proofing are that authors need not be at their home institutions to get the proofs and it is easy to share proofs among co-authors.

Also effective this year, the electronic version of GCA papers posted on Elsevier's website can also include electronic supplements. The supplements are files provided by the authors; the website listing of the main article will include links to the supplement files. The supplements may include text, tables, figures, images, animations, etc., which are important to archive and keep available to the public but which are judged to require too much space to be published in the journal or are otherwise inappropriate for journal publication (e.g. animations, computer programs).

### Goldschmidt Abstracts in GCA

As was proposed and approved last year, abstracts for the Goldschmidt Conference will be published in a supplemental issue of GCA, starting with this year's conference in Davos. The abstract issue, just like any other, will be mailed to individual subscribers and to institutional hardcopy subscribers. It will also be part of the registration packet for all conference attendees. There are approximately 1750 abstracts submitted this year, which will make a thick (two abstracts to a page) but manageable issue.

Abstracts for the Davos conference were collected, formatted and organized by Cambridge Publications, who contracted for these services with conference organizers before publication of abstracts was approved last year. Cambridge Publications has subsequently contracted separately with Elsevier for additional services involved in preparing abstracts for publication in GCA.

Elsevier will absorb most of the cost of publishing the abstracts as part of GCA. They will provide hardcopies to the conference organizers, and include the hardcopies in individual member subscriptions, at the run-on cost. For this year the run-on cost is estimated at $19 per copy.

A draft set of guidelines for publication of Goldschmidt Conference abstracts in GCA is given in Appendix IV. These guidelines are intended primarily for future use, but they are consistent with this year's practice. It can be expected that they will be revised from time to time, particularly later this summer in light of this year's experience, but the basic features should persist. The Editor requests a formal society resolution approving these guidelines. This is expected to be important in maintaining continuity even though the people primarily responsible for organization of the conference are different from one year to the next, and for abstract publication becoming part of the overall process of planning future Goldschmidt conferences.

Eric Oelkers moved that the Board approve the guidelines for publication of Goldschmidt Conference abstracts in GCA. Scott Wood seconded the motion, and the motion passed with 8 votes for, 0 against, and 0 abstentions.

It was further moved that the Board recommend to future Goldschmidt Conference organizers that hardcopies of the GCA volume that contains the Goldschmidt abstracts be made available to conference attendees as an option at the time of conference registration. The motion passed with 8 votes for, 0 against, and 0 abstentions.

Judith McKenzie closed the GCA Executive Editor Report session by thanking Frank Podosek for accepting another three-year term as the Executive Editor of GCA, for his continued service, and for bringing innovative ideas to the production of GCA.

**Special Publications Editor's Report:** Scott Wood reported on the status of the Special Publication volumes:

1) Special Publication No. 7 (Crerar volume): It appeared in April 2002, with a cost of $55 for members, $80 for non-members, and some copies were sold to authors at $25/copy. 1000 copies were printed at a cost of $22,500. 151 copies had been sold as of August 5, 2002. Approximately 50 copies were given free to first authors of all papers, to Princeton University, to Scotia Macrae (Crerar's widow), to the Library of Congress for copyright registration, etc. Book reviews of the volume have been arranged to appear in '*The Canadian Mineralogist*, *Economic Geology*, and *Mineralium Deposita*. A full page ad for the volume appeared in the July 2002 issue of *The Geochemical News*, and free ads have appeared in the newsletters of the Mineralogical Association of Canada (June 2002) and the Association of Exploration Geochemists (July 2002) in return for future ads in our newsletter. An ad was sent to the Society of Economic Geologists to appear in their newsletter, a notice was sent via e-mail to all GS members, and ads were also posted to a number of electronic bulletin boards, and on the GS website.

2) Special Publication No. 8 (Giggenbach volume). The volume will be published in cooperation with the Society of Economic Geologists, and will be edited by Stuart Simmons. Manuscripts are still in the review stage.

3) Special Publication No. 9 (Kaplan volume – proposed). A proposal for a Special Publication to honor the scientific contributions of Dr. Isaac R. (Ian) Kaplan was prepared by Ronald Hill and presented by Scott Wood. The Board discussed the merits and expenses of this proposal, as well as the range of topics covered by the papers that have been lined up for the proposed volume.

Eric Oelkers moved that the Board approve the proposal, with a limitation for the Special Volume of 450 pages. In order to achieve this page limit, the Board recommends that Dr. Hill reevaluate the author list to focus the volume more on organic geochemistry. The motion was seconded by Erwin Suess, and it passed with 8 votes for, 0 against, and 0 abstentions.

Scott Wood further reported on a proposal for student book award. He also provided updates on the Reviews in Mineralogy and Geochemistry (RiM&G) volumes that are co-sponsored by GS. The following volumes have been approved by the Board of Directors in previous meetings:

Noble Gases in Cosmochemistry and Geochemistry (Porcelli, D., Ballentine, C. and Wieler, R., eds.) – V. 47. This volume went to press in early summer 2002 and should be available at Goldschmidt 2002. No short course is associated.

Applications of Synchrotron Radiation in Low-Temperature Geochemistry and Environmental Science (Fenter, P., Rivers, M., Sturchio, N. and Sutton, S., eds.). A short course is scheduled to take place on December 4-5, 2002 in Monterey, CA.

Uranium-series Geochemistry (B.Bourdon, S.P. Turner, G. M. Henderson and C.C. Lundstrom). A short course to be held in Bristol before the EGS/AGU/EUG in Nice in April 2003 is planned.

**Program Committee Report:** Judith McKenzie reported that Marty Goldhaber is the new Chair of the Program Committee. A number of items were discussed that could be used to make the Program Committee more effective, including the submission of more proposals to other conferences for symposia that could be sponsored by the Geochemical Society, and the advertisement in the Geochemical News of calls for these types of proposals.

*In a related topic, Judith McKenzie described the Geochemical Society's Meetings Assistance Program (MAP). The Geochemical Society wishes to help support geochemically-oriented meetings. GS MAP has been created to this end. This program is divided into two parts:*

Part I: This is a $10K award given each year from the Treasurer of the GS to the organizers of the Goldschmidt Conference that year. This award is automatic, that is, no application is required. The money is to be used exclusively for assistanceships to graduate students attending Goldschmidt Conferences. It is the responsibility of the conference organizers to distribute the money as they think best. However, it is also the responsibility of the organizers to report to the GS Treasurer how the money was distributed in a brief report after the meeting takes place.

Part II: This is a $10K sum per year that is to be used by GS members to financially support geochemistry sessions/symposia at any scientific conference of geochemical relevance. The following guidelines will be enforced.

1) Individual GS members who are symposium/session organizers can apply for such a MAP award.

2) Proposals should be between 1 and 2 pages in length and should describe the overall conference, the session(s) for which funds are required along with the session(s) speaker list, and exactly how the requested funds will be spent.

3) The amount requested cannot exceed $2,000 per proposal.
4) Only one proposal from the same individual or group can be submitted in a 12 month period.

5) Proposals are reviewed and awarded/rejected by the Program Committee of the Geochemical Society. Submission is made to the Chair of the Program Committee (see the GS website for current chair by clicking on About the GS, then Governance, then GS Personnel). Although the proposals are judged primarily on merit and funds available, grants will be distributed as widely as possible across the board range of disciplines and geographical areas represented by the GS, and also as evenly as possible throughout the calendar year.

6) There is no submission deadline, but it would be wise to submit a proposal as early as one can be put together. If the proposal is rejected because that year's funds have already been assigned, the organizers will still have time to seek funding elsewhere.

**Discussion of Developing World Scientist Sponsorship Program:** This issue was brought up in response to a letter by Mark Logsdon that was published in the July 2002 issue of *Geochemical News*. A number of possibilities were discussed, including the use of sponsorship programs to enable students from developing countries to attend Goldschmidt conferences and to enable Geochemistry Society members to sponsor a member from a developing country at a reduced rate.

**Current and Future Goldschmidt Conferences:**

1) 2002 Goldschmidt Conference: Davos, Switzerland – Alex Halliday presented a report on the 2002 conference. The conference organizers broadened the scope of the meeting by engaging a wide range of scientists; they used scientists from across Switzerland to help plan the meeting; they arranged sponsorship to provide extra support for those from developing countries; they developed the concept of the International Program Committee to produce relevant and exciting scientific sessions; and they chose a location that is well-supported by local infrastructure. By many measures, the conference was a success: over 1700 abstracts were submitted, with over 1500 preregistrations. The conference generated over 400 new members to the GS and EAG. For continued success for future Goldschmidt conferences, Halliday recommended the use of a proactive Goldschmidt Advisory Board, the continued use of the International Program Committee, the continued use of Cambridge Publications, GCA and Elsevier, the promotion of Goldschmidt as the one international meeting that geochemists must attend each year, and an effort to make geochemistry as organized as geophysics and geology in promoting itself and organizing its major conferences.

Halliday further recommended: 1) that if Goldschmidt conferences remain large, it would be worthwhile budgeting to provide half a year sabbatical for the conference organizer as well as half a year of secretarial time; 2) that a well configured and organized conference center is essential for a successful large conference; and 3) that the submission of abstracts in MS Word format allows delegates to easily include much more information (e.g., tables, figures, equations) in each abstract, but a number of technical difficulties exist with the use of MS Word.

