The Geochemical News

Newsletter of The Geochemical Society

in cooperation with The European Association of Geochemistry

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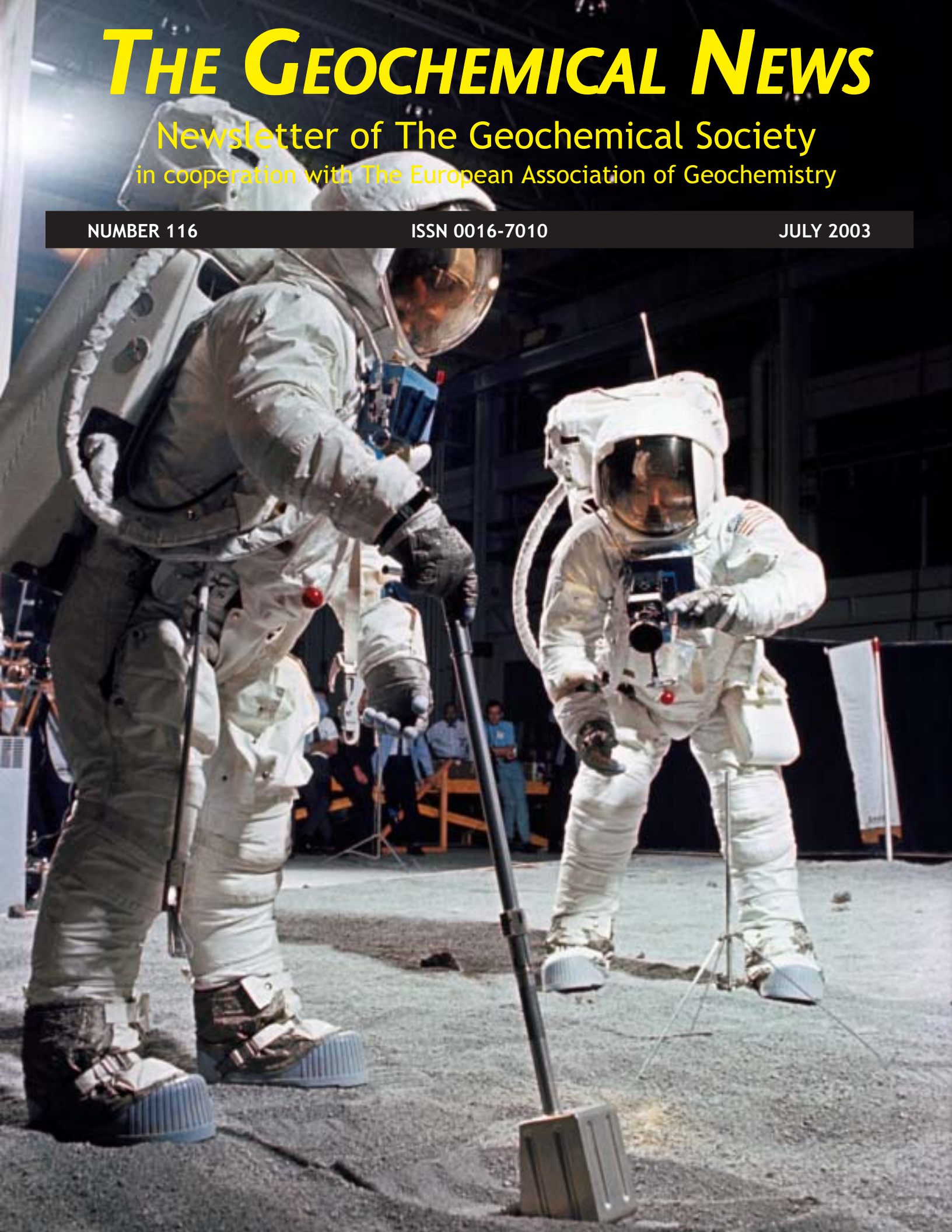

The Geochemical Society

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 ***G³*** (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
July 2003

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Contents

From the President

The 2003 Goldschmidt Conference – "Frontiers in Geochemistry"

As lectures come to an end and the field season begins, the 1st of July marks the true beginning of the geochemist's summer in Switzerland. More time is available to think about new and old scientific projects and write the manuscripts that are long overdue. And, many of us are now turning our thoughts towards making preparations to join our colleagues at the upcoming 13th Annual Goldschmidt Conference to be held in Kurashiki, Japan from 7 to 12 September 2003.

Dr. Yukihiro Matsuhisa, the chair of the Organizing Committee, informs me that preparations for the Conference are well underway. A total of 1,162 abstracts were received, many more than expected. The organizers have now constructed the program, which comprises 9 general symposia and 53 special symposia and will be divided between approximately 800 oral presentations in 10 parallel sessions and approximately 350 posters. To enable students and young researchers to attend the conference and present their papers, 90 individual grants will be awarded. Based on abstract submittals, the most popular symposia topics include "Origin and distribution of life in the Universe", "Geochemical immobilization and long-term isolation of waste", "Subduction zone processes and global material circulation", and "Early solar system processes". The program is available on the conference website at http://www.ics-inc.co.jp/gold2003. Cambridge Publications will again publish the abstracts as a special supplement to *Geochimica et Cosmochimica Acta*. Delegates will be given a copy of this volume, as well as receiving the printed program volume and the abstracts and program on CD-ROM. Details on individual presentations, including the date, time, location and style (oral or poster), have been or will be forwarded to the authors. Please note that slide projectors will not be available. All oral presentations should be prepared for either PowerPoint or overhead projectors.

If you have not, as yet, registered, the deadline for the reduced price registration is 7th July for members of the sponsoring societies (GSJ, GS, EAG and MSA). After this date, registration will continue, but the reduced fees will no longer be available. Note that a reasonably priced childcare program has been arranged and is now outlined on the conference website. Space is still available for participation in the mid-conference and post-conference tours. Other social events planned for the conference include the icebreaker party on Sunday evening after registration, a welcome reception on Monday evening, and the conference banquet in the Kurashiki old town. Additionally, the JTB Corp, the official travel agent, is available to help you arrange your personal tours in Japan. So, please go to the conference website to complete your conference transactions, including hotel reservations. Some more practical information for the delegates will be E-mailed and announced on the website one month in advance of the conference.
Since the publication of the second circular, a short course on inductively coupled plasma-mass spectrometry (ICP-MS) for students and young researchers has been announced for 6-7 September 2003. The location of the short course is in Okayama Terrsa, about 7 km east of Kurashiki. It will cover the entire range of ICP-MS techniques and applications for Earth and planetary science, as well as the basic theoretical aspects of the mechanism of isotope fractionation. Distinguished lecturers will include: Gunther Detlef (ETH, Switzerland), Alex Halliday (ETH, Switzerland), Toshiyuki Fujii (Kyoto Univ., Japan), Simon E. Jackson (GEMOC, Australia), and Keith O'Nions (Oxford Univ., UK). The details of the program and registration form can be found on the conference website.

Thanks to Outgoing Committee Members

The 1st of July is the date when new members join the various committees of The Geochemical Society, replacing those who have completed their 3-year terms. The new composition of the committees is published elsewhere in this issue of the Newsletter. To the retiring committee members:

Peggy Delaney, Chair and Alex Halliday, F.W. Clarke Award Committee,
Francis Albarede and Stan Hart, V.M. Goldschmidt Award Committee,
Cindy Lee and Erwin Suess, Chair, Clair C. Patterson Award Committee,
Emily Klein and Jan Veizer, Chair, Nominations Committee, and
Peter K. Swart, Program Committee,

I would like to take this opportunity to recognize your important service to the geochemical community and thank you for the time and effort you have devoted to the activities of your respective committees. I would especially like to thank the 3 outgoing chairs for insuring that the work of the society is accomplished. For those of you who would like to more actively participate in The Geochemical Society and have not, as yet, been tapped to serve on one of the committees, remember to express your interest on next year's dues form.

The State of Geochemistry

The 13th Annual Goldschmidt Conference in Japan is the first to be organized outside of the USA or Europe. The large number of abstract submitted to the conference is an excellent indication that the trend towards larger Goldschmidt conferences continues, regardless of location. Indeed, the Goldschmidt conferences have come to represent an excellent opportunity to interact with fellow geochemists from around the world. This annual review of state-of-the-art geochemistry is becoming an increasingly important event in every geochemist's calendar and its popularity signifies the healthy state of the field of geochemistry. Recognizing, however, that it is not possible for many members of GS and EAG to attend the upcoming conference in Japan, it is an appropriate time for me to remind you that the 2004 Goldschmidt Conference will be held in the sophisticated and charming city of Copenhagen, Denmark. And, in 2005, the Goldschmidt Conference will once again return to a North American location on the western frontier of the USA, to be held in Moscow, Idaho. As a preview for 2005, see the article on geochemistry in Idaho on page 13 of this issue of GN.

For those of you who are planning to travel to Japan in September, I am sure you will agree with me that the 13th Annual Goldschmidt Conference promises to be a scientifically exciting event at the "Frontiers in Geochemistry", one to be shared with colleagues from around the world in a unique culture setting. I am personally looking forward to a simulating conference and to meeting you in Kurashiki. I wish you a pleasant journey.

With best wishes,

Judith A. McKenzie
GS President

COVER:
Buzz Aldrin (left) pours a sample out of the large scoop into a sample bag Neil Armstrong (right) is holding. On the Moon it would have been difficult for Buzz to bend the suit enough to get his hands this close together and probably would have had to hold the scoop in one hand and turn the basket around a horizontal axis to make the pour. Neil and Buzz ran short of time during their EVA and did not collect any documented samples. 18 April 1969. Photo credit: NASA. Scan by J.L. Pickering.

Editor's Corner...

This issue features an interview with geochemistry pioneer Geoff Eglinton, and in honor of him - and of the July 20 anniversary of the 1st lunar landing by humans - our cover features astronauts Buzz Aldrin and Neil Armstrong, in training for their historic Apollo 11 journey. In this issue we also present a travelogue of geochemical wonders in the US Northwest; the Palouse region of Idaho-Washington, USA, written by Scott Wood. We hope Scott's article peaks everyone's interest, because this magnificent geologic setting will serve as the backdrop for the 2005 Goldschmidt Conference, in Moscow, Idaho, USA. But first, we wish everyone a good time and good science, at this year's Kurashiki Goldschmidt, the 1st Goldschmidt meeting in Asia.

Until next issue...

Johnson R. Haas
Carla Koretsky
Editors

Dutch Researchers Join Hands and Establish Netherlands Centre for Luminescence Dating

The previous issue of The Geochemical News briefly mentioned luminescence dating and the Netherlands Centre for Luminescence dating (NCL). The NCL was established on January 1, 2003 and the symposium in celebration of that event took place on March 20. It included the signing of the collaboration agreement by representatives of University of Groningen, the Netherlands Institute of Applied Geoscience TNO - National Geological Survey (TNO-NITG), TU Delft, Utrecht University, the Universiteit van Amsterdam and the Vrije Universiteit.

Luminescence dating is a still somewhat new technique in the earth sciences. It allows geologists to determine when a mineral in sediments was last exposed to light or heat. There are two varieties: optically stimulated luminescence dating and thermoluminescence dating. Luminescence dating works for time scales of decades up to a few hundred thousand years. That makes it the only technique that can span an entire glacial cycle (*i.e.*, about 100.000 years) and therefore enables earth scientists to unravel, for instance, the development of glaciation. For comparison: the limit of ^{14}C dating is about 40,000 years.

Another example of an application of luminescence dating is the reconstruction of coastal evolution (think of dunes!). Finding out how such a landscape developed in the past can help predict how it may develop in the future. That connects the technique with societal concerns, which helps to get it supported financially.