2) 2003 Goldschmidt Conference: Kurashiki, Japan – Yukihiro Matsuhisa reported on the plans that are underway for the 2003 conference, planned for Sept. 7— 12, 2003. This will be the first meeting held in the western Pacific region. The Geochemical Society of Japan will take part in the sponsorship.The city of Kurashiki is located about 200 km west of Osaka, easily accessible by the bullet train (*Shinkansen*) from Tokyo (3.5 hours), Osaka (1 hour), or Fukuoka (2 hours). A local airport at Okayama is also connected to Seoul, Shanghai and Tokyo. Kurashiki was a local trading center in western Japan in the 17th to 19th centuries, preserving attractive medieval Japan atmosphere in its old town area. Matsuhisa reported that the organizing committee has reserved the facilities of Kurashiki-Sakuyo University for the conference. At least 9 parallel oral sessions each with 100 to 150 people seated can be organized, together with plenary sessions, poster sessions, and exhibition areas. A large cafeteria, computer facilities, and childcare facilities are also available. The International Program Committee (IPC) will help plan the special sessions for the meeting as they did for the Davos meeting. Besides proposals by the Task Groups of IPC, the organizing committee also has issued a call for session proposals from the geochemical community in general. For details, see the *Geochemical News*, No. 112 and the Goldschmidt 2003 website (http://www.ics-inc.co.jp/gold2003/). The abstracts of Goldschmidt 2003 will be published in a supplemental special issue of *Geochimica et Cosmochimica Acta*, and will be distributed to the participants together with CD-ROM at the conference venue.

3) 2004 Goldschmidt Conference: Copenhagen, Denmark – Susan Stipp presented a report for the Organizing Committee of the 2004 conference, planned for June 6 – 11, 2004. A significant concern is the expected growth of the Goldschmidt Conference. Using previous European Goldschmidt conferences as a model, approximately 2000 delegates can be expected for the 2004 meeting. A number of options were discussed to deal with this size of meeting. The scientific emphasis of the meeting will be on Geochemical Processes, and the physical and scientific planning of the meeting are progressing on schedule.

4) 2005 Goldschmidt Conference – Scott Wood and Mickey Gunter presented a full proposal to hold the 2005 Goldschmidt Conference at the University of Idaho, on May 23-27, 2005. After considerable discussion concerning the advantages and disadvantages of the proposal and the site, it was decided to postpone a decision concerning the location of the 2005 conference in order to consider alternative sites and to further consider the Idaho site. The Board would also seek to elicit comments from the Goldschmidt Forum, and from Board members who could not attend the Davos Board of Directors meeting.

**MSA Co-Sponsorship of Goldschmidt Conferences:** Rod Ewing briefly summarized the strong interest of the MSA in collaborating and supporting Goldschmidt conferences and Geochemical Society activities in general. He urged the Board of Directors to compose program committees to include scientists with expertise in mineralogy, and he thought it would be especially productive to forge closer relationships between these two communities.

**Patterson Award:** Judith McKenzie, Lynn Walter, and Alex Halliday led a discussion of the criteria considered for awarding of the Patterson award. The award was originated in response to a perceived need for more awards in geochemistry in general, to reward an outstanding piece of recent research rather than a career award, and to bring added recognition to environmental geochemistry. Some discussion ensued as to whether 'environmental' connotes 'anthropogenic', and the Board agreed that the Patterson Award committee should interpret the word in its most general sense.

**Geochemical News Editors' Report:** Johnson Haas and Carla Koretsky reported that they have initiated a number of changes to the *Geochemical News* during their tenure as co-editors. These changes include the addition of color pages, a significant reduction in the cost of foreign mailings of the newsletter, the creation of a free job advertisement section, and a number of editorial and content changes. They presented details on the newsletter budget, the cost of which is approximately $7,000 USD per issue. This cost is approximately the same as the cost under the previous newsletter editor.

Judith McKenzie commended both Haas and Koretsky for the excellent job that they have done with *Geochemical News*, adding to the attractiveness of the product and to the value of the newsletter to society members.

**Proposal for GS/MSA Magazine Collaboration:** Rod Ewing presented a proposal to establish a monthly magazine of mineralogy and geochemistry. This new endeavor would help shape the image and activities of the mineralogical and geochemical disciplines, and would provide a medium for interacting with the broader geoscience, material science, and chemistry communities. Primary functions of the magazine would be to better showcase achievements in mineralogy and geochemistry to the scientific community in general as well as to the public, and to attract students to the disciplines represented in the magazine. Ewing outlined the potential content, editorial structure, staffing requirements, and budget of the magazine, which would be roughly patterned after the MRS Bulletin. This proposal was also presented to the Mineralogical Association of Canada and to the Clay Minerals Society. Ewing called for each society, if interested, to appoint two persons to represent it on a steering committee which would develop a business plan and schedule for publication, propose a new name, and propose candidates for the positions of editor and Editorial Board members.

Tim Drever moved that the Board of Directors express its enthusiastic support for the concept of the new magazine, and that the Board will supply two members of the Geochemical Society to serve on the steering committee. Erwin Suess seconded this motion, which passed unanimously with no abstentions.

**Renaming of the Organic Geochemistry Division:** Ken Peters expressed his strong disagreement with the suggestion to rename the OGD or to create a new division focused on biogeochemistry. Peters argued that biogeochemistry is actually a subset of organic geochemistry, and that the discipline is alive and well-represented within the Organic Geochemistry Division. There was general agreement expressed that the Geochemical Society already has adequate inclusion of biogeochemistry in both the Goldschmidt meetings and in GCA, and no change was recommended at this time.

The meeting adjourned at approximately 7:00 pm.
These minutes were prepared by Jeremy B. Fein, Secretary, The Geochemical Society, and were submitted September 2, 2002.

**APPENDIX I. 2002 Member Demographics.**
2002 Membership by Country

| Country | No. ofMembers | % |
|---|---|---|
| USA | 886 | 57 % |
| Canada | 85 | 6 % |
| Germany | 77 | 5 % |
| Japan | 76 | 5 % |
| United Kingdom | 71 | 5 % |
| Australia | 43 | 3 % |
| Switzerland | 41 | 3 % |
| France | 40 | 3 % |
| The Netherlands | 21 | 1 % |
| Sweden | 16 | 1 % |
| 38 Other Countries | 167 | 11 % |

*The United States still makes up the bulk of memberships. However, it has decreased by 2% from last year's report, indicating that the society is continuing to diversify*

2002 Membership by Payment Method

| Method | No.Submitted | % |
|---|---|---|
| Visa | 668 | 44 % |
| Mastercard | 378 | 25 % |

| | | |
|---|---|---|
| Check / MO | 350 | 23 % |
| American Express | 111 | 7 % |
| Other | 16 | 1 % |

*Credit card processing is still vital function of the business office, comprising over 76% of membership payments.*

2002 Membership by Submission Method

| **Method** | **No.Submitted** | **%** |
|---|---|---|
| Mail | 609 | 40 % |
| Email | 440 | 29 % |
| Fax | 361 | 24 % |
| Phone | 113 | 7 % |

*Due to the unsecured nature of e-mail, this year's drive promoted other means of submission. As a result e-mail submissions dived 18% from last year, as many members switched to post and fax submissions.*

2002 Membership by Category

| **Category** | **No.Submitted** | **%** |
|---|---|---|
| Professional | 934 | 61 % |
| Professional OGD | 326 | 21 % |
| Student | 141 | 9 % |
| Student OGD | 59 | 4 % |
| Senior | 52 | 3 % |
| Senior OGD | 11 | 1 % |

*Over º of members are in the OGD. Last year approximately 10% of membership would qualify for senior status. This year, the first to have senior membership, shows that only 4% are choosing to take advantage of it.*

2002 Membership History

| **Method** | **No.Submitted** | **%** |
|---|---|---|
| Renewals | 1350 | 89 % |
| New Unsolicited | 127 | 8 % |
| New: Solicited | 43 | 3 % |
| Life Members | 3 | <1 % |

*As usual, the majority of our numbers are by membership retention. But, progress has been made in recruiting memberships through GCA author solicitations via post and e-mail. A test sample of 554 GCA Authors were solicited for GS membership. Of those, 43 have joined (a 7.7% return) and just as many were returned undeliverable. Although this may seem an insignificant number, these 554 represent a fraction of the number of authors that are published in GCA and are not members. Since there is no postage for e-mail solicitations, this policy will be continued.*

**APPENDIX II.**
**Subscriptions**

2002 GCA Subscriptions (as of GCA v.66 issue 16)

| **Membership/Type** | **No. ofSubscriptions** | **%** |
|---|---|---|
| GS Professional | 781 | 76 % |
| GS Student | 69 | 7 % |
| GS Senior | 33 | 3 % |
| MS Professional | 130 | 13 % |
| MS Student | 10 | 1 % |

Subscriptions are down from last year. A reasonable cause for this is the increased availability of Elsevier's Contents Direct on-line program.

Starting in 2002, Elsevier also gave limited access to GCA subscribing members to access GCA on-line. Note that this is currently in addition to the normal paper subscription and not a replacement of it.

In April 2002, Elsevier Science switched to a new address label format for GCA subscriptions. There have been quite a few errors in this change, most notably is the number of back issue requests for v66 issue 6, although requests for issues after 6 are also more numerous than normal. Elsevier has assured the GS that they have worked the bugs out of the new labeling system and should no longer pose a problem.

2002 GN Subscriptions (as of GN #112)

| **Membership/Type** | **No. ofSubscriptions** | **%** |
|---|---|---|
| GS Professional | 1257 | 58 % |
| GS Student | 197 | 9 % |
| GS Senior | 63 | 3 % |
| EAG | 660 | 30 % |

Labels for the GN issues are now submitted electronically to the GN editors who handle transferring them on to the newsletter.

Shortly after the issues have been mailed, the business office is sent the remaining overprint issues for storage and back issue distribution.