The method was initially developed in the 1960's for dating pottery. It is based on the facts that 1) quartz and other minerals in sediments absorb the ionizing radiation that is produced by U, Th and K, which are also present in those sediments and 2) that this clock is reset by light or heat. (The radiation frees electrons that are then trapped at lattice defects and light or heat releases them again.) Illuminating or heating samples elicits luminescence and the amount of produced luminescence is proportional to the accumulated radiation dose. It's basically also how a dosimeter works.

The recently founded NCL has two laboratories, one in Groningen and one in Delft. The Groningen facility focuses on developing techniques that use zircon, while the lab in Delft - that is, the Radiation Technology group at the Interfaculty Reactor Institute of the Delft University of Technology - offers quartz luminescence dating and investigates further possibilities of quartz, and of feldspars. The Delft facility just purchased more state-of-the-art equipment and will become fully operational over the summer.

For further information, please see http://www.ncl-lumdat.nl or read "An introduction to Optical Dating" by M.J. Aitken (1998 - Oxford University Press) as the NCL's site advises.

Angelina Souren
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From The Geochemical Society Business Office

Active Members, as of June 1, 2003 total 1,441. The GS website has a directory of members available at http://gs.wustl.edu/members/

Elsevier has limited GCA back issue requests to the previous two calendar years, currently v.65 [2001] through v.67 [2003]. Issues before 2001 are no longer available through back issue requests.

Some conventions offer discounted registration if you are a member of the Geochemical Society. If they require a membership number, you may use your GS receipt number sent to you when you renewed. This number is unique to you and is valid through the current year. If you have misplaced this number and need it, contact the business office and it will be resent.

The Business Office has switched its credit card processing system. The system is more secure and will give us the ability to process credit card orders/renewals on-line in the near future.

I will be manning the Geochemical Society's exhibit booths at Goldschmidt in Kurashiki, Japan on September 7 – 12, 2003 as well as the 2003 GSA Annual Meeting on November 2 – 5, 2003 in Seattle, Washington. If you are at these conventions, feel free to stop by for a visit.

Publications – Special Publication Volume 8 is in the works. Stuart F. Simmons and Ian Graham are the editors. The working title is: Volcanic, Geothermal and Ore-Forming Fluids: Rulers and Witnesses of Processes within the Earth. It is estimated to be released in late 2003/early 2004.
Cheers,

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THE GEOCHEMICAL SOCIETY
2004 Officer and Director Candidates

The Geochemical Society has a 16-member Board of Directors, currently composed of 10 Officer-Directors and 6 Non-officer Directors. Vice President Tim Drever will replace current President Judith McKenzie on January 1, 2004, and a new Vice President Candidate must be selected. International Secretary Eiichi Takahashi will also step down at the end of 2003, as will Directors Roberta Rudnick and Edward Sholkovitz. The slate of new officer and director candidates is listed below.

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

Additional nominations may be made by at least ten (10) members of the Society and the nominees must agree to serve if nominated. If you are satisfied with the proposed slate of Officers and Directors for 2004, do nothing. Additional nominations must be submitted by September 1, 2003, to the Secretary of the Geochemical Society (Jeremy Fein, University of Notre Dame, Department of Civil Engineering and Geological Sciences, 156 Fitzpatrick Hall, Notre Dame, IN 46556 USA, email: fein.1@nd.edu, fax: 574-631-9236, phone: 574-631-6101).

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Committee Memberships

F.W. Clark Award Committee
Rotating off: Peggy Delaney, Alex Halliday
Continuing: Craig M. Bethke (becomes chair), Philippe Van Cappellen, Janet S. Herman, W. F. McDonough
New members: Laurie Reisburg (Nancy), Bernard Boudreau (Dalhousie)

V.M. Goldschmidt Award Committee

Rotating off: Stan Hart, Francis Albarede (as President of EAG) (One person to be nominated; new EAG President is automatic)
Continuing: Lee R. Kump (continuing as chair), Robert A. Berner, Richard Carlson, Sigurdur Gislason
New Member: John Valley (U. Wisconsin); Terry Seward as EAG President

Nominations Committee

Rotating off: Jan Veizer, Emily Klein
Continuing: Roland Hellmann (becomes chair), Arthur F. White, Mary I. Scranton, Philip N. Froelich
New Members: Carol Frost (Univ. Wyoming), Vickie Burnett (ANU)

Program Committee

Rotating off: Peter K. Swart
Continuing members: M. Goldhaber (continuing as chair), Adina Paytan, Briant A. Kimball, Patricia A. Maurice, Michael A. Velbel
New member by prior arrangement: Daniele Cherniak

Clair C. Patterson Award Committee

Rotating off: Erwin Suess, Cindy Lee
Continuing members: F.J. Millero (becomes chair), Kurt Konhauser, , Nancy Hinman, Barbara Sherwood Lollar
New members: Bob Aller (SUNY Stony Brook), Bernhard Wehrli (EAWAG, Switzerland)

An Interview with Professor Geoff Eglinton

By Professor Vala Ragnarsdottir

As most of you know, Geoffrey Eglinton basically founded the field of molecular organic geochemistry. The scientific community's recognition for his achievements shows in a number of awards he received, such as the NASA Gold Medal for Exceptional Scientific Achievement in 1973. Although he 'retired' from the University of Bristol in England in 1993, he is as busy as ever. In 1993, he received the Royal Society of Chemistry's prestigious Theophilus Redwood Lectureship award. Four years later, he shared the Harold C. Urey Medal (EAG) with Dr. John M. Hayes of WHOI and at the same time received one of The Queen's Medals, as the Royal Medals are popularly called. In 1999, he was a HWK Fellow at the University of Oldenburg in Germany where he investigated aeolian dust in marine sediments. Before that, he worked on similarly intriguing topics, such as sticky smelly oozing stuff, daisy flower compounds that go bang, and fungal pigments.

He is also one of EAOG's past presidents. In 2000, Geoff Eglinton received the V.M. Goldschmidt medal and at that occasion, Professor Vala Ragnarsdottir interviewed him. This article is the result of a joint effort of the three of us.

Angelina Souren
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Vala: How did you first get interested in science?

Geoff: That goes back to school days in Sale, Cheshire, prior to 1945. I used to go to the local library every week and just get all sorts of books off the shelves. One particular book sticks in my mind. It is by a French author called Jean-Henri Fabre, translated into English. It is about his observations of insects, made in the mid-1800's, and is a super book ('Social Life in The Insect World', now available as ISBN 0898757177; see also http://www.e-fabre.net/). Fabre just sat for hours and hours and watched sand wasps. What they did and where they went. Then after they had gone away, he would go and look at what they had been doing. His descriptions seemed to me so beautifully careful and interesting. Natural History at its best! That was one type of science and the sort of thing that I really would have loved to do, but of course at school I was studying just ordinary 'text book' science. I remember what the teachers said, after I took aptitude tests in '44/'45, 'Well, you should be able to work either writing or doing science. So why don't you go into science and write about the science!' So that's actually how I got started.

I also read lots of books on chemistry. I found those exciting because they contained all the usual things that students like, such as how to make explosions and how to make crystal gardens. Of course, I then got myself some bottles and equipment to work with at home and that caused quite a problem in a small house!

Vala: How old were you then?

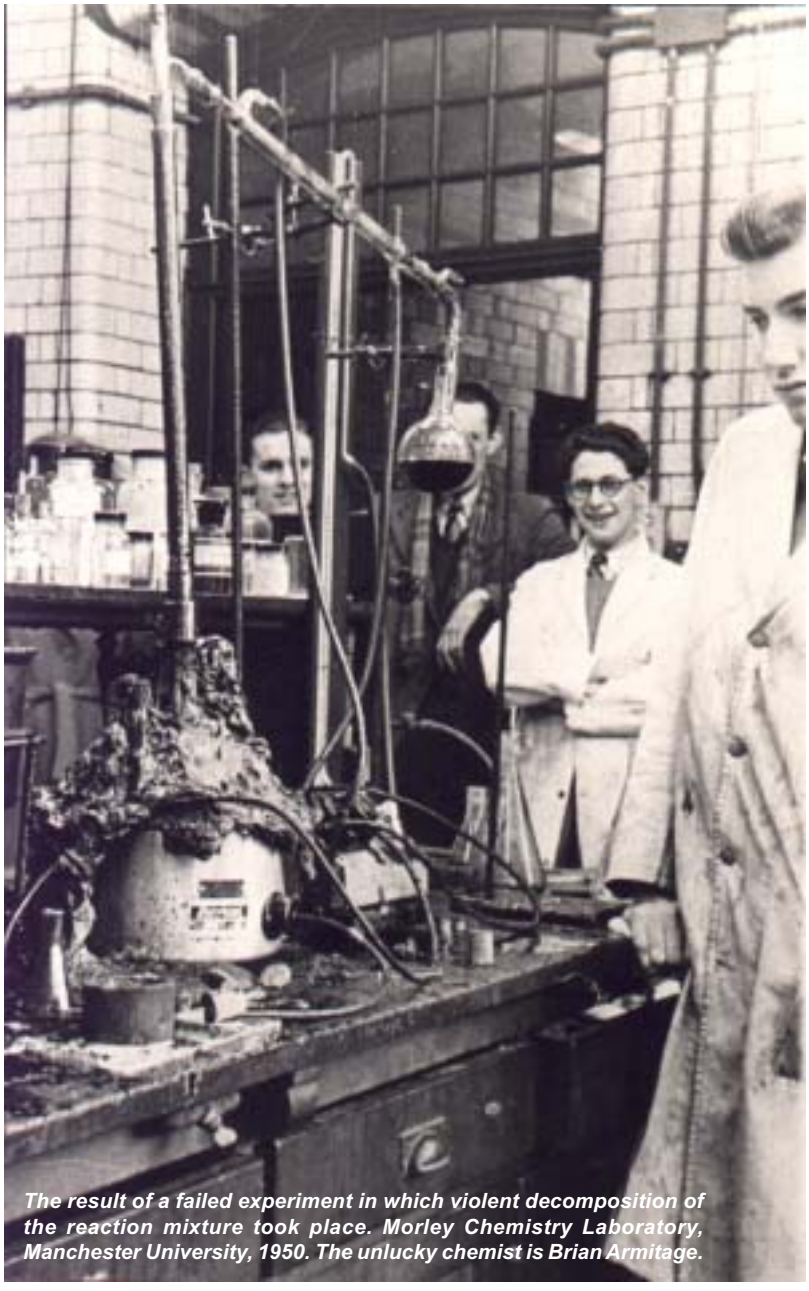
Geoff: I was 15, 16. By that time, I was able to do experiments and mix chemicals and all that sort of stuff, without too much trouble.

Vala: I bet your mother wasn't very amused!

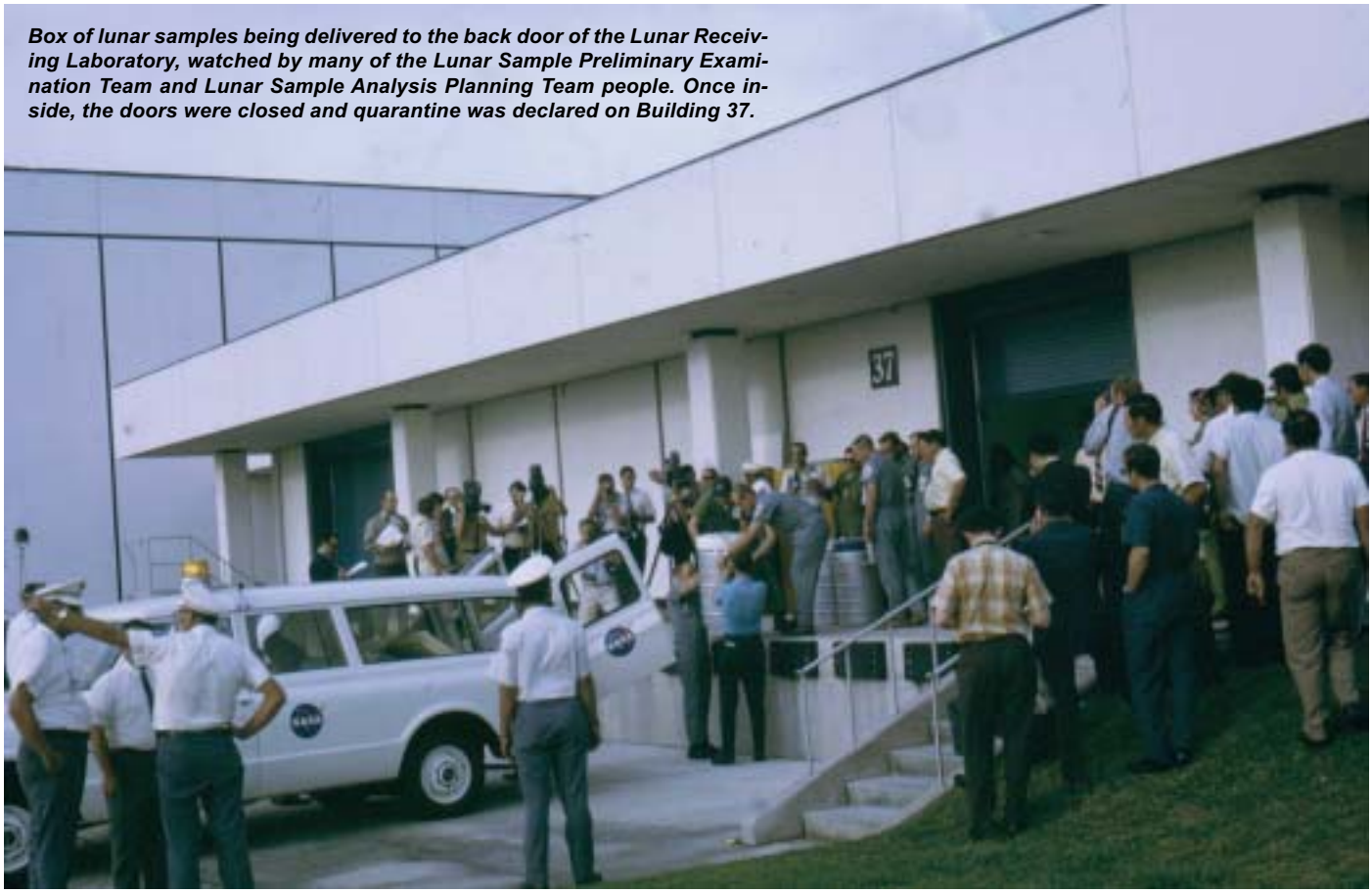
Geoff: No, my parents were not too excited about that!

Vala: Then you decided to do A-levels in science. That is, were there A-levels in those days?

Geoff: No, there really weren't the same things, but there were some similar exams for the Higher School Certificate. Because the school was very limited with the staff it had during wartime, I was doing general science at first, but I ended up doing chemistry, physics and English. With that, you could get entry to the local university, which was Manchester. I opted to do chemistry, but I very quickly made friends with students in the Geology Department because it so happened that I joined the mountaineering club. I found that quite a few of its members were in the Geology Department, as you might expect. The great thing about the Manchester University Mountaineering Club was that past students were also members, and active members at that. You could have a really good time out in the hills and



The result of a failed experiment in which violent decomposition of the reaction mixture took place. Morley Chemistry Laboratory, Manchester University, 1950. The unlucky chemist is Brian Armitage.



Box of lunar samples being delivered to the back door of the Lunar Receiving Laboratory, watched by many of the Lunar Sample Preliminary Examination Team and Lunar Sample Analysis Planning Team people. Once inside, the doors were closed and quarantine was declared on Building 37.

mountains of Derbyshire, the Lakes and North Wales, not only with your own age group but also with older people who knew a lot more about mountaineering and were already in careers. Some of them were, for example, lecturers elsewhere and others were doctors, dentists and engineers. What it really boiled down to is that, while I was out on the hills, if there was something curious about the rock formations – as there often was – I could ask somebody about it. What was it and how did it get there? A great way of learning a little bit of geology.

Smelly sticky stuff

Vala: After you finished your Chemistry Degree, what did you decide to do then?

Geoff: Well, that is rather interesting, Vala. Actually, it started already when I was doing my degree in Chemistry. On one of these mountaineering trips in 1948, I remember asking about a curious material, which was oozing out of a cave in Derbyshire, in the limestone area. A great pack of shales, the Mam Tor Shales, dipped across into this limestone area. There's a deep cleft, called The Winnatt's Pass, where out of the shale and associated rocks was oozing a sort of rubbery stuff. Really very weird. It goes by the mineral name of elaterite – not laterite, but elaterite – and elaterite is clearly organic. It smells, it's rubbery, it's sticky and dark and all the rest of it. So I took some back to the lab and showed it to one of the lecturers in Chemistry. He said, 'Yes, that looks very interesting.' And I carried on, 'Do you think one could find out what generated this by examining the organic compounds present? For example, will there be compounds related to chlorophyll if it were from plants?' He looked at me a bit aghast and said something like, 'Well, that's the sort of thing you should think about when you've done your degree. Get that out of the way first.' So I put the idea on one side for quite a number of years, but I still had this stuff on the shelf and kept having a look at it. Finally, early in the 1960s I decided to take the plunge, change my research and look for organic compounds of biological origin in rocks and fossils.

Working on things that go bang

But, going back to1948, I started off on my PhD in a very straightforward manner. The easiest thing to do, after all, for a young student in the UK, was and still is to go on in the same department to do your PhD. The research group at the School of Chemistry at Manchester was really very keen to have me join and was offering studentships. I was then asked to work in the field of synthetic organic chemistry, making – as it happened – acetylene compounds, which are quite explosive. We had a lot of fun then because there was quite a big group of us. We made a whole lot of different compounds. Some of them were very explosive because they would be made at low temperatures and when the equipment warmed up, they would sometimes go off spontaneously.

Vala: Was there any particular reason for making these compounds?

Geoff: Oh yes! But you don't ask chemists that! It's rather like asking a geologist why should you try and explain what that rock formation is? No, these acetylenic compounds were very interesting as tools to make others. That is, you can use them as reactive units. That's one thing. Another is that while we were working on them, it became increasingly obvious that, surprisingly enough, certain types of these compounds – the polyacetylenes – actually occur in plants. You can isolate explosive compounds from daisy flowers!.

Vala: Really?

Geoff: Yes. This was a field that was developing very rapidly while I was doing my PhD. But I wasn't working on polyacetylenes myself. I was working on the simple acetylenes – with single carbon-carbon triple bonds – and finding ways to make them and also how to use them for making a series of compounds. After three years, I put my PhD in on that and then I went to America to work for a year on synthesizing steroids.

Columbus, Ohio

Vala: And where was that?

Geoff: That was at Ohio State University in Columbus, Ohio. After that, I went to Liverpool University and started to work on determining the structures of the yellow pigments of the ergot fungus, which is a well known parasite of rye. You might say again, why was I doing that? Well, going back to what I had been doing at Columbus, you can imagine that at that point, the making of steroids was getting to be very important, because of medical usage. In the case of the ergot fungus, however, there was no real point in finding out what the bright yellow colour was due to, except out of pure interest because these compounds were clearly structurally peculiar. I didn't solve the colours while I was there, but I made some progress. I was there for almost two years and then I was offered a post in the Chemistry Department at Glasgow. I went up there and set up an analytical laboratory – which they had asked me to do – on infrared spectroscopy. This was to be used for finding out the structures of compounds, particularly those we call natural products, which are the compounds you can extract from plants and animals.

That continued until about 1962, when I decided I would like to start a completely new line of research based on that question I had put at Manchester more than a decade earlier. There were relatively few people working – in the UK anyway – on organic compounds in rocks and fossils, except, of course, in the oil companies about which very little was published. So, I wrote to Melvin Calvin, the Nobel Prize Winner at Berkeley whom I'd heard speak at Glasgow on ***The Origin of Life*** and asked him if I could spend a year's leave of absence with him, starting up this project. I got an enthusiastic 'Yes' and the family set off for California.

Vala: You were in Glasgow then?

Geoff: Yes.

The microbial mats at Laguna Mormona on the West Coast of Baja California provided a good site for low-level ^{14}C biolabelling experiments with in situ mineralization processes involving lipid biomarkers, such as ^{14}C-labelled cholesterol.

Berkeley, California

Vala: When did you move to Berkeley?

Geoff: I went to Berkeley in 1963 for a year, '63/'64,on a sabbatical. Calvin was very interested. He had attracted public attention because of his work on the photosynthetic process, the Calvin Cycle. As a result, he had quite a lot of financial capability and laboratory space. He actually gave me a completely empty laboratory. I mean, that was really something! This laboratory was in the Chemistry building at Berkeley, and had all brand-new benches, taps, electric sockets – the lot. So I decided that I would first of all do a lot of reading! But Calvin was getting more and more impatient and said, 'When are you going to start?' because I arrived in or around September and by November he was pretty restless. He kept on appearing in this empty lab and saying, 'What's going on?' and I replied, 'Well nothing, because I haven't started yet.' But eventually I found a young research student who wanted to come and work on the project. He liked the idea. I said to Calvin, 'We ought to look for certain organic compounds in rocks and fossils.' He wanted to start on the Precambrian right away. In his origin-of-life studies he had worked with people like Preston Cloud and others and they had given him lots of early cherts and similarly unpromising-looking rocks.

Vala: What was the name of this student?

Geoff: This student was called Belsky, Ted Belsky, and he had been working, actually – in the early stages of his PhD – on the reflection spectra from Mars. The connection was infrared spectroscopy. He knew that I was involved with infrared. He turned out to be a very practical character and also, he knew his way round the University, so very quickly we were able to beg, borrow or steal equipment, which he then set up. We bought the first gas chromatograph in the building, got it to work and started to extract rocks. But I refused to start on the Precambrian samples because I thought they were too difficult. I think I was right. We started on the Green River Shale, an organic-rich rock of Eocene age from Wyoming. That came about because I met Bill Fyffe from the Geology Department. We talked and he asked what I was trying to do. A few weeks later he came bouncing back with a set of abstracts from a meeting. I think it was an ACS meeting, a local one, in which somebody from Wyoming reported that he had been extracting these Green River Shales, and had found – or claimed to have found – certain isoprenoid organic compounds in it. And he said, 'This looks interesting.' and I replied that indeed it did! And so we started. We did the Green River Shale compounds and then we went on to the Nonesuch Shale, which was about 1 billion years old, from the Canadian border near Lake Superior. The Nonesuch Shale comes from the copper mines up there and contains small amounts of oil, and it was this we looked at.

Vala: What did you find when you started measuring?

Geoff: What did we find? We were looking for hydrocarbons, because especially with the very old rocks, where there isn't that much left except hydrocarbons. With the relatively young Green River Shale, then there are a lot of functionalised compounds present, but we concentrated mainly at that stage on the hydrocarbons. What we found were the usual straight-chain compounds, which largely come from algae and plants. The shorter ones from algae and the longer ones from higher plants. And also the branched compounds, for which there was a lot of interest, the isoprenoids. Pristane, phytane and so on. We – for the first time – showed that these structures were correct and that these compounds were abundant in the shale. At that time, we thought that they were mainly derived from chlorophyll, but it turns out that more of these hydrocarbons are probably formed by microbial activity than directly from plant production.

Vala: You identified all of these compounds by using infrared.

Geoff: No, by using GC and MS. Well, we also used infrared and a few other techniques.

Combining GC and MS

Vala: When was the first combined gas chromatograph-mass spectrometer (GC-MS) built?