**APPENDIX III.**

| **2002 Publication Prices and Inventory** | **Current Price** | **Inventory as of 7/31/02** |
|---|---|---|
| v.1 *Magmatic Processes: Physicochemical Principles. A volume in honor of Hatten S. Yoder, Jr.*, edited by B.O. Mysen (1987) | $25.00 | 348 |
| v.2 *Fluid-Mineral Interactions: A Tribute to H.P. Eugster*, edited by R.J. Spencer and I.-M. Chou (1990) | $25.00 | 968 |
| v.3 *Stable Isotope Geochemistry: A Tribute to Samuel Epstein*, edited by H.P. Taylor *et al.* (1991) | $25.00 | 966 |
| v.4 *Victor Moritz Goldschmidt: Father of Modern Geochemistry*, by Brian Mason (1992) | $20.00 | 593 |
| v.5 *Mineral Spectrosocpy: A Tribute to Roger G. Burns*, edited by M.D. Dyar *et al*. (1996) | $40.00 / $60.00 | 1099 |
| v.6 *Mantle Petrology: Field Observations and High-Pressure Experimentation: A Tributeto Francis R. (Joe) Boyd*, edited by Y. Fei, C.M Bertka and B.O. Mysen (1999) | $60.00 / $90.00 | 644 |
| v.7 *Water-Rock Interactions, Ore Deposits, and Environmental Geochemistry A Tribute to David A. Crerar*, edited by R. Hellmann and S.A. Wood (2002) | $55.00 / $80.00 | 849 |

The inventory is an estimated count of remaining stock. A manual accounting of stock will be performed this fall.

2002 Special Publication Sales

| **Volume/Tribute** | **2001Sales** | **2002Sales** |
|---|---|---|
| **Volume/Tribute** | **2001Sales** | **2002Sales** |
| Sets | 15 | - |
| v.4 Goldschmidt | 160 | 4 |
| v.1 Yoder | 6 | 6 |
| v.5 Burns | 16 | 11 |
| v.2 Eugster | 10 | 5 |
| v.6 Boyd | 37 | 9 |
| v.3 Epstein | 12 | 9 |
| v.7 Crerar | - | 142 |

**APPENDIX IV.**
**Guidelines for publication of Goldschmidt Conference abstracts in GCA**

The Geochemical Society, the Meteoritical Society, the Executive Editor of*Geochimica et Cosmochimica Acta* and Elsevier, as represented by its Publishing Editor responsible for GCA, have agreed that beginning in 2002 the abstracts of the Goldschmidt Conference should be published in a supplemental special issue of GCA. This document describes guidelines for implementation of this resolution.

**Abstract Compiler**
Conference abstracts will not be processed in the regular GCA editorial office. Instead, it will be the responsibility of the Conference organization to process abstracts and provide appropriate materials to the Elsevier Production Manager for publication in GCA. The specific group responsible for abstract processing is hereafter termed the Compiler. It is anticipated that the Compiler responsible for delivery of materials to Elsevier will be the same organization responsible for processing abstracts for other purposes, such as preparation of a CD, creation of the program of technical sessions, etc. From prior experience it is expected that the Compiler will be a commercial entity which contracts with the Conference organization, but in principle the same task could be undertaken by a volunteer organization. As regards publication in GCA, the basic responsibility of the Compiler is to deliver to Elsevier formatted camera-ready copy (CRC), along with the equivalent electronic files in pdf format. A table of contents is not necessary but the materials provided to Elsevier should include an author index.

**Schedule**
The Compiler must deliver the CRC and equivalent files to Elsevier no less than five weeks prior to the beginning of the Conference. Experience indicates that this requires that the deadline for electronic submission of abstracts be at least sixteen weeks prior to the beginning of the Conference. If the Compiler meets this deadline, Elsevier will deliver hardcopy abstract issues to the Conference venue one week before the beginning of the Conference. The abstract issue will also be mailed to hardcopy subscribers, institutional and individual, at the printer's earliest convenience.

**Finance**
From prior experience it is expected that most of the Compiler's efforts in processing abstracts are necessary for Conference objectives other than publication of abstracts in GCA, and therefore that most of the Compiler's financial compensation will be derived from Conference organizers' funds. Conference organizers are encouraged to charge an explicit abstract fee to cover this cost (rather than absorbing the cost in the registration fee).

Some of the Compiler's work will involve preparation of materials for delivery to Elsevier for abstract publication, beyond what would be necessary without publication of abstracts. Elsevier will negotiate with the Compiler to pay for this additional service. Elsevier will provide copies of the abstract issue to the Conference at cost (run-off plus shipping). Conference organizers are requested to include the abstract issue in the registration packet and to include the cost of the abstract issue in the registration fee.

**Format**
Abstract text font should be Times New Roman. Essential elements include title (14 point, bold), list of authors (10 point, large and small uppercase letters), institutional affiliation(s) (9 point) and main text (9 point), including references (9 point). As in the accompanying illustrations, title, author, affiliation and main text fields should be separated by a blank line. Title, author and affiliation fields should be centered, main text should be fully justified with indented paragraphs. Literature citation callouts in the text should be by bracketed sequence numbers, and references should be provided at the end of the text. References should have an abbreviated format, rather than the more extended format regularly required for GCA, and successive references may be run-on on the same line (see examples). Optional figures (black and white only) and/or tables, at the authors' discretion, should be permitted, subject to compliance with total length guidelines. The Compiler should provide a template in a widely used word processor format (e.g. Microsoft Word) along with instructions to assist authors in complying with these format guidelines.

The Compiler will be expected to exercise reasonable diligence in assuring that abstracts conform to these format guidelines, and also in correcting gross word-processing errors and minor typographical, orthographical and grammatical errors, as long as the meaning is obvious. Where it is evident that authors have made an error but the meaning is not obvious, or where information is missing, the Compiler will be expected to contact the author if possible and work with him/her to produce a correctly formatted abstract.

All abstracts, including required format elements and possible optional figures and/or tables, should be no more than one journal column long, so that they may be printed two to a page. This rule should be enforced strictly, to the point that abstracts are deleted if their authors cannot be contacted or do not provide a compliant abstract in timely fashion. The only exceptions are that at the discretion of the Conference organizers, a few abstracts may be designated as "plenary" abstracts and allotted one full page (two columns) rather than one column.

The formatted pages delivered to Elsevier should be numbered consecutively, with a numeral following the letter "A", i.e. pages A1, A2, etc. Abstracts should appear in alphabetical order by author. If there are any plenary abstracts they should be grouped together before the regular abstracts (alphabetical by author within each group).

**Selection**
Conference organizers, in concert with the Compiler, are requested to enforce a limit of only one abstract per first author. An exception may be made in the case of invited plenary or keynote speakers, who may submit a second, "regular" abstract in addition to an abstract for the invited presentation.

There should be no "print only" category for abstract submission, i.e. abstracts should be accepted only from authors who intend to attend the Conference and make the corresponding presentation, oral or poster. It is understood that conference organizers cannot enforce an author's intent, but the abstract submission form should include a statement that there is no print-only category.

Abstracts are not to be peer reviewed in the normal sense, but abstracts should be screened for substantive content, and any obviously frivolous or otherwise unsuitable (libelous? salacious? incoherent?) abstracts should be rejected. While the Compiler may be involved in such screening, it is expected that this should mainly be the responsibility of symposium and/or technical session chairpersons or of the Conference's program committee.

**Program Committee**
To help implement these guidelines, Conference organizers are requested to include the Executive Editor of GCA on the local Program Committee or other group most closely responsible for evaluating abstracts.

Continued on next page.

**APPENDIX V.**

**GCA MANUSCRIPT ACTIVITY REPORT (WASH. U. EDITORIAL OFFICE)**

| **Year** | **1999** | **2000** | **2000** | **2000** | **2000** | **2001** | **2001** | **2001** | **2001** | **2002** | **2002** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Quarter** | **4th** | **1st** | **2nd** | **3rd** | **4th** | **1st** | **2nd** | **3rd** | **4th** | **1st** | **2nd** |
| Last Update | 3/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 | 6/30/02 |
| Last manuscript number | W0134 | W0269 | W0411 | W0556 | W0710 | W0862 | W1015 | W1154 | W1317 | W1456 | W1587 |
| Total manuscripts logged | 134 | 135 | 142 | 145 | 154 | 152 | 153 | 139 | 163 | 139 | 131 |
| Regular Articles | 121 | 128 | 135 | 140 | 147 | 146 | 147 | 132 | 152 | 129 | 125 |
| Comment/Response | 1 | 2 | 4 | 2 | 1 | 3 | 0 | 2 | 4 | 5 | 1 |
| Invited papers | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Editorials | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Book Reviews | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 4 | 0 | 0 |
| Awards speeches | 6 | 0 | 0 | 2 | 6 | 0 | 5 | 3 | 0 | 0 | 0 |
| Announcements | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 1 |
| Errata | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 2 | 3 | 4 |
| Status (all manuscripts) | | | | | | | | | | | |
| In print | 92 | 72 | 91 | 79 | 97 | 67 | 58 | 30 | 4 | 2 | 0 |
| In press | 0 | 0 | 1 | 2 | 5 | 10 | 22 | 41 | 39 | 8 | 4 |
| In revision | 0 | 1 | 1 | 0 | 2 | 6 | 23 | 19 | 51 | 54 | 10 |
| In review | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 103 |
| Rejected | 39 | 55 | 40 | 57 | 46 | 60 | 44 | 45 | 64 | 46 | 14 |
| Withdrawn | 3 | 7 | 9 | 7 | 4 | 9 | 6 | 4 | 5 | 9 | 0 |
| Statistics (Scientific Manuscripts Only) | | | | | | | | | | | |
| Science MS accepted | 81 | 68 | 89 | 78 | 96 | 74 | 80 | 71 | | | |
| Acceptance rate (%) | 66 | 52 | 64 | 55 | 65 | 50 | | | | | |
| Mean Days to AE Report | 95 | 87 | 88 | 92 | 93 | 94 | 101 | 92 | 93 | | |
| Max Days to AE Report | 174 | 258 | 199 | 191 | 196 | 224 | 236 | 242 | 172 | | |
| Mean Days to Decision | 184 | 165 | 182 | 170 | 164 | 163 | | | | | |
| Mean Months Sub-Pub | 13.5 | 14.1 | 13.4 | 12.5 | 12.5 | | | | | | |

# EMPLOYMENT OPPORTUNITIES

**Environmental Geologist.** Tenure track position at Assistant Professor rank is available at Dept. of Earth and Environmental Sciences at Rutgers University for Fall 2003. Specialization in biogeochemistry or groundwater modeling but other specialties will be considered. A new Applied Earth Science program is being developed with neighboring New Jersey Institute of Technology (NJIT). Outstanding research opportunities both at Meadowlands Environmental Research Institute and with NJIT. Candidate is expected to establish a vigorous research program with external funding preferably in collaboration with program collaborators in Geology, Biology, Chemistry and Engineering. Good teaching and mentorship are also expected. A Ph.D. is required and post-doc or other experience is desirable. For additional information contact http://geology2.rutgers.edu. Send letter of application and three letters of reference to: Dr. Alexander E. Gates, Chair, Dept. of Earth and Environmental Sciences, Rutgers University, 195 University Avenue, Newark, NJ 07102, agates@andromeda.rutgers.edu by January 1, 2003. Rutgers University is an equal opportunity/affirmative action employer

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**The Department of Earth and Environmental Sciences (EES), Korea University,** invites application for a tenure-track faculty position in igneous or metamorphic petrology. Appointment will be at the Assistant, Associate or Full Professor level depending on the candidate's experience and research record. There are currently seven full-time faculty members, one research professor, six part-time lecturers, and about 30 graduate students in the department. We have excellent research equipment for petrology including newest models of microprobe, XRD, XRF, ICP (AES & MS) and Gas-isotope mass spectrometer in EES. The starting salary will vary depending on the qualification of the candidate, and ranges from approximately U.S.$37,000 to 60,000 per year. Income tax will be exempted for the first two years of the appointment for foreigners and after the two years the tax rate (including income and social security taxes) will be about 10% of the salary.

The successful candidate is expected to maintain a vigorous research on igneous or metamorphic petrology, possibly in collaboration with faculty members in EES, and teach one undergraduate and one graduate courses per semester in English. This appointment will start from as early as March 1, 2003. Initial appointment will be for three years.

Applicants should send a curriculum vitae, a publication list, reprints of papers published from 1998, three letters of reference, and a statement of research and teaching interest by October 26, 2002 to: Dean of the Office of Academic Affairs, Korea University, Seoul 136-701, Korea. A detailed information on our department may be obtained from http://ees.korea.ac.kr. For any inquiry about this position, contact Prof. Jin-Han Ree (reejh@korea.ac.kr).

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**Department Administrator:** The Department of Earth and Environmental Sciences and the Lamont-Doherty Earth Observatory of Columbia University seek applicants for a tenure-track Assistant Professor or a tenured Associate or Full Professor in Solid Earth Geochemistry. The successful applicant will have a strong research program and complement existing strengths in geochemistry, experimental petrology, geology, geodynamics of the mantle, ocean floor and continents.

Minimum qualifications for the position are a Ph.D. in a relevant field, with appointment to senior level position contingent upon years of experience, scholarly credentials, professional standing, and demonstrated scientific creativity. Screening will commence September 1, 2002 and continue until the position is filled. Send detailed statement of research and teaching objectives, names of referees and full curriculum vitae to: Prof. David Walker, Chair of Search Committee, LDEO, Route 9W, Palisades, New York 10964, USA, or by e-mail to dwalker@ldeo.columbia.edu.

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**Postdoctoral Research Assistant in Organic Geochemistry**

This post is available for two years within the Organic Geochemistry Unit in the School of Chemistry. To expand on existing records, Dr. Rich Pancost with Dr. Paul Pearson and Dr. Tim Elliot (Department. of Earth Sciences) will drill several cores in Tanzania from which pCO2 records will be reconstructed using i) the carbon isotopic composition of algal biomarkers and ii) the boron isotopic composition of select microfossils. This work will generate the first continuous pCO2 record through this time interval, is the first application of both pCO2 proxies to the same set of samples, and utilizes some of the best preserved sediments in the world. A candidate skilled in multiple aspects of organic geochemistry is sought by RDP to complete the biomarker-based analyses. The successful candidate will also have opportunities to supervise students, explore a range of cutting edge analytical techniques to fully exploit the organic geochemical archive of climate change data, and vigorously pursue investigations of time intervals of specific interest that may be recovered during drilling (e.g. K-T or Paleocene-Eocene boundaries).

The OGU is one of the premiere organic geochemistry units in the world, having published over 600 papers in its 30+ year history, and is equipped with a range of state-of-the-art equipment, including four continuous flow stable isotope ratio mass spectrometers (3 of which are interfaced to GC-combustion/reduction units), and four organic mass spectrometers.

Further details and an application form can be found at http://www.bris.ac.ukhttps://www.bris.ac.uk/boris/jobs/ads?ID=3701. Alternatively you can telephone (0117) 954 6947, minicom (0117) 928 8894 or E-Mail Recruitment@bris.ac.uk (stating postal address ONLY), quoting reference number 8686. For further information about the Bristol Organic Geochemistry Unit or the scientific aspects of this project, please e-mail Rich Pancost at r.d.pancost@bristol.ac.uk

# Employment Opportunities

## SCIENCE AND TECHNOLOGY POLICY INTERNSHIP PROGRAM OF THE NATIONAL ACADEMIES, WASHINGTON, D.C.

This Internship Program of the National Academies—consisting of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—is designed to engage graduate and postdoctoral students in science and technology policy and to familiarize them with the interactions among science, technology, and government. As a result, students—in the fields of science, engineering, medicine, veterinary medicine, business, and law—develop essential skills different from those attained in academia, which will help them make the transition from being a graduate student to a professional.

**We are pleased to announce that applications are now being accepted for our 2003 program**. This year, the internship program will comprise three sessions:

- **Winter:** January 13 through April 4
  (12 weeks with a possible 4 week extension)
- **Summer:** June 2 through August 8 (10 weeks)
- **Fall:** September 8 through November 26 (12 weeks)

To apply, candidates should submit an application and request their mentor fill out a reference form. Both are available on the Web at **http://national-academies.org/internship**. **The deadline for applications is November 1 for the Winter program, March 1 for the Summer program, and June 1 for the Fall program.** Candidates may apply to all three programs simultaneously.

Additional details about the program and how to join our mailing list are also available on the Web site. Questions should be directed to: internship@nas.edu.

Here is what four former interns said about the program:

*"The National Academies Internship has been one of the most valuable life experiences I have had thus far. The scope of the influence of the Academies in helping shape science, medical and engineering related policy is amazing to witness. Through this internship, I have learned more about my work as a social scientist than I imagined, and I have a better sense of how my research can relate to public policy."*

*"This program will open your mind to a world rarely envisioned from the confines of laboratory bench work. I learned an immeasurable amount about the policy and politics behind science and after the internship opens your mind, it opens career doors."*

*"The Internship program provides an exceptional opportunity for scientists to explore various facets of scholarly research and policymaking. As an intern, you will work with an eclectic mix of highly educated, diverse intellectuals who help advance the future of science. You will leave not only armed with important and influential contacts but also with invaluable skills and experiences."*

*"This is an important career building opportunity for people interested in the scientific community outside academia. Even if you plan to pursue a traditional academic track, seeing science from a policy perspective is very enlightening. There is something valuable in this experience for first year grad students to recent PhD's. Come with an open mind and expect to learn more than you bargained for."*

***Geochemical News* publishes employment opportunity announcements free of charge. Send all ads to:**

***geochemical-news@wmich.edu***

**Please send announcements as email attachments in MSWord format or as plain text in the body of the message.**

## Chairperson-Chemistry
## Western Michigan University

Western Michigan University invites applications for the position of Chair of the Department of Chemistry beginning Fall 2003. WMU is a student-centered, research university of 30,000 students which has a record of excellence in undergraduate education and is dedicated to promoting its graduate programs. We seek applications from dynamic and experienced professionals who will embrace the challenge of advancing our evolving BS, MS and Ph.D. programs, and who can lead a department of 18 faculty with diverse specializations in traditional chemical and modern interdisciplinary fields. The Chair will be expected to: shape the future direction of the department through the hiring of additional faculty, set the highest standards of pedagogical and scholarly activity, and promote collaborative, interdisciplinary research, particularly in the areas of environmental chemistry, biotechnology and nanotechnology. Candidates who have demonstrated the ability to direct a well-funded, internationally competitive research program, demonstrated excellence in teaching, and possess sophisticated and creative administrative skills are strongly encouraged to apply. Applicants should currently have tenure and credentials commensurate with the rank of full professor. Applicants should send a letter of application, vita, statement of research plans, a description of start-up requirements, and should arrange to have three or more letters of reference sent to: Dr. Marc W. Perkovic, Department of Chemistry, Western Michigan University, Kalamazoo, MI 49008-3842. Fax (269) 387-2909. Internet:perkovic@wmich.edu. For more information, visit our web site at http://www.wmich.edu/chemistry. Review of applications will begin Dec. 1, 2002, and continue until the position is filled. WMU is an EOE/AA employer.

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## PhD Position Available within Major Project on: Volcanic-hosted Massive Sulphide Deposits in Northern Sweden

An exciting large and multidisciplinary research project has recently commenced in northern Sweden on "Characterisation of the Ore Horizons and Alteration Systems of Volcanic-associated Massive Sulphide Deposits in the Skellefte district, Sweden".