Geoff: I have never looked back to find out precisely when that was, but it may have been as early as the late 1940s or early 1950s. It's a very interesting question. The first commercial one, I think, was the LKB made around 1960 in Stockholm for biomedical customers, and that model was the one that we eventually bought for Glasgow. I had written a joint grant application with another colleague at Glasgow, Charles Brooks (these were almost the first days of grant applications). We requested a GC-MS system to be used for the analysis of both biomedical and geological extracts. It came through and we then wondered where to set it up! That was a famous occasion: to give it a room we had to ask permission to demolish a ladies' toilet in the basement of the Chemistry Department. We wrote a justification that there weren't that many women students (at that time anyway, because of course it has changed now) and yet, this was a quite luxurious one, in terms of space but not location. And that's where the Gas Chromatograph-Mass Spectrometer System went. That was somewhere around '65, I think.

Vala: Where did the funding come from?

Geoff: It came from the Science Research Council, which was the forerunner of the Research Council system. In fact, I've still got the application somewhere and a letter approving the GC-MS.

Vala: This was your first grant?

Geoff: Not quite, but it was one of the early Research Council grants. Usually you relied on the department having a little bit of running money and also getting a studentship from the department or something like that. Then, the equipment was generally small and you bought that out of the Department budget. Gradually, the system changed to where now almost everything has to come from grants.

Vala: In Glasgow, you set up a lab to analyse organic compounds?

Geoff: Yes. Well, what I had done when I went to Glasgow in 1954 was to set up the new infrared laboratory as a service for the whole department and also as a research facility. During that time, we also installed our first piece of home-made gas chromatographic equipment. It was about 10 feet

Geoffrey Eglinton and Queen Elizabeth study the display in 1987, at the signing of a formal Collaborative Agreement between The Royal Society and The Academica Sinica. The name of the display was 'Blood from a Stone'. It showed the real-time extraction of bright red porphyrin compounds from shales, including some Chinese examples. Geoffrey: 'We all put on our best behaviour and stood by our exhibits and that's when the picture was taken.' Photograph provided by Royal Society.

tall (as high as one story), heated by boiling solvents and very primitive. Nothing like the bench top instrument we bought when we went to Berkeley in 1963. And then gradually, during this time, the department at Glasgow developed mass spectrometry as a tool for use in organic chemistry. A huge step forward, led by Rowland Reed.

So we had all the bits and pieces: adsorption chromatography, GC, MS, UV and the infrared. But I was still working, or my people were, on acetylene compounds because I hadn't given up yet on those. Still, gradually we tailed off the acetylenes and started in real earnest on the rocks and fossils. So that's how the change happened. By the time I left in '68 and came to Bristol, we had completely stopped working on acetylenes. So we set up the Organic Geochemistry Unit and started getting ready for the arrival of NASA's Apollo samples promised for the autumn of 1969.

Vala: That was the first Organic Geochemistry Unit anywhere?

Geoff: No, Newcastle was the first one in the UK although a small group had made a start earlier, in the Geology Department in Nottingham. One of my colleagues, Archie Douglas, had gone to Newcastle from Glasgow and joined its geology department, which effectively became an organic geochemistry unit. Newcastle's work was based on microscopy and bulk measurements, especially of coals and kerogens. Less to do with molecules. But gradually it changed to become more like what we were doing, which was entirely molecular from the start. In Glasgow, we had developed this approach and then, when we came to Bristol, we set it up more formally as the main theme of the Organic Geochemistry Unit (OGU). And, you see, James Maxwell was one of my students in Glasgow. He then went to join Calvin separately for a year before he came to Bristol as a lecturer. That way, there was a continuity of expertise.

Vala: Did the funding come from oil companies or NERC?

Geoff: It was a composite of oil companies and NERC (Natural Environment Research Council). I remember, when I was at Glasgow, two BP people coming to see me specifically. They were Gordon Speers and Ted Whitehead. They were pioneers in doing this type of work at BP. I remember it was Gordon Speers saying, 'Now, wouldn't you like to have a contract to do some work?' And I remember I said, 'Well now, hold on, we feel we should be doing the academic stuff.' And he looked quite hurt, you know, and afterwards I thought how daft we were. That was way back, when in fact it was frowned on to have much in the way of industrial support, so I said, 'Well, you know we should be doing the basic stuff.' When we moved down to Bristol, they came to see us again and this time, of course, we replied, 'Well, yes!' Indeed, we were really very pleased to see them. I think they too now wanted to set up an arrangement whereby we were to work on basic things and they on the more applied. We were then to meet with them from time to time to swap results and ideas. In fact, we had some very enjoyable and productive weekend outings with them

What BP did was to approve general areas that they would like us look at and then leave us to get on with them. Then we would have weekend meetings where we would invite most of the group, especially those working on areas that were of interest to them. We would present the work that had been going on, with the BP people there. They would ask questions and make suggestions, and we would for go for walks and have some nice meals. One of these meetings, I remember, was in a small hotel, which can only be described as a second Fawlty Towers. It was really funny to see BP people struggling with the manager – just like we were – who had much in common with Basil Fawlty himself.

This funding from BP went on in various ways for a number of years and certainly helped us greatly. And indeed, it helped them too because some of the results that came out of this were the work of Andrew McKenzie and James Maxwell and others: parameters for assessing the maturity of a rock, or rather the organic material in a rock, or the type of oil and its thermal history. This all came out of the proxies, as we called them, derived from the ratios of one compound to another, where these compounds were being converted, or in some cases eliminated, so that the ratios gave you an indication of where the rocks were on the thermal history plots. That type of subject became really the norm for a lot of work in the oil industry: trying to see which rocks were at which stage of generation and which oil had come from which rock. Although this all came out of the academic work going on at Bristol and elsewhere, we were well aware that there were potential applications in the oil industry, and this approach is now routinely used everywhere.

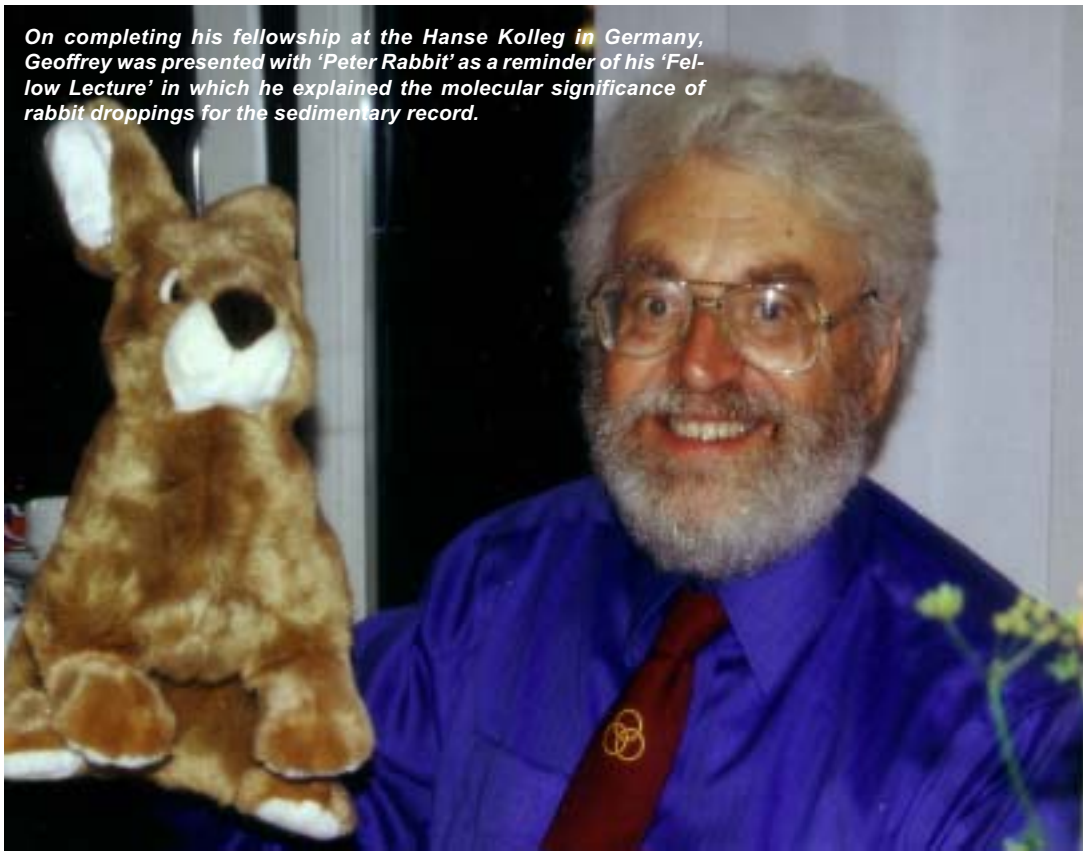
Vala: How about telling me about how you came to have a NERC-funded service lab here in Bristol?

Geoff: That gradually took place as a result, I think, of us applying for NERC grants over the years. We started off, of course, in Glasgow because NERC was a derivation from the earlier Research Councils structure, which took over responsibility in 1965 for the area that we represented. We had a whole series of NERC grants, in which we were looking

Above: James Maxwell transfers lunar dust (blackish material in test tube) from the special container used to ship it from Houston. All transfer operations were conducted in the Clean Air Facility in the basement of Chemistry, provided for the Apollo work. We managed to keep terrestrial organic contamination by, for example, skin lipids, plasticizers and lubricants to very low levels indeed.

at both lake and ocean environments. We were also looking at the maturity question for oil source rocks of different sorts, and so on. But we were not really concerned directly with industrial applications; we wanted to get at the fundamentals. We constantly sought better equipment. With each grant, we would try to improve the facilities because this was the only way really to be at the front edge of analysing complex mixtures of organic compounds. Just as with isotopic measurements for age determination. Unless you are really pushing the techniques to the limit, you're soon going to fall behind. Something that we worked hard for was computerisation of the mass spectrometers and NERC was very supportive. We got to the point where we had really good equipment run by an expert team of analysts, notably Ann Gowar and Jim Carter. We were able to help other people run their samples

on this instrumentation. Eventually it became a NERC facility and NERC set up a facility committee, which of course included people from outside industry. That, in a way, made life more difficult for us because we had to satisfy them and prepare reports and all the rest of it. But it was a very good discipline for us and it also led to a lot of interest and input from the committee. They would make suggestions and offer help, so the whole facility idea worked extremely well, and we were very glad we went that route.



On completing his fellowship at the Hanse Kolleg in Germany, Geoffrey was presented with 'Peter Rabbit' as a reminder of his 'Fellow Lecture' in which he explained the molecular significance of rabbit droppings for the sedimentary record.

Vala: When was the NERC facility founded?

Geoff: The first GC-MS analytical lab was set up at Glasgow and stayed there as it really was not sensible to move 'my' half of it. We had to start again from scratch at Bristol. But NERC did come up trumps with the much-needed GC-MS. Indeed, NERC has funded us in one way or another through grant support, right since the time we first came to Bristol.

Vala: What about external access?

Geoff: We always made our equipment available to researchers elsewhere, but the official NERC Facility was created some twelve years later, in the early 1980s.

Card games

Vala: Perhaps you would like to tell me a little bit about your role as a teacher. How do you feel you have fitted in with all the other chemists that you have interacted with?

Geoff: I must admit that our area was so different from most of what was going on in the Chemistry Department, that there were problems in trying to satisfy the chemists that we were effectively proper card-carrying chemists! However, we were certainly very much analytically minded, and after all, Bristol has had an analytical side to its Chemistry Department almost since square one. Unfortunately, in recent years the Chemistry Department, in its wisdom, has demolished that, which I think is very sad. We were part of that area and I think the two went extremely well together. That is trying to make improvements in analytical chemistry that were relevant for the field and then applying them in organic geochemistry and in environmental chemistry especially. It was a good marriage for science.