The Skellefte district is the leading region in Sweden for the production of base and precious metals, and is one of the most important mining regions in Europe. The district contains a wide variety of volcanic-hosted Zn-Pb-Cu-Au-Ag sulphide (VMS) ore deposits, five of which are currently being mined.

The aim of the project is to document the geology and hydrothermal alteration patterns for the various types of VMS ore deposits in the Skellefte district. The regional stratigraphic setting of these ore deposits and proximal to distal (along-strike) variations in alteration will also be characterised. Results from the specific ore deposit studies will be synthesized to develop a practical system of delineating and ranking hydrothermal alteration patterns which can be used by exploration companies as guides to find new ores.

The project is supervised by a multi-disciplinary team of scientists specializing in VMS deposits and Swedish geology:

| | |
|---|---|
| Rodney Allen: | Volcanology, stratigraphy, alteration systems |
| Tim Barrett: | Lithogeochemistry and alteration systems |
| Stephen Freeman: | Structural geology |
| Kjell Billström: | Radiometric dating and isotope studies |
| Pär Weihed: | Regional geology |
| Rolf Jonsson: | VMS ore deposits and mineral exploration |

Two PhD students are currently working on this project. We now seek applications for a third PhD student who will study the geology and alteration system of the Storliden Cu-Zn massive sulphide deposit under the supervision of the senior researchers. Storliden is owned by North Atlantic Natural Resources (NAN) and is the most recently discovered ore deposit in the Skellefte district. Underground mining commenced this year. The deposit is high-grade, unusual, and a very interesting subject for applied research. The student will carry out detailed drill core logging, mine mapping and geochemical sampling, and use these data to construct geological sections and plans. The sections and plans will be used together with advanced volcanological and lithogeochemical studies to define the stratigraphic sequence, structural relations and alteration patterns. The applicant must have a BSc degree in Earth Sciences. Preference will be given to students holding an MSc degree. It is essential that the applicant has a good command of written and spoken English. The applicant must also have good knowledge of field mapping techniques, structural geology and geochemistry, and some practical experience in these areas. An understanding of the basic principles of ore deposit geology and sedimentology (or volcanology) and some experience with logging of drill core are desirable.

The PhD student will be based at the centre for applied ore deposit studies (CTMG) at Luleå University of Technology. Luleå is an attractive and thriving city situated on the coast of the Gulf of Bothnia, 130 km north of the Skellefte mining district. Luleå University is a modern university that specialises in Technology Development and is one of the major universities of Sweden.

The project is funded by the Swedish-European Georange initiative and the mining industry (Boliden Mineral and North Atlantic Natural Resources companies). The deadline for applications is 10 November and the position needs to be filled as soon as possible; by the beginning of 2003 at the latest. The time-frame for completion of the PhD study is four years. Salary will be approximately 160,000 Swedish kronor per year, tax-free, for the first two years. Salary for the final two years will be taxed, but the salary will provide a minimum of 160,000 Skr after-tax.

Applicants should submit a letter outlining their academic background and recent and geological experience, and their specific research interests. Copies of BSc and MSc certificates and a list of examination results for these degrees are also required. Applications should be sent to the following email and post address:

Rodney Allen
Volcanic Resources Limited
Guldgatan 11
936 32 Boliden, Sweden
rodallen@algonet.se

# The Geochemical Society 2003 Awards Nominations

## (Nominations will be separately called for the Alfred Treibs Award of the Organic Geochemistry Division)

### 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. 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. 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.A. Berner (1995), A.W. Hofmann (1996), D. Lal (1997), W. Stumm (1998), J.L. Bischoff (1999), G. Eglinton (2000), I. Kushiro (2001), J. Hayes (2002).

**Nominations for the 2003 V.M. Goldschmidt Award should be submitted before November 15, 2002, to:**

Dr. Lee Kump
Department of Geosciences
The Pennsylvania State Univ.
303 Deike Bldg.
University Park, PA 16802 USA

Tel: 1-814-863-1274
Fax: 1-814-865-3191
Email: kump@geosc.psu.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. Eligibility for this award is met if either of the following criteria is satisfied on the first day of the year in which the award is given: (a) the candidate must have received a recognized doctorate or its equivalent within the last six (6) years; or (b) must not have celebrated their thirty fifth (35th) birthday. 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. 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. 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), A.M. Scheidegger (1999), J. Farquhar (2000), C.C. Lundstrom (2001), R. Blake (2002).

**Nominations for the 2003 F.W. Clarke Award should be submitted before November 15, 2002, to:**

Dr. Margaret L. Delaney
Ocean Sciences
1156 High Street
University of California
Santa Cruz, CA 95064 USA

Tel: 1-831-459-4763
Fax: 1-831-459-4882
Email: Delaney@
cats.ucsc.edu

### Clair C. Patterson Award

The Clair C. Patterson Award, for a recent innovative breakthrough in environmental geochemistry of fundamental significance, published in a peer-reviewed journal, will normally be made annually 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. Current 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. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society.

**Past Recipients:** M.L. Bender (1998), R.L. Edwards (1999), E.A. Boyle (2000), F. M.M. Morel (2001), H. Elderfield (2002).

**Nominations for the 2003 Clair C. Patterson Award should be submitted before November 15, 2002, to:**

Dr. Erwin Suess
GEOMAR
Christian-Albrechts University of Kiel
Olshausenstr. 40, 24118 Kiel, Germany

Tel: 49-431-600-2233
Fax: 49-431-600-2928
Email: esuess@geomar.de

# GS Organic Geochemistry Division Alfred Treibs Award Nominations

Nominations for the Alfred Treibs Award, sponsored by the Organic Geochemistry Division of The Geochemical Society will be accepted between January 1 and June 1 each year for presentation during the following year. This award, consisting of a gold-plated medal and certificate, is awarded for career achievements, over a period of years, in organic geochemistry. Such achievements consist of pioneering and innovative investigations which have made highly significant contributions to the understanding of the origin and fate of organic materials in the geosphere and/or in extraterrestrial environments. The previous Treibs Award recipients can be found on the Geochemical Society web site at: http://gs.wustl.edu/archives/treibs.html

To be considered for the current year's award, complete nomination packages, consisting of hard paper copies, must be received by June 1 of this and subsequent years. Nomination packages received later will be considered for the award in the following year. Nomination packages must include six hard copies of each of the following:

1) a nominating letter describing the career achievements of the nominee, 2) 3-5 additional letters supporting the nomination, 3) the nominee's curriculum vitae, not to exceed 2 pages, and 4) a list of the nominee's most relevant publications, not to exceed 2 pages. 5) All files will remain active for 3 years. After that time, the nominator will be required to request that the file remain active for an additional 3 years, or the nominator may submit a new or revised nomination. All submissions will be acknowledged. Only complete nomination packages (containing all materials described in 1-4 above) will be accepted. Complete nominations packages should be sent to:

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|---|---|
| Dr. Peggy Ostrom, Secretary of the OGD | |
| 206 Natural Science Building | |
| Dept. of Geological Sciences | Office 517 353 9768 |
| Michigan State University | Lab 517 353 5988 |
| East Lansing, Michigan 48824-1115 | Fax 517 353 8787 |

# 2001 Balzan Prize for Climatology Congratulations Claude Lorius!

Claude Lorius is one of the pioneers in the development and implementation of new methods to determine past climates from ice cores. Isotopic analysis of the oxygen-18 and deuterium contents of the ice allowed him to estimate air temperature. Air bubbles in the ice gave information about the content of "greenhouse gases" such as carbon dioxide and methane or aerosols.

The investigation on ice cores from Antarctica and Greenland demonstrated not only that the composition of the Earth's atmosphere had undergone large, well defined oscillations but that these oscillations were correlated with drastic climatic changes between warm and glacial epochs.

Lorius was the driving force behind the Antarctic ice core work, a Russian-French collaboration. From the Vostok station about 2100 m of ice were cored in 1982, covering about 140,000 years. In 1999, 3623 m became an archive for 420,000 years, containing four transitions between such warm and glacial epochs at about 18,000, 135,000, 245,000 and 335,000 years BP. This supports the idea that changes of the orbital parameters on the Earth cause variations in the intensity of solar radiation which in turn trigger natural climatic changes.

Among the important results of immediate interest from Lorius' work are the following: our present warm, "interglacial", epoch is of extremely long duration and stability compared with all others. In the past there have been repeated, sudden, drastic changes in temperature occurring on a decadal time scale. Finally the current greenhouse gas concentration is much higher than during the last 400,000 years. This is difficult to explain without taking into consideration human activities over the last two hundred years.

Lorius was and is in the forefront of these globally important research activities, a participant in 22 polar expeditions, and an excellent organizer of multidisciplinary teamwork and international scientific collaboration, by which he has become the father of a new generation of scientists in this field.

*IOPD: Cont'd from page 20.*

considers that even basic questions, such as "What types of microorganisms inhabit the oceanic crust?" remain unanswered.

### *Recommendations: Common Issues Uniting Uncommon Needs*

To best advance these scientific priorities, workshop participants identified several key, common approaches and recommendations that will facilitate progress in geochemical research during the IODP.

**Increase Commitment to Thematic Consistency** by emphasizing the links among drilling expeditions with closely allied goals. The IODP should permit the grouping together of highly ranked drilling targets from several proposals using one or more drilling platforms to address scientific questions in an integrated and comprehensive manner.

**Expand the Scope of Research Targets** to improve the IODP's ability to address integrative science questions and to better coordinate drilling activities with other large-scale geoscience initiatives. The current practice of parsing scientific proposals into small research questions that can be addressed within the time-span of a traditional two-month drilling leg has forced the community to'"think small."

**Increase the Use, Development, and Quality of *In Situ* and Other Instrumentation** by encouraging use of non-traditional sampling techniques and acquiring larger samples for analyses. Data acquisition from sources other than the mud and rock recovered by coring should also be emphasized (e.g., from seafloor and/or borehole observing systems and experiments). This will require significantly increased emphasis on shipboard and shorebased data acquisition, analysis, and management.

**Expand the Capabilities of Shipboard Laboratories** to take advantage of, and develop, new technologies and high-quality instrumentation that are both robust and suitable for use in the shipboard operating environment. Geochemists must aggressively promote the use of such instrumentation, and recognize that new, high-quality data streams will benefit virtually all members of the scientific drilling community.

**Improve Database Design and Increase the Scope of Data Capture** by integrating shipboard data (e.g., currently in JANUS) with the data generated during the post-cruise period, and link that database to the corresponding publications in the IODP and open literature.

**Establish a Larger Source of Post-Cruise Funding** to meet the needs of shipboard participants as well as the broader scope priorities established for fundamental scientific objectives that emphasize post-cruise activities beyond the immediate core analyses. In addition to continuing a system of small "pilot project" grants that are cruise-specific, we recommend creating a new system of objective-based science support to provide opportunities for more detailed investigations, integrative studies, modeling, and *in situ* or long-term experiments and observations.

### *Conclusion*

The participants profited greatly from the collegiality at the workshop and the ability for open exchange and discussion of common interests uniting the broad subdisciplines of geochemistry. While it is clear that the IODP offers great opportunities for advanced geochemical study, it is equally clear that the geochemical community must continue to articulate its needs through the statement of a common vision, so as to capitalize upon the central role geochemistry plays in scientific ocean drilling. Regardless of subspecialty, the geochemists present at the workshop readily identified the unifying needs of the community, and were encouraged and optimistic about the potential for increased capabilities and scientific sophistication in the IODP. The meeting provided the basis for future geochemical successes by emphasizing the scientific objectives of prime interest to geochemists and providing specific recommendations for the future program.

## MEETINGS ANNOUNCEMENTS

# Biogeochemical Controls on the Mobility and Bioavailability of Metals in Soils and Groundwater

### *Monte Verita, March 2. - 7. 2003*
### *Ascona, Switzerland*

Organizers: Stephan Kraemer, Janet Hering, Ruben Kretzschmar, Barbara Sulzberger, Giovanni Bidoglio, Alexander Zehnder

Numerous trace metals have been identified as essential micronutrients for plants and/or microorganisms and as electron acceptors or donors in metabolic processes. At elevated concentrations, however, many of these same metals exhibit significant toxicity and trace metal pollution in soils. This workshop will foster discussion of the biogeochemical processes that control metal mobility and bioavailability. The relevant experimental and modeling approaches used by scientists and students from various fields will be discussed. Ultimately, an understanding of fundamental biogeochemical processes is needed for the accurate and quantitative prediction of the fate and transport of metals on a range of time and length scales. This issue will be addressed in the workshop through case studies on the application of process oriented knowledge and modeling to local and regional scale problems.

Sessions
- Solubility and sorption controls on metal mobility
- Effects of redox processes on metal mobility
- Characterization of mineral and biological surfaces and surface reactions
- Modeling of surface and transport processes
- Microbial processes
- Plant- and fungi-soil interactions
- Case studies
- Additional case studies and consequences for water supply and soil quality

Invited speakers
J.K.Fredrickson, Batelle Pacific Northwest Laboratories; G.Gadd, University of Dundee; P. Jaffe, Princeton University; D.Kinniburgh, British Geological Survey; D.R.Lovley, University of Massachusetts; S.T.Martin, Harvard University; D.M.McKnight, University of Colorado; P.Persson, Umeå University; A. Scheinost, Swiss Federal Institute of Technology; A.Stone, Johns Hopkins University; S.J.Traina, Ohio State University; P.Van Cappellen, Utrecht University.

Please consider contributing a poster or oral presentation to this workshop. Please send the title of your presentation and a short abstract before November 15. 2002 to monteverita.2003@ito.umnw.ethz.ch. For further information please see the attached flyer or visit the website: http://www.ito.umnw.ethz.ch/SoilChem/kraemer/main.html

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# Geological Society of London: Petroleum Group

### 4-5 February 2003
### Reservoir Geochemistry

At The Geological Society, Burlington House, Piccadilly, London W1J 0BG, Tel: +44-(0)20-7434-9944; Fax: +44-(0)20-7439-8975

Geochemistry is playing an increasingly important role in understanding the complexities of reservoir performance. However since the successful inaugural meeting at the Geological Society on the Geochemistry of Reservoirs in 1993, the technology and applications have changed markedly. It is therefore timely to revisit Reservoir Geochemistry but this time concentrating on the areas of potentially greatest benefit to E&P, namely geochemical controls on rock and fluid properties and the integration of reservoir engineering and geochemical fluid assessments.

First Call for Papers: A two-day meeting will be hosted by the Petroleum Group to promote the latest advances in organic and inorganic geochemistry and their applications in the evaluation and study of reservoirs. In particular the following themes are planned:

- Geochemical controls of reservoir fluid properties (PVT, geochemical, crude oil assay).
- Geochemical control of reservoir rock properties.
- Integrated reservoir engineering and geochemical fluid assessments.

Those interested in contributing to the meeting should initially send the titles of their potential presentations to one of the convenors but note that the deadline for submission of formal abstracts is **1 June 2002**. Meanwhile, John Cubitt will be pleased to receive any ideas to strengthen the meeting.

**Convenors:**

| | |
|---|---|
| Dr. John Cubitt | john-cubitt@es-information.demon.co.uk |
| Dr Gordon Macleod | Gordon.Macleod@shell.com |
| Professor Steve Larter | Steve.Larter@ncl.ac.uk |
| Dr William England | englandw@bp.com |

# MEETINGS ANNOUNCEMENTS

### *Call for Papers*

## Metal Sulfide Formation And Reactivity: A Multi-Disciplinary Approach To The Role Of Metal Sulfide Minerals In Past And Present Environments

at the 225th ACS National Meeting, New Orleans, LA

Sponsored by the Division of Geochemistry (GEOC)

**March 23-27, 2003**

The formation and reactivity of metal sulfide minerals are recognized to be important throughout geologic history. Reactions of metal sulfide minerals are key in understanding the role of these minerals in the environment, and in the evolution of chemical systems and early life. Understanding the formation and reactivity of metal sulfides requires a multi-disciplinary approach, drawing from diverse fields such as geochemistry, surface chemistry, photochemistry, electrochemistry, mineralogy, microbiology, and computational chemistry. Significant advances have been made in each of these fields over the past decade. We are seeking contributions from a range of disciplines to facilitate a discussion of these advances with the goal of developing a detailed picture of the role metal sulfides have in past and preset environments.The focus of this symposium will draw on the following:

- Formation of metal sulfide minerals, from the assembly of metal sulfide clusters through the precipitation of nanocrystals and the further reactions resulting in bulk metal sulfide phases
- Characterization of both pristine and reacted surfaces, utilizing traditional surface science techniques, time-resolved in-situ methods, and computational calculations
- Mechanistic details of the overall oxidation of metal sulfide minerals in different environments, including electrochemical, batch, flow-through, and theoretical techniques
- Microbiological aspects of the formation and oxidation of metal sulfide minerals, including the field-scale role of microorganisms in specific environments

Abstracts may be submitted online at: http://oasys.acs.org/
Deadline for online abstract submission: November 22nd 2002
Deadline for hardcopy abstract submission: November 8th 2002

Check the Geochemistry Division web site for updates: http://membership.acs.org/g/geoc/

For additional information contact the organizers.

Michael J. Borda
The Aqueous Geochemistry Laboratory
The State University of New York at Stony Brook
Stony Brook, NY 11794-2100
Tel: (631) 632-6839
Fax: (631) 632-8240
mike@pbisotopes.ess.sunysb.edu

## Applications of Synchrotron Radiation in Low-Temperature Geochemistry and Environmental Science

Reviews in Mineralogy and Geochemistry Short Course

Dec. 4-5 (2002) Monterey, CA
-and-
American Geophysical Union Fall Meeting, session V05
December 6-10 (2002) San Francisco CA

The powerful applications of synchrotron radiation in geochemistry and environmental science began to be realized about two decades ago. With the advent of third-generation synchrotron radiation sources, significant progress has been achieved in the development and application of synchrotron methods to geological and environmental materials. There has been tremendous growthin the number of synchrotron users from the earth and environmental science communities. This session solicitspresentations of current research by scientists who are applying synchrotron radiation techniques, including X-ray micro-imaging, X-ray spectroscopy, and X-ray scattering, to probe diverse structures and processes relevant to low temperature geochemistry and environmental science. Novel applications of synchrotron radiation techniques in these areas are especially encouraged.

Please see the following webpages for more information:
RIMG short course: http://cars9.uchicago.edu/shortcourse2002/

AGU Fall meeting: http://www.agu.org/meetings/fm02top.html
AGU abstract deadlines: 29 Aug 2002 (paper) and 5 Sept 2002 1400 UT (Web)

# MEETINGS CALENDAR

**Oct 26, 2002: Setting Priorities in Solid Earth Sciences** - Workshop, Denver, CO, USA. Contact: Mike Brown; mbrown@geol.umd.edu or Basil Tikoff; basil@geology.wisc.edu.

**Oct 26-27, 2002: Phosphates: Geochemical, Geobiological and Materials Importance,** Golden, CO, USA. Short Course organizers: John Rakovan , Matthew Kohn, and John M. Hughes. At the Geological Society of America Meeting, sponsored by Mineralogical Society of America.