Other than that we were of course supposed to be part of the Chemistry Department. For example some of us, such as James Maxwell and myself and some of the postdocs, would teach straight organic chemistry or analytical chemistry. We took full part in the tutorial system and I enjoyed that very much. I found it extremely stimulating, fun even, because the tutorial system in the Chemistry Department operated with first-year students. Of course, you only saw a small fraction of the total number of students, but you got to know those quite well. It was satisfying to get them interested in chemistry. Sometimes we did this by playing card games! We devised a type of chemical card game, which was based on something one of the lecturers in Glasgow had started. It's a bit like Scrabble, and it's a bit like Dominoes, but essentially you have to specify the chemical reactions that will take you from one card to another. You can, for instance, test each other by asking which reaction you are using and why.

Vala: I bet that was very popular!

Geoff: Oh, it was! It made an interesting diversion from the usual rather formal questions that were set. The other thing we did was to go over to Earth Sciences, or Geology as it then was, and teach an optional Organic Geochemistry course for geologists. That involved trying to explain some basic organic chemistry as a start to the course and then take it on into geochemistry. That was also very worthwhile.

Vala: What about the joint degree in Chemistry and Geology?

Geoff: Yes, Chemistry and Geology was actually one of the reasons I was invited to Bristol from Glasgow: to start that course. Eventually, it became difficult to carry on because Geology was running part and we were running the other part and we had some practical problems in interfacing the two parts.

Vala: It's a pity that it fizzled out.

Geoff: Well, yes, it really was a popular little course. It turned out some very good people, such as Simon Brassell who is now on the staff at Indiana. But after a number of years, apart from the internal issues such as trying to get agreement about marking systems, another problem had surfaced, which was national in scope and more serious. When we started in '68 or thereabouts, we were virtually the only place in the UK offering something involving Joint Chemistry and Geology as an honours degree. By the time we had gone on for a number of years, 30 or 40 universities were offering some variant of this. They had diluted the pool of interest very greatly. The intake numbers were becoming so variable and low, that we decided that it wasn't really worth all the effort, which was a shame.

Vala: Tell me a little bit about your PhD students. How many have you had and how many are now eminent organic geochemists around the world?

Geoff: We have to remember that what we used to call the OGU, *i.e.* the Organic Geochemistry Unit, consisted really of myself and James Maxwell as teaching staff. We shared activities and tasks with some of the postdoctoral people, visitors and also those on research grants. But the

two of us were then jointly responsible for a considerable number of PhD students going through. Since then, Richard Evershed has replaced me and he has also had a number of PhD students. I gather from talking to Sue Trott, our secretary, who is just retiring, that something close to about 90 PhDs went through the OGU from 1968 to now (2000).

Vala: You have also had a large number of postdocs and visitors?

Geoff: Oh yes, lots! We were very fortunate that so many people wanted to come to the OGU. It's nice to have something as a label and the Organic Geochemistry Unit was indeed a useful label. The OGU attracted people from all over. For example, when we were doing the lunar sample work back in 1968/70, John Hayes came over from the United States, also Paul Abell from Rhode Island. He was one of the people who worked on the Olduvai fossils but he was really a physical chemist. So there were two Americans at that time working in the lab on the Apollo 11 lunar samples. We have had numerous academic visitors – especially Americans, Australians, Brazilians and Chinese. It's really been a very enjoyable time with this international aspect as well as our own students.

Vala: Most children want to do something completely different from their parents, but you have a son in organic geochemistry. How come he didn't get put off from the research that you were doing?

Geoff: We have two sons, David and Timothy. Both of them did PhDs in chemistry, but the elder one – that's David – joined Exxon as a trainee on the management side. He left research in chemistry as soon as he joined the company. He's been with them ever since and is now involved in the distribution of natural gas and oil, whereas Timothy seemed to want to work in organic geochemistry. I think that possibly came about because we have a number of 'geochemical' friends in other places, like Archie Douglas at Newcastle. Timothy did his PhD jointly with Archie Douglas and with Charles Curtis at Manchester. But I've encountered other cases like ours, for example, Kate Freeman at Penn State, whose father is an organic chemist. But I must admit there is a much closer parallel for Timothy and I because we're both doing some form of organic geochemistry. In fact, I'm an Adjunct at WHOI and he's employed by WHOI, so that comes even closer. It's fun for me because we talk about things that he's done. He's the really active one!.

Vala: Did you ever collaborate?

Geoff: Yes, we did a long time ago, but it was never written up because Tim got so active doing other things. But recently we had a little paper on some hydrocarbons from Serbian plants, which was done jointly with some Serbs.

Vala: I saw a photograph in your office at home of you with the Queen at The Royal Society. Could you tell me about that event?

Geoff: This was in 1987 at the signing of a formal Collaborative Agreement between The Royal Society and The Academica Sinica. We had a display of some of our work, which we had entitled 'Blood from a Stone'. It showed the real-time extraction of bright red porphyrin compounds from shales, including some Chinese examples. The chemistry told us that these biomarkers had come from the original green chlorophyll pigments of the abundant algae that had contributed debris to the shales during deposition. Ann Gowar, Simon Brassell, I and a grad student, Bin Zheng who was funded by the Chinese Academy, manned the exhibit. The Queen was due to come round with Prince Phillip that evening. We all put on our best behaviour and stood by our exhibits and that's when the picture was taken.

A Few Hundred Biomarkers

Vala: There is one term that is very much used in biogeochemistry and that's the term 'biomarker'. Can you tell me how that term came about?

Geoff: This usage developed mainly as a result of the ever growing popularity of what Calvin and I had first called 'chemical fossils'. The term chemical fossil never really caught on for some reason. I think it was the connotation that maybe it was the chemists that were the fossils! However, 'molecular biomarker' did. I do not know who actually put these terms together first. But 'molecular biomarker' got shortened. I think it was an organic geochemist called Wolfgang Seifert, who was working for Chevron who telescoped it to just 'biomarker'. So instead of 'biological marker compound', which is clear but not very easily used, or 'molecular biomarker' with is easier, you could just have 'biomarker'. For a long time, we thought that the term 'biomarker' belonged exclusively to us organic geochemists, and then we found out that the DNA people were using it as well. But it is very convenient. It's short and it tells you immediately that it's something with a biological origin and that it's some sort of indicator.

Vala: How many biomarkers do you think that you have discovered, or found, in your career?

Geoff: With all the people passing through the OGU, many of them contributed new compounds, or recognised compounds for the first time. Certainly, Bristol must be responsible for, I would say, a few hundred compounds, which in some way are sufficiently distinct that they can be recognised as individual biomarkers. Often, it's only a question of stereochemistry, but that's still highly important to have. Of course, the number of potentially fully identifiable, distinct compounds in nature must be in the millions. But certain molecules stick out as being readily recognisable, information-rich and also useful because they are often preserved to some extent. The whole biomarker game is trying to guess which compounds are going to be important because of the information they carry. That's partly the fun of the hunt for new ones. It's like finding new minerals. Some minerals may not differ much from others but they may still contain key new information. Likewise, small differences in biomarker structure or isotopic content can be very significant.

'Retired' is Not in His Dictionary

Vala: Since you retired from Bristol, you have been travelling round the world as a 'troubadour', as you referred to yourself in your acceptance speech when you got the Goldschmidt Award. Where have you been and who were you working with?

Geoff: I have been lucky to be invited to places, partly by my ex-colleagues. People like Paul Philp, Michael Sarnthein and Jurgen Rullkotter with whom I have worked in the past. I've been at Norman, Oklahoma, which is one of the great homes of oil exploration. I've been at Woods Hole, of course, a lot. That, I feel, is a really great place because of its basis in marine organic geochemistry and also because it's very well known for its connection to oil, through John Hunt. It also happens to be where my son Timothy is! And then I have taught at Kiel and been a Fellow at the Hanse Advanced Study Institute at Delmenhorst in North Germany and that's been very enjoyable. And then finally a place my wife Pam and I have been to several times is Dartmouth College in New Hampshire where one of my other ex-colleagues, Meixun Zhao, is on the staff. I've taught a postgraduate course there and really enjoyed doing that. It's also a very good place to go because of the snow. It gives a complete contrast to Bristol in the winter. Both Pam and I really like experiencing the crisp snow and the blue skies, when you get that combination, which you often do in the New Hampshire winter

Vala: Where are you going next?

Geoff: Next month, November (2000), I'm going back to Germany and going to the Hanse Institute to attend a conference and to write up some of the work and then on to Leipzig. And then after that we get ready to go to Dartmouth College for January, February and March.

Vala: Most of the winter you will be away?

Geoff: Yes, we are often on the move. However, I keep meaning to stay at home and write up a whole lot of stuff that I have ready for a book, but it's just such a monumental business trying to do that. I really need a highly energetic, young, computer-wise colleague to join me. If anyone wants to volunteer?

Geochemistry and Mineralogy on the Palouse

by Scott Wood

The Palouse region of the Pacific Northwest, U.S.A. comprises part of eastern Washington and northern Idaho and is home to Washington State University (Pullman, WA) and the University of Idaho (Moscow, ID). These two universities straddle the state line and are only eight miles apart. The total combined enrollment approaches 30,000, and there is considerable cross-border collaboration in both teaching and research between the two institutions. A wide variety of geochemical and mineralogical research is being conducted by investigators at these two universities. Because Moscow will be the site of the 2005 Goldschmidt meeting, it seems timely to highlight the range of research activities in geochemistry and mineralogy on the Palouse. As will be evident, such activities take place not only in the geology departments of the two universities, but also in many other related departments. The description of research activities in the following paragraphs is organized alphabetically according to research groups.

Aqueous Geochemistry
(Scott Wood and Leslie Baker, Geology, UI)

The main goal of this group is to understand the thermodynamics and kinetics of interactions between minerals and aqueous fluids, mostly under crustal conditions. The main tool employed is laboratory experimentation, including solubility, potentiometric, and spectroscopic measurements, but field-based and computational approaches are used as well. In particular, the work of the group focuses on contributing to genetic models for resources such as metallic ore deposits and geothermal energy, as well as environmental issues such as the safe disposal of nuclear waste. Although there is emphasis on the geochemistry of rare earth elements and platinum-group elements, the areas of research covered are very broad, and only a few examples are given here.

Recently, the group provided the first experimental data on the solubility of Re and Os in hydrothermal solutions (Xiong and Wood, 2000, 2001). These results show that both Re and Os are quite soluble under oxidizing conditions, but they become essentially immobile in the presence of reduced sulfide. Under all conditions investigated, Re was found to be considerably more soluble than Os. These results have important implications for use of the Re-Os isotopic system in hydrothermally altered rocks.

The aqueous geochemistry group has also made important contributions to understanding the behavior of REE in hydrothermal solutions. In collaboration with colleagues at Oak Ridge National Laboratory (Dave Wesolowski, Don Palmer, Pascale Benezeth), Montana Tech (Chris Gammons), and McGill University (Willy Williams-Jones), the group provided the first experimentally-derived thermodynamic data for complexes of REE with acetate (Wood et al., 2000), chloride (Gammons et al., 1996; 2002), and hydroxide (Wood et al., 2002) at temperatures up to 300º C. In addition, a major effort to determine REE contents in continental geothermal systems from New Zealand, California, Nevada and Oregon has recently been completed (Shannon et al., 2001; Wood et al., in prep.) in collaboration with Greg Arehart and Kevin Brown. In addition to providing fundamental insights into the nature of water-rock reaction in geothermal systems, these data may lead to increased success in exploring for geothermal resources.

One of the major obstacles to experimental measurements of mineral solubilities at elevated temperatures is the difficulty in accurately determining in-situ pH. Wood and Baker have recently constructed a hydrogen electrode concentration cell (HECC) for the measurement of mineral solubilities in hydrothermal solutions with accurate and precise in-situ pH measurement. This cell is modeled after the highly successful design employed at Oak Ridge

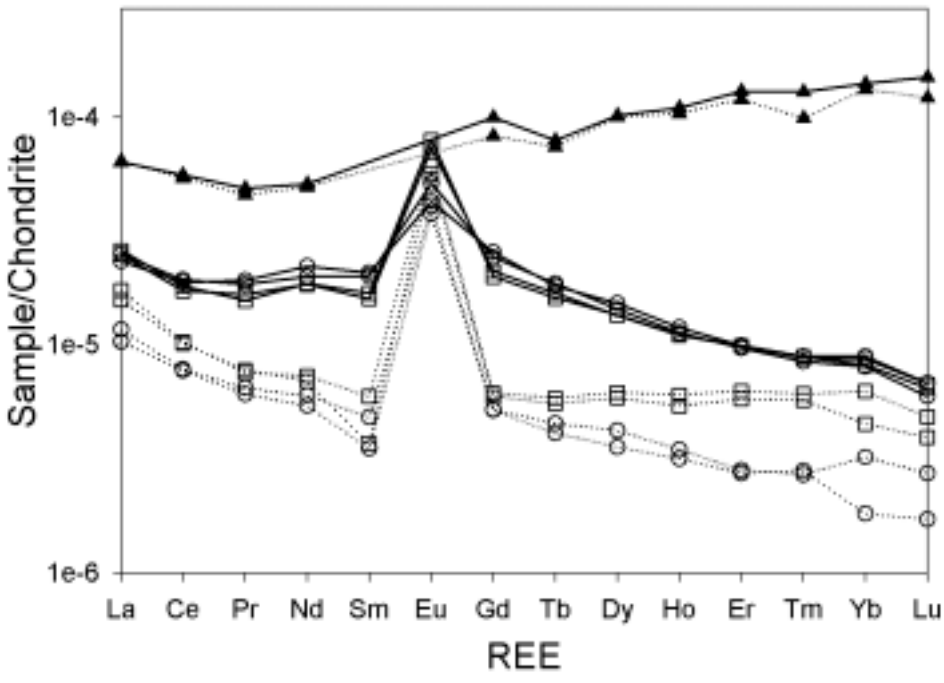


Figure 1. *Chondrite-normalized REE concentrations from the Ngawha geothermal field, New Zealand. Solid lines denote unfiltered aliquots and dashed lines denote aliquots filtered through a 0.45μm filter. Solid symbols show data from the Kamo Soda springs, a natural, bicarbonate-rich, cold spring south of Ngawha. The open symbols show data from geothermal well fluids from Ngawha. Note that the unfiltered aliquots generally contain higher REE contents than the filtered aliquots, suggesting an important contribution of suspended particles to the total REE load. The exception is Eu, which shows a positive anomaly and appears to be present largely dissolved in solution.*

Figure 2. Sampling acid-sulfate thermal springs at Waiotapu, New Zealand.

National Laboratory. As outlined in a recent review (Wood and Samson, 2000), the solubilities of the important tungsten ore minerals, scheelite and wolframite, are poorly known. Scheelite, in addition to being a tungsten ore, has found application as a target mineral for a variety of isotopic studies. Precise measurement of the solubilities of these minerals in aqueous NaCl solutions will be the first application of the HECC at UI.

Additional projects currently underway in the aqueous geochemistry group include: investigation of REE as tracers in mine drainage and ground water; determination of the relative solubilities of Pd and Ir in hydrothermal solutions; investigation of sorption of REE and U onto clays and iron oxides in the presence of organic ligands; study of the origin of geothermal systems in southeastern Oregon; in vitro investigation of the behavior of asbestiform minerals in the human lung (in collaboration with Mickey Gunter); measurement of the solubilities of Ce and Th oxides at high pH and ionic strength; and investigation of the geochemistry of Au-Ag and REE mineralization (in collaboration with Iain Samson).

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Cosmochemistry
(Leslie Baker, Geology, UI)

Leslie Baker studies the properties of Martian weathering products. She is currently conducting experimental studies of alteration of Mars analog rocks by brines at low water-rock ratios, and is also involved in testing of the SNOOPY Angle of Repose experiment which is designed to examine the physical properties of Martian atmospheric dust. She has previously studied remnant magnetization on Mars and its potential for assisting in locating Martian aquifers.

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Environmental Biogeochemistry
(Matt Morra, Soil Science, UI)

Lake Coeur d'Alene in Idaho is the second largest natural lake in the Inland Northwest, providing drinking water for five communities and serving as a primary recreational area for inhabitants of the Pacific Northwest. Over the last century Lake Coeur d'Alene became, and continues to be, the major collecting bed for contaminated sediments produced during mining and ore processing activities. As a result of these mining activities, tailings enriched in Pb, Zn, As, Cd, and other trace elements were deposited in stream banks and bars along the South Fork and main stem of the Coeur d'Alene River. These materials have been regularly resuspended during periods of high stream flow and secondarily transported into Lake Coeur d'Alene.
The overriding concern is the potential release of the accumulated metal(loid)s into the overlying water column. The relative importance of factors regulating the release of toxic metal(loid)s from the sediment and their flux into the water remain controversial. Morra's group is attempting to determine metal(loid) flux by characterizing sediment biogeochemistry and modeling metal(loid) diffusion. Metal(loid) concentrations have been measured in pore waters secured from equilibrium samplers ("peeper") installed 30 cm into the sediment. Sulfur and iron within sediment cores have been speciated using x-ray absorption spectroscopy (XAS).

Current data show that the sediments are oxic or suboxic only in the first several centimeters, after which a large increase in soluble Mn is observed followed by a soluble Fe increase, and sulfate depletion. The formation of soluble Fe and Mn results in the release of as much as 1.5 mg/L As into sediment pore water. Benthic fluxes calculated from this group's data indicate that the transfer of dissolved Fe, Mn, As, Zn, and P from the sediment into the water column is likely. Sediment analyses with XAS indicate sediment diagenesis in that pyritic materials and siderite increase with depth. Iron minerals dominate the system and are most likely the major solid phase material controlling soluble metal(loid) concentrations.

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Kariuki, S., M.J. Morra, K.J. Umiker, and I.F. Cheng. 2001. Analysis of ionic polysulfides by differential pulse polarography. Anal. Chim. Acta 442:277-285.

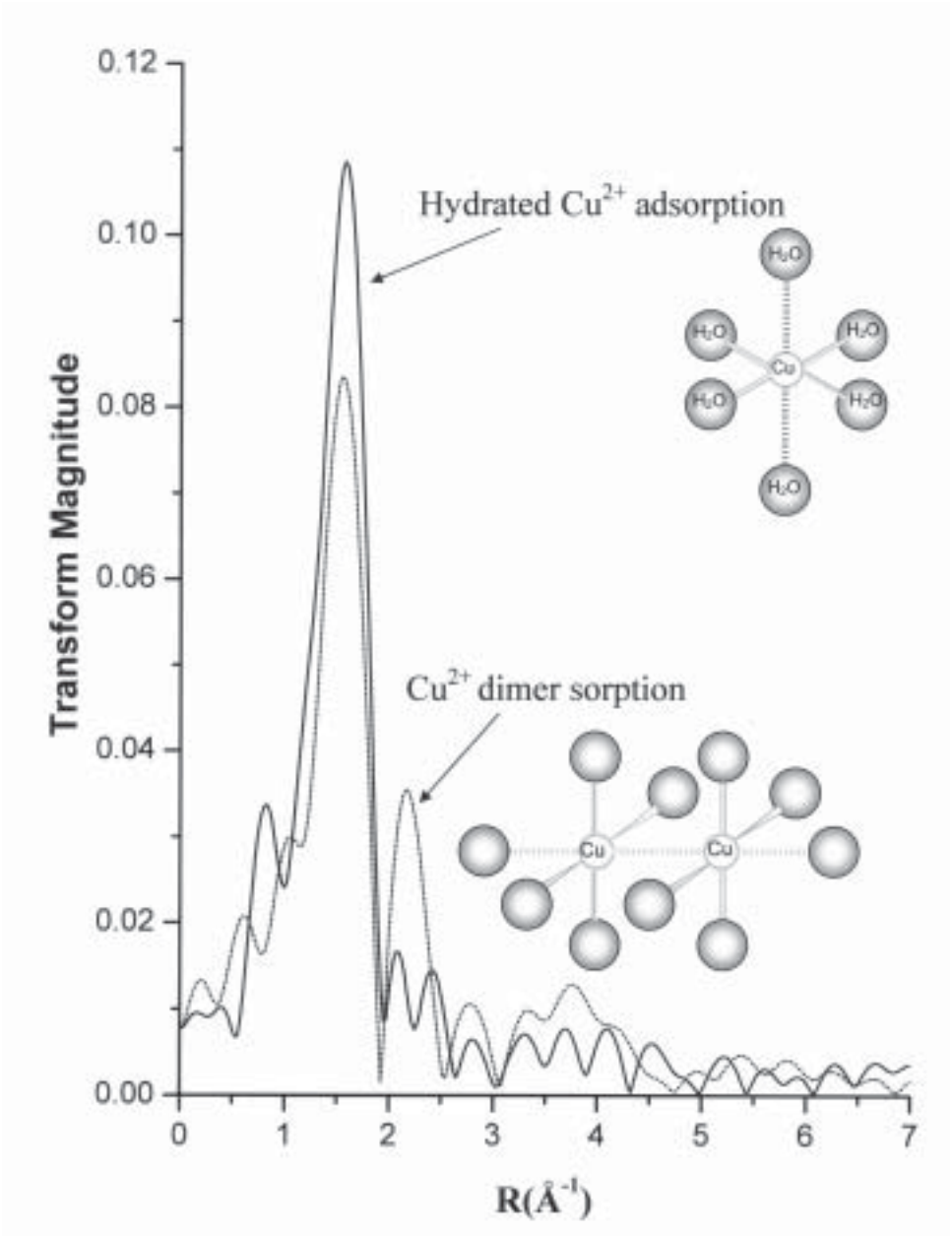
Umiker, K.J., M.J. Morra, and I.F. Cheng. 2002. Aqueous sulfur species determination using differential pulse polarography. Microchem. J. 73:287-297.

Environmental Soil Chemistry
(Daniel G. Strawn, Soil Science, UI)

Since soils are in direct contact with surface waters, plants and animals, and overlie subsurface waters, the biological availability of chemicals is linked to their interactions with soils. Thus, a clear understanding of the biogeochemical cycling processes and reactions occurring in soils is needed for effective management and remediation of contaminated sites. Therefore, the primary goal of the Environmental Soil Chemistry Program at the University of Idaho is to elucidate reaction processes of contaminants in soils. Research projects being undertaken in this lab range from fundamental studies of metal interactions at the solid-solution interface, to studying the mechanisms and effectiveness of remediation processes in metal contaminated environments. Despite the range of projects, they have the common goal to understand reaction processes, such as adsorption and desorption kinetics and equilibrium, and discover the speciation of the reactants, including mineral identification and contaminant complexation. The leader of this group, Dan Strawn, has been awarded a Presidential Early Career Award to carry out this research program.

Figure 3. Taking samples from "peepers" installed in sediments in Lake Coeur d'Alene, Idaho.

To understand the reaction products of heavy metals, such as Cu, with clay minerals this group is using advanced spectroscopic analysis, such as X-ray absorption fine structure (XAFS) spectroscopy and electron spin resonance spectroscopy. Results to date have shown that the layer charge associated with the clay minerals plays an important role in the complexation mechanisms occurring. XAFS spectroscopy is also being used to investigate the plant-soil biogeochemistry of Se uptake in plants grown on contaminated mine sites. This investigation includes the use of micro-XAFS, which is ideal for heterogeneous samples such as soils since the microscopic component allows for focusing on individual aggregates, and the spectroscopic component allows for molecular speciation. In a third project this group is investigating the speciation of in-situ remediated Pb in a wetland, and making associations of this



speciation with bioavailability. Since wetlands are subject to temporal wetting and drying cycles biogeochemical cycling is very dynamic, and requires an investigation into how associated redox processes impact remediation effectiveness.

Strawn D.G., H.E. Doner, M. Zavarin, and S.A. McHugo. 2002. Microscale Investigation into the Geochemistry of Arsenic, Selenium and Iron in Soil Developed in Pyritic Shale Materials. Geoderma. Vol. 108/3-4, pp 237-257.

Strawn D.G., and D.L. Sparks. 2000. Effects of Soil Organic Matter on the Kinetics and Mechanisms of Pb(II) Sorption and Desorption in Soil. Soil Science Society of America Journal. Vol. 64, pp. 144-156.

Strawn D.G., and D.L. Sparks. 1999. The Use of XAFS to Distinguish Between Inner- and Outer-Sphere Lead Adsorption Complexes on Montmorillonite. Journal of Colloid and Interface Science. Vol. 216, pp 257-269.

Geochemical Studies of Hotspot Lavas
(Dennis Geist, Geology, UI)

The petrology and volcanology group at the University of Idaho focuses on the geochemical study of rocks from two of the world's most important hotspot provinces, the Galapagos Islands and the Snake River Plain. The Galapagos is one of the planet's best examples of plume-ridge interaction, because the hotspot lies immediately adjacent to, but not directly on, the nearby mid-ocean ridge. Isotopic and trace element studies in collaboration with Karen Harpp (Colgate), Mark Kurz (WHOI) and Bill White (Cornell) have revealed two-way exchange between the hotspot and ridge, and seem to require a deeply-rooted plume.

Detailed geochemical and geological study of the individual volcanoes also reveals evidence for the evolution of magmas as they pass through the lithosphere and are transported through the magmatic plumbing systems. In 1991, Geist helped lead an oceanographic expedition to explore the submarine part of the archipelago. The Yellowstone-Snake River Plain is the world's best example of a continental hotspot track. Geochemical tracers are used to assess the contributions of different mantle and crustal components in the magmas and evaluate the mantle plume hypothesis. The research group makes use of the analytical facilities at UI and at WSU,

Figure 4. Above. Radial structure functions obtained from EXAFS spectroscopy analysis of Cu sorbed on montmorillonite at pH=6 and different background electrolyte concentrations. At high ionic strength equilibration a distinct second shell is present that is indicative of Cu dimers forming on the surface, while at low ionic strength only a single shell is present, indicating that that the adsorbed Cu is fully hydrated.

Figure 5. Right. Monitoring and sampling active eruptions, like this one at Cerro Azul in 1998, permit evaluation of the geochemical evolution of Galapagos magmas over short time scales.

especially the XRF, oxygen isotope facility, and electron microprobe.

Geist, D, White, WM, Albarede, F, Harpp, KS, Blichert-Toft, J, Reynolds, R, and Kurz, M, Volcanic Evolution in the Galapagos: the Dissected Shield of Volcan Ecuador, Geochemistry Geophysics Geosystems 3, (10), 10611,1029/2002GC000355, 2002.

Geist, D, Sims, E, and Hughes, S, Open-system evolution of a single cycle of Snake River Plain magmatism, GSA Special Paper 353, 193-204, 2002.

Geist, D, Naumann, T, and Larson, PB, Evolution of Galapagos magmas: mantle and crustal level fractionation without assimilation, Journal of Petrology 39, 953-971, 1998.

Kurz, MD and Geist, D, Dynamics and evolution of the Galapagos hotspot from helium isotope geochemistry. Geochimica Cosmochimica Acta 63, 4139-4156, 1999.

Geochemistry of Humic Materials
(Ray von Wandruszka, Chemistry, UI)

Von Wandruszka's group works on the chemistry of humic materials, especially in aqueous solution. They are interested in the aggregation of aqueous humics as it relates to solution conditions such as ionic strength, metal content, pH, and temperature. They use fluorescence spectroscopy, dynamic light scattering, ultrafiltration, HPLC, MPLC, 13C NMR, pyrolysis-GC-MS, and conductivity measurements to study the nature of humic and fulvic acids and their behavior in solution.

They also work on developing methods for using solid humic materials as extractants of contaminants from polluted waters. The focus is on metals such as cadmium and zinc, and their removal via elution through columns filled with solid leonardite humic acid. Recently work has begun on the study of the role of humics in the transport of phosphates from calcareous soils to bodies of natural water, with emphasis on eutrophication in the Snake River basin. An investigation is also underway on the nature of organic materials in sediment cores from the bottom of Lake Coeur d'Alene.

Effects of pH and metals on the surface tension of aqueous humic materials, L.M. Yates and R. von Wandruszka, Soil Sci. Soc. Amer. J., 63(6), 645-1649 (1999).

Decontamination of Polluted Water by Treatment with a Granular Leonardite Blend, Leland M. Yates and Ray von Wandruszka, Environ. Sci. Technol., 33,2076-2080 (1999).

A comparison of aggregation behavior in aqueous humic acids, Christi Young and Ray von Wandruszka, Geochem. Trans., 2 (2001).

Conductometric characterization of dissolved humic materials, Jeremy Riggle and Ray von Wandruszka, Talanta., 57, 519 - 526 (2002).

Geomathematical Modeling
(Monte Boisen, Mathematics, UI)

Monte Boisen is a mathematician who has worked with a number of mineralogists (principally G.V. Gibbs) on several types of problems in mineralogy. He has used mathematical (computer) modeling to predict bulk properties of silicates and has also used simulated annealing strategies to determine likely SiO2 polymorphs. He is currently working to advance the understanding of the mechanisms and properties of bonded interactions in earth materials and representative molecules and to locate, at the atomic level, the surface and internal sites that are susceptible to electrophilic and nucleophilic attack. He is attempting to provide a theoretical basis for modeling surface and internal reactions of earth materials, which may lead to a better understanding of processes involving mineral surfaces.

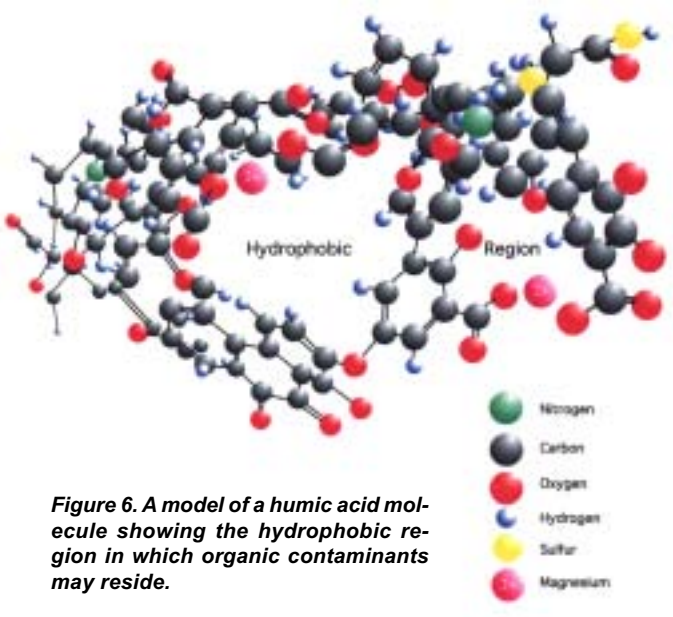


Figure 6. A model of a humic acid molecule showing the hydrophobic region in which organic contaminants may reside.

Geomicrobiology
(Susan Childers, Geology, UI)

Microorganisms are fascinating in that they are able to alter or enhance the physical world around us and thus the focus of the research of Childers' group is to explore the impact of microorganisms and microbial processes upon the environment. In particular, Childers is interested in mineral-microbe interactions between dissimilatory metal-reducing microorganisms and insoluble iron and manganese oxides. Her lab is investigating how microbes recognize and locate insoluble oxides and how they use the oxides for energy generation via respiration. They are also exploring the relevance of microorganisms on the binding and distribution of contaminants such as chromium and uranium to various geological surfaces.

Another area of investigation is the respiration of iron (and sulfur) by thermophilic bacteria. Molecular analyses have demonstrated that thermophiles have been around for billions of years, thus physiological studies of modern-day Fe(III)- and S(0)-reducing thermophiles will further our understanding of the evolution of life on Earth and potentially other planetary bodies. Furthermore, many Fe(III)-reducers are capable of reducing other elemental compounds (i.e., gold, arsenate, uranium, etc.) which leads to the formation of insoluble metal precipitates and implicates the ancestors of modern-day thermophiles as influencing the geochemical composition of primitive Earth. Therefore, Childer's group is investigating how thermophilic Fe(III)- and S(0)-reducing bacteria actually respire these substrates and other metals and metalloids.

Childers, S.E., S. Ciufo and D.R. Lovley. 2002. Geobacter metallireducens accesses insoluble Fe(III) oxide by chemotaxis. Nature 416:767-769.

Childers, S.E. and D.R. Lovley. 2001. Characterization of dissimilatory Fe(III) reduction in the hyperthermophilic archaeon Pyrobaculum islandicum. FEMS Microbiol. Lett. 195:253-258.

Noll, K.M. and S.E. Childers. 2000. Sulfur metabolism among hyperthermophiles. In Journey to Diverse Microbial Worlds. Adaptation to Exotic Environments in the series "Cellular Origin and Life in Extreme Habitats", J.Seckbach, ed., Kluwer Academic Publishers, Dordrecht, the Netherlands.

Heavy-Element Stable Isotope Geochemistry
(Peter Larson and Frank Ramos, Geology, WSU)

Recent advances in MC-ICPMS now allow for routine, highly precise and reproducible measurements of transition metal isotopes. At WSU, the Finnigan Neptune MC-ICPMS is used to analyze isotopes of various metals, including Cu, Fe, and Mo, to trace the sources and processes responsible for generating isotopic fractionation in these systems.

Cu isotope variations in high-temperature geologic environments. This group is currently investigating the distribution of Cu isotopes in magmas and ore-forming hydrothermal systems with the ultimate goal of understanding the metal sources of ore components in these systems, and the mechanisms by which metals are transported and deposited (Larson et al., 2003). The research, in conjunction with work from other laboratories, has demonstrated that significant and measurable Cu isotope ratio variations exist in hydrothermal systems. However, many questions need to be addressed before we can achieve the ultimate goal of defining metal sources. This group is focusing on the following questions: 1) What are the Cu isotope ratios in natural reservoirs from which Cu may be derived? 2) What controls Cu isotope fractionation among phases in geologic environments (redox, speciation in solution, and/or temperature)? The current research focuses on a range of geologically well-known ore deposits (Maher et al., 2002; Larson et al., 2002)

Fe Isotope variations in sulfides and biological systems. Larson and Ramos are currently addressing fundamental questions to ascertain whether Fe isotopes are fractionated in geological systems such as hydrothermal ore deposits. In addition, collaborative projects with outside scientists are addressing whether or to what degree modern organisms fractionate Fe isotopes.

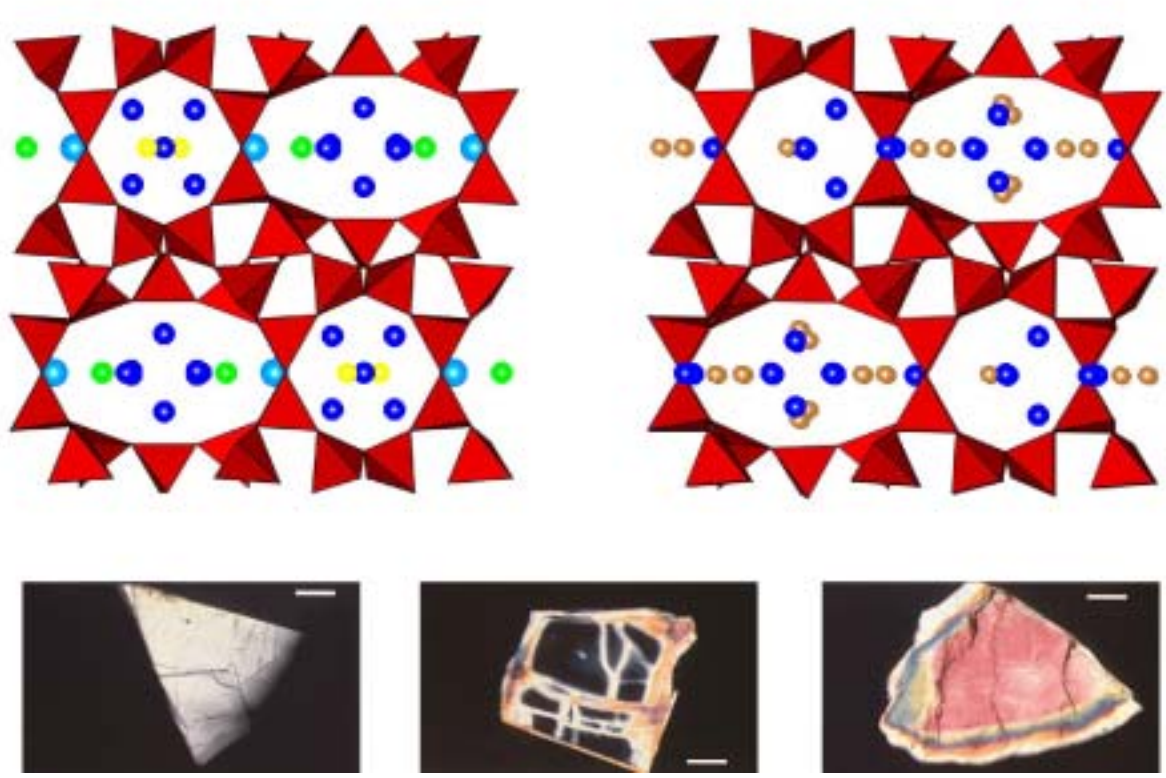


Figure 7. Crystal structures of a natural (top left) and Pb-exchanged (top right) heulandite zeolite. The blue atoms represent water, yellow Ca, light blue K, green Na, and brown Pb viewed down c axis. At bottom are three photomicrographs taken in cross-polarized light of a the natural heulandite (left), a partially Pb-exchanged sample (center), and a fully Pb-exchanged sample (right). (All samples are resting on (010) and the scale bars are 100 microns.) Pb exchange greatly increases the retardation, thus retardation can be used to show areas of Pb-exchange and to determine cation diffusion as can be seen in the center image were Pb has exchanged along the grains edges and cracks. Images modified from Gunter et al. (1994) Am. Mineral. 79, 675-682.

Mo fractionation in nature. The group is in the initial stages of defining settings in which Mo isotopes may be fractionated. The current database confirms a range of Mo isotope signatures in nature, especially in oceanic hydrothermal settings. Current research focuses on continental hydrothermal systems and ore deposition. The group aims to incorporate and integrate multiple trace systems to delineate the processes involved in trace metal fractionation.

Larson, P.B., Maher, K., Ramos, F.C., Chang, X., Gaspar, M., and Meinert, L.D., Copper isotope ratios in magmatic and hydrothermal ore forming environments. Chemical Geology, 2003, submitted.

Larson, P.B., Ramos, F.C., Maher, K., Gaspar, M., Chang, Z., Meinert, and Wolff, J.A., 2002, Cu Isotopes: Tracing metal sources in ore deposits, Geochim Cosmochim Acta, v. 66, p A432.

Maher, K., Larson, P.B., Ramos, F.C., Chang, X., Gaspar, M., 2002, Insights into ore deposit genesis using copper isotopes, AGU Transactions, v. 83, Number 47, p F1499.

Hydrogeochemistry
(Kent Keller and Richelle Allen-King, Geology, WSU)

This group works on the relationships between physical and biogeochemical processes in vadose and shallow groundwater environments. Current research questions include: what are the mechanisms by which vascular plants control the chemical denudation of the continents? Can we employ hydrologic tracers to better understand the hydrogeochemistry of fertilizer nitrogen? How does the heterogeneity of sorption phenomena affect the transport of organic contaminants in groundwater? Our experimental systems include laboratory microcosms, experimental ecosystem mesocosms, and agricultural watersheds.

Light-Element Stable Isotope Geochemistry
(Peter Larson and John Wolff, Geology, WSU)

Stable isotope investigations of magmatic processes on Tenerife, Canary Islands. Spain. Oxygen isotope ratios of hydrothermally altered crust can provide a significant fingerprint for assimilation in crustal magmas. Assessing the role of assimilation is particularly important in oceanic island settings because the interpretation of variations in mantle geochemistry, and hence, mantle heterogeneity, are often dependent on the assumption that OIB magmas are uncontaminated. Tenerife is a natural laboratory where hydrothermally altered wall rocks can be sampled and their elemental concentrations and isotopic ratios can be measured. Additionally, excellent exposures of the volcanic stratigraphy provide an opportunity to examine the geochemical evolution of complex magma systems in detail. Oxygen and hydrogen isotope ratios of evolved volcanic rocks on Tenerife indeed vary beyond the limits predicted solely by fractional crystallization models, and indicate that assimilation is a significant process in their evolution.

The role of uplift in the Cascade range in controlling paleoclimatic variations in eastern Washington. Currently, eastern Washington lies within the rain shadow of the Cascade range. Orographic uplift over the Cascade range controls the amount of rain-out an air mass experiences prior to moving over eastern Washington. The magnitude of prior rain-out is manifest in the stable isotope ratios of precipitation that falls from these air masses. In turn, these ratios control the stable isotope ratios of minerals produced by surficial weathering. Thus, the stable isotope ratios of minerals in paleosols in eastern Washington reflect whether the Cascades were high or low during the period when the weathering occurred. This recently initiated research focuses on

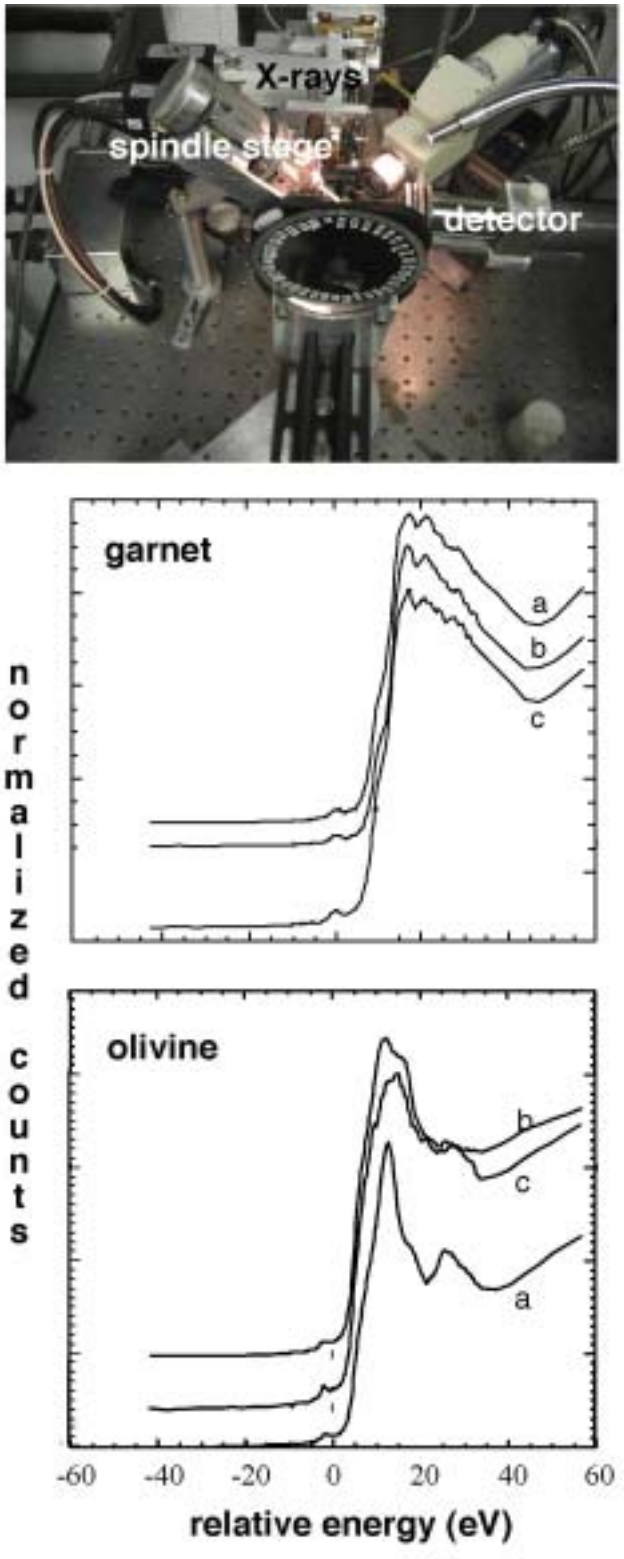


Figure 8. Left. Photograph of a modified spindle stage mounted on beamline X26a at the National Synchrotron Light Source. The spindle stage is used to orient a single crystal to ascertain the orientational dependence of their X-ray absorption spectra. XANES (X-absorption near-edge structure) spectra of a garnet and olivine with the polarized X-ray beam coinciding with the a, b, and c crystallographic axes. As would be predicted based on symmetry, the spectra for garnet do not vary with orientation, while those for olivine do. From Dyar et al. (2002) Am. Mineral. 87, 1500-1504.

measuring the stable isotope ratios of clays and other minerals purified from many paleosols from flow tops and interbeds in the Miocene Columbia River Basalts, and younger and older sedimentary units, in eastern Washington.

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Wolff, J.A., Grandy, J.S. & Larson, P.B., 2000. Interaction of mantle-derived magma with island crust? Trace element and oxygen isotope data from the Diego Hernandez Formation, Las Ca–adas, Tenerife. J. Volcanol. Geotherm Res. 103, 343-366.

Mineralogy
(Mickey Gunter, Geology, UI)

Gunter's research interests are in optical mineralogy, both classical techniques and development of new methods, crystal chemistry and crystal structure of natural and cation-exchanged zeolites, and the health effects of inhaled mineral dusts. His graduate students are employed in areas as diverse as international gemstone development, asbestos characterization, and academia. Along with the above research, he is also interested in development of new methods in teaching mineralogy. Currently he is a Mineralogical Society of America Distinguished Lecturer giving lectures on health effects of mineral dust and current trends in research using light microscopy.

Gunter's optical mineralogy research has recently led to new methods to observe cation exchange in zeolites with the aid of the polarizing light microscope (PLM). Integration of the spindle-stage methods with the SEM, as developed by one of his graduate students, led to a better method to characterize amphibole-asbestos. Also, integration of the spindle stage with synchrotron radiation clearly showed the orientational dependence of X-ray absorption spectra for optically anisotropic minerals, and direct observation of the X-ray absorption indicatrix. Gunter's research in health effects of mineral dust are concentrated in the areas of characterization of background dust levels, especially quartz concentration, and characterization of the asbestiform and non-asbestiform amphiboles from the former vermiculite mine near Libby, Montana. Also, in collaboration with Scott Wood and PhD student Anne Taunton, he is trying to determine the fate of minerals once inhaled into the lung.

Armbruster, T. and Gunter, M.E. (2001) Crystal structures of natural zeolites. In Reviews in Mineralogy and Geochemistry, Natural Zeolites: Occurrence, Properties, Applications, 45, 1-68.

Bandli, B.R. and Gunter, M.E. (2001) Identification and characterization of mineral and asbestos particles using the spindle stage and the scanning electron microscope: The Libby, Montana, U.S.A. amphibole-asbestos as an example. The Microscope, 49, 191-199.

Dyar, M.D., Gunter, M.E., Delaney, J.S., Lanzarotti, A., and Sutton