**Oct 27-30, 2002: Geological Society of America Annual Meeting, Denver, Colorado, USA.** Contact: GSA Meetings, Phone: +1 303 447 2020, ext. 164; Fax: +1 303 447 1133. http://www.geosociety.org/meetings/2002/

**Nov 18-22, 2002: WOCE and beyond**, San Antonio, Texas. http://www.woce2002.tamu.edu/

**Dec 2002: Plastic Deformation and Deformation Structures of Minerals, short course.** Organizers: Shun-ichiro Karato and H.-R. Wenk. At the AGU Fall meeting. Sponsored by Mineralogical Society of America.

**Dec 6-10, 2002: AGU Fall Meeting**, San Francisco, California, USA. www.agu.org.

**Dec 9-11, 2002: 'Black Shales' meeting - Organic-carbon burial, climate change and ocean chemistry (Mesozoic-Paleogene)**, Burlington House, London, UK. Organization: Marine Studies Group, The Geological Society. Abstracts due by 1 November. Web site: http://www.geolsoc.org.uk/template.cfm?name=MSG2447 and http://www.earthsci.ucl.ac.uk/conferences/GSLC .

**Dec 9-12, 2002: International symposium - Clays in natural and engineered barriers for radioactive waste confinement**, Reims, France. Contact: M. Klajman; Fax: +33 1461 18410; meeting2002@andra.fr; http://www.andra.fr/eng/actu/archi-0055/index.htm.

**Dec 11-14, 2002. 3rd European Meeting on Environmental Chemistry**, Geneva, Switzerland. Contact: Dr. Montserrat Filella; montserrat.filella@cabe.unige.ch. http://www.unige.ch/emec3/.

**Dec 14-19, 2002: Geochemistry of Crustal Fluids: The Role and Fate of Trace Elements in Crustal Fluids**, Seefeld, Tirol, Austria, by the European Science Foundation. Contact: Dr. J. Hendekovic, Phone: +33 388 76 71 35: Fax: +33 388 36 69 87; euresco@esf.org. http://www.esf.org/euresco/02/lc02106

**Jan 6-10, 2003: 10th International Symposium on deep seismic profiling of continents and their margins**, Huka Village Conference Centre, Taupo, New Zealand. By the IASPEI; Royal Society of New Zealand, IGNS, Geoscience Australia. Contact: Dr Fred Davey, Ph: +64-4-570-1444; Fax: +64-4-570-4600; seismix2003@gns.cri.nz. http://www.gns.cri.nz/news/conferences/seismix2003

**Jan 7-10, 2003: OCEANS: Ocean Biogeochemistry and Ecosystems Analysis** (International Open Science Conference), Paris, France. Abstract and early registration deadline: October 15, 2002. This conference will focus on integrated studies of biogeochemistry and ecosystem dynamics in the ocean in the context of the Earth System and global change. It is designed to assist the development of a new ten-year international SCOR/IGBP research project. E-mail: scor@dmv.com; http://www.igbp.kva.se/obe/

**Jan 29-31, 2003: Environmental Geochemistry of Metals,** Denver, Colorado, U.S.A. National Ground Water Association. http://www.ngwa.org/education/index.html#03jan

**Feb 4-5, 2003: Reservoir Geochemistry Conference**, Petroleum Group Geological Society of London, to promote the latest advances in organic and inorganic geochemistry and their applications in the evaluation and study of reservoirs. Deadline for submission of formal abstracts was June 1, 2002. Contact: Dr. John Cubitt; E-mail: john-cubitt@es- information.demon.co.uk

**Feb 16-21, 2003: Gordon Research Conference - Chemical Reactions At Surfaces**, Holiday Inn, Ventura, CA, U.S.A. http://www.grc.uri.edu/programs/2003/chemreac.htm

**Mar 3-4, 2003: Fundamentals of Ground Water Geochemistry (course),** Scottsdale, AZ, U.S.A. Presented by: Bill Deutsch and Patrick Longmire, National Ground Water Association. http://www.ngwa.org/education/03-0303-235.shtml

**Mar 5-7, 2003: Applications of Ground Water Geochemistry (NGWA Education Course),** Scottsdale, AZ, U.S.A. Presented by: Bill Deutsch and Patrick Longmire, National Ground Water Association. http://www.ngwa.org/education/03-0305-485.html

**Mar 5-7, 2003: The Petrolem Geology And Hydrocarbon Potential Of East Africa**, The Nairobi Safari Park Hotel, Nairobi, Nairobi, Kenya. ContactDr. N.C. Weggoro, Phone: +257-27-2504253/8; Fax: +257-27-2504255; weggoro@eachq.org.

**Mar 17–21, 2003: 34th Lunar and Planetary Science Conference**, near NASA Johnson Space Center, League City, Texas. International specialists in petrology, geochemistry, geophysics, geology, and astronomy to present the latest results of research in planetary science. http://www.lpi.usra.edu/meetings/lpsc2003/lpsc2003.1st.html

**Mar 23-27, 2003: 225th ACS National Meeting**, New Orleans, LA, USA. Geochemistry Division Sessions: Organic Geochemistry in Contemporaneous Environments - Ancient Sediments and Laboratory Simulations (In Honor of Professor Earl W. Baker) - Ancient Biomolecules: New Perspectives in Archaeology and Palaeobiology. http://membership.acs.org/g/geoc/upcoming.html

**Mar 24-27, 2003: Study of Matter at Extreme Conditions (SMEC),** to promote the integration of mineral-physics, high-pressure chemistry/physics and materials science, Florida International University, Miami. Contact: Debby Arnold; arnoldd@fiu.edu. (http://www.lcm3b.u-nancy.fr/ecasig5/Activity.htm#SMEC)

**Mar 29-Apr 2, 2003: 3rd International Limnogeology Congress**, Presidio Plaza Hotel, Tucson, AZ, USA. Contact: Andrew Cohen, Phone: +1 520 621 4691; acohen@geo.arizona.edu.

**Apr 2-4, 2003: 18th Himalaya-Karakoram-Tibet Workshop (HKTW)**, Ascona, Monte Verita, Switzerland. http://www.geology.ethz.ch/sgt/Himalaya/default.htm

**Apr 6-11, 2003: EGS-AGU-EUG Joint Assembly**, Nice, France. Http://www.copernicus.org/egsagueug

**Apr 13-17, 2003: European Union of Geosciences (EUG) XII**, Strasbourg, France. eug@eost.u-strasbg.fr, http://eost.u-strasbg.fr/EUG

**Apr 14-17, 2003: Uranium Geochemistry – 2003 - Ore deposits – Natural Analogy – Rehabilitation**, Nancy, France. Fax: +33 - 3 83 91 38 01; Michel.Cuney@g2r.uhp-nancy.fr. http://www.gl.rhbnc.ac.uk/geode/Registration.html

**Apr 24-26, 2003: 15th Argentine Geological Congress**, El Calafate, Santa Cruz Province, Southern Patagonia, Argentina. Contact: President Dr. Miguel Haller or Secretary Dr. Roberto Page,Phone: +54 11 4325 3104; Fax: +54 11 4325 3104; haller@cenpat.edu.ar or fomicruz@internet.siscoPhonecom.

**May 5-8, 2003: 3rd JGOFS Open Science Conference**, Washington DC, USA. Contacts: Roger Hanson, Phone: +47 555 84244; Fax: +47 555 89687 or Ken Buesseler, Phone: +1 508 289 2309; Fax: +1 508 457 2193.

**May 8-10, 2003: Third meeting on Magmatism, Metamorphism and associated Mineralizations** (3Ma), Hassan II Aïn Chock University, Casablanca, Morocco. http://www.colloque3ma.com

**May 9, 2003: International Coalbed Methane Symposium**, Tuscaloosa, AL, USA. Fax: +1 205 348 9276; ghood@ccs.ua.edu.

**May 12-17, 2003: GEOFLUIDS IV - on fluid evolution, migration and interaction in sedimentary basins and orogenic belts**, University of Utrecht, Utrecht, The Netherlands. (Special Issue of Netherlands Journal of Geosciences: 'Geofluids in the Netherlands', early 2003. Deadline for manuscripts: January 15, 2002.) Contact: Mrs. Drs. J.M. Verweij, Phone: +31 30 256 46 00; Fax: +31 30 256 46 05; E-mail: j.verweij@nitg.tno.nl; http://www.nitg.tno.nl/eng/geofluid2.pdf

**May 19-23, 2003: Isotope Hydrology and Integrated Water Resources Management: 40th Anniversary International Symposium**, Vienna, Austria. http://www.iaea.or.at/programmes/ripc/ih/

**May 18-24, 2003: 39th Forum on the Geology of Industrial Minerals**, John Ascuaga's Nugget Hotel & Casino, Sparks, Nevada, USA , by the Nevada Bureau of Mines and Geology, Nevada Division of Minerals, and Nevada Mining Association. Contact: Terri Garside, Phone: +1 775-784-6691 ext 126; Fax: +1 775-784-1709; tgarside@unr.edu. http://www.nbmg.unr.edu/imf2003.htm

**May 20-23, 2003: GERM 4**, Lyon, France. Contact: Janne Blichert-Toft, Phone: +33 (0)472 72 84 88; Fax: +33 (0)472 72 86 77; jblicher@ens-lyon.fr.

**May 25 - 28, 2003: Joint meeting of GAC/MAC/SEG**, Vancouver, B.C., Canada. Web site: http:// www.vancouver2003.com/

**May 26-28, 2003: 2nd International Symposium on Contaminated Sediments: Characterisation, Evaluation, Mitigation/Restoration, Management Strategy Performance**, Quebec City, Quebec, Canada. Contact: Helene Tremblay, Phone: +1-418-656-2193; Fax: +1-418-656-7339; E-mail: 2sisc@ggl.ulaval.ca; http://www.scs2003.ggl.ulaval.ca/

**May 26-30, 2003: XII international conference on heavy metals in the environment**, Grenoble, France. Tel: + 33 4 76 82 42 53; Fax: + 33 4 76 82 42 01; E-mail: echevet@glaciog.ujf-grenoble.fr and ichmetals@glaciog.ujf-grenoble.fr

**May 26-30, 2003: Fifth International Symposium on Applied Isotope Geochemistry (AIG-5)**, Heron Island, Great Barrier Reef, Australia. Applied Isotope Geochemistry is a working group of the International Association of Geochemistry and Cosmochemistry. Contact: Barry Batts; E-mail: aig-5@chem.mq.edu.au. http://www.chem.mq.edu.au/aig-5

**May 29-June 1, 2003: Geology Without Frontiers: Magmatic and Metamorphic Evolution of the Central European Variscides,** Blansko, Czech Republic. Contact: Jaromir Leichmann, Phone: +420 (5) 41 12 92 61; Fax: +420 (5) 41 21 12 14; E-mail: cgs@mail.natur.cuni.cz; http://www.natur.cuni.cz/~cgs/nofrontiers/

**June 4-9, 2003: 17th Biennal European Current Research on Fluid Inclusions (ECROFI XXVII)**, Budapest, Hungary. Contact: Csaba Szabo, E-mail: ecrofi17@geology.elte.hu; http://ecrofi17.geology.elte.hu/

# MEETINGS CALENDAR

**June 4-15, 2003: High-Pressure Crystallography**, Erice, Italy. E-mail: katran@amu.edu.pl; http://www.geomin.unibo.it/orgv/erice/highpres.htm

**June 7–11, 2003: The Clay Minerals Society 40th Annual Meeting**, Athens, Georgia, USA. Jointly held with the Mineralogical Society of America. Web site: http://cms.lanl.gov

**June 8-13, 2003: Gordon Research Conference - Interior Of The Earth**, Mount Holyoke College, USA.

**June 9-12, 2003: Hedberg conference - Origin of Petroleum — Biogenic and/or Abiogenic and Its Significance in Hydrocarbon Exploration and Productions**. Web site: http://www.aapg.org/education/hedberg/london/index.html

**June 15-19, 2003: 7th international conference on the biogeochemistry of trace elements (7th ICOBTE)**, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden. Includes "Arsenic in Soil and Groundwater Environments: Biogeochemical Interactions". Contact: ICOBTE7@slu.se; Web site: http://www-conference.slu.se/7thICOBTE/index.htm

**June 15-20, 2003: EUSTONE 2003 - Forum for stone, Natural stone congress**, University of Joensuu, Joensuu, Finland. Organization: Geological Survey of Finland. Contact; Mr Hannu Luodes, P.O.Box 1237, 70211 Kuopio, Finland; Phone: +358 20 550 3528; Fax: +358 20 550 13; E-mail: hannu.luodes@gsf.fi; Web site: http://www.gsf.fi/events/eustone2003

**June 15-20, 2003: Gordon Research Conference - Permeable Sediments**, Bates College, Lewiston, ME, USA. Web site: http://www.grc.uri.edu/programs/2003/perm.htm

**June 16-18, 2003: 5th International Conference on the Analysis of Geological and Environmental Materials**, Rovaniemi, Finland. Web site: http://www.gsf.fi/geoanalysis2003

**June 19-20, 2003: Timor Sea symposium**, Darwin, Australia. Includes Petroleum systems and geochemistry. Web site: http://www.dme.nt.gov.au/ntgs/timorseasymposium/home.html

**June 22–26, 2003: Euroclay 2003**, Modena, Italy. Web site: www.unimo.it/euroclay2003/

**June 22–27, 2003: 8th International Kimberlite Conference**, Victoria, BC, Canada. http://www.venuewest.com/8IKC

**July 20-25, 2003: Gordon Conference - Catchment Science: Interactions of Hydrology, Biology & Geochemistry - Water as a Mirror of the Landscape - How Valid and Useful is the hypothesis?,** Colby-Sawyer College, New London, http://www.grc.uri.edu/programs/2003/forest.htm

**July 21-25 2003: Ultra-high pressure metamorphism, 5th EMU School in Mineralogy**, Eötvös L. University, Budapest, Hungary. http://www.lcm3b.u-nancy.fr/ecasig5/Activity.htm#EMU5

**Aug 24-27, 2003: 4th South American Symp on Isotope Geology (IV SSAGI)**, Salvador, Bahia, Brazil. http://www.cbpm.com.br/ivssagi/index.htm

**July 28-Aug 1, 2003: 66nd Annual Meeting of the Meteoritical Society**, M¸nster, Germany. Contact: E-mail: ekj@nwz.uni-muenster.de (subject: 66MetSoc); http://www.uark.edu/campus-resources/metsoc/index1.htm

**Aug 2003: XVth International Congress on the Carboniferous and Permian (XV ICC-P) and 55th Meeting of the International Committee for Coal and Organic Petrology (55 ICCP)**. http://www.nitg.tno.nl

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**Sept 8-12, 2003: 21st IMOG meeting**, Krakow, Poland. http://www.imog.agh.edu.pl/.

**Sept 9-13, 2003: Assoc. of Eur. Geol. Soc. (13th Annual Biennial Meeting)**, http://www.uni-essen.de/geologie/aegs.htm

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**Fall, 2003: Biomineralization Short Course**. http://www.minsocam.org/MSA/Short_Courses.html#Biomineralization

**Oct 6-9, 2003: North Africa & Mediterranean Geoscience Conf.**. Tunis. http://www.eage.nl/conferences/index2.phtml?confid=15

**Nov 2–5, 2003: Annual meeting GSA**, Seattle, Washington. http://www.geosociety.org/meetings/index.htm.

**Dec 7-9, 2003: International Congress of Chemistry and Environment ICCE-2003.** India. http://www.chemenviron.com

**Dec 8-12, 2003: AGU Fall Meeting**, San Francisco, California, USA. Web site: www.agu.org.

**Dec 12-13, 2003: ACE 2003 - 4th European meeting on environmental chemistry**, UK. E-mail: mfitzsimons@plymouth.ac.uk.

**May 17-21, 2004: 2004 AGU Spring & Canadian Geophysical Union:** MontrÈal, Canada. Contact: meetinginfo@agu.org.

**May 26-Juni 6, 2004: Polymorphism: Solvates and Phase Relationships**, Erice, Italy. Yoel@bgumail.bgu.ac.il;

**July 25-20, 2004: 7th INTECOL International Wetlands Conference**, Utrecht, Netherlands. http://www.bio.uu.nl/INTECOL

**Aug 20-28, 2004: 32nd International Geological Congress (IGC)**, Florence, Italy. http://www.32igc.org/

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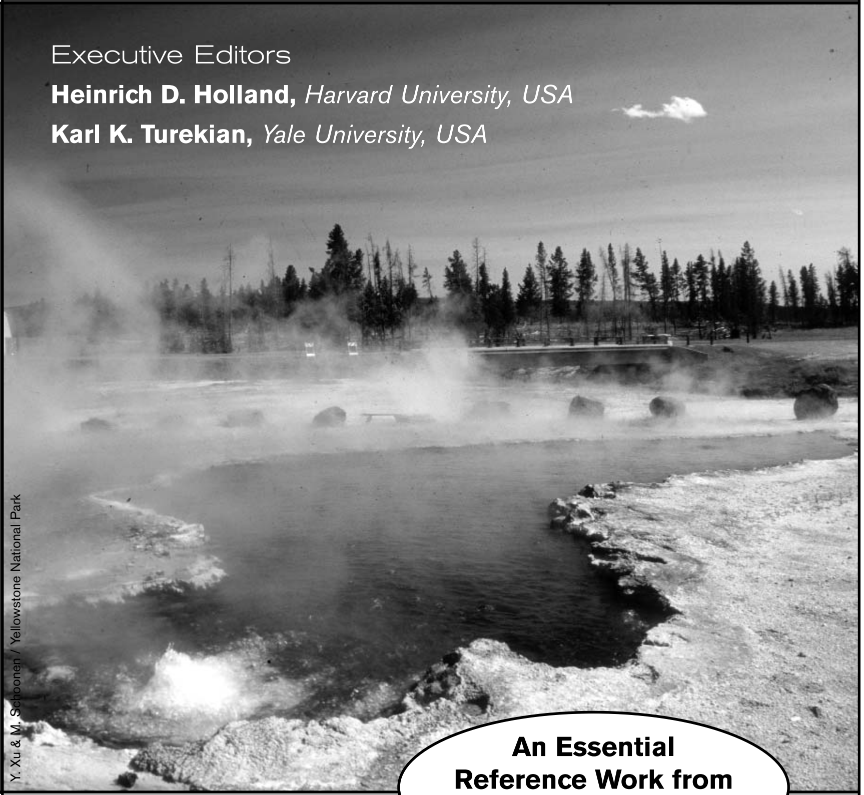

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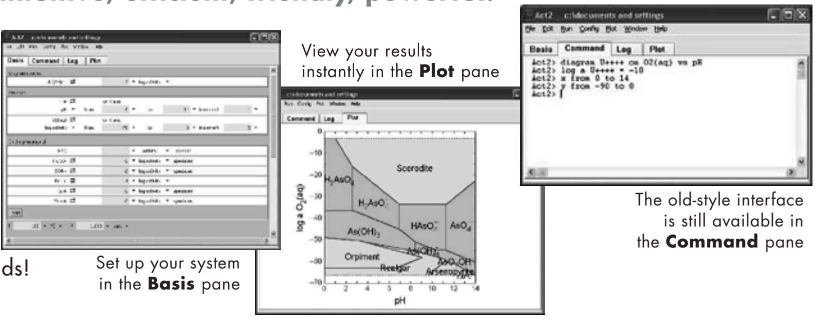

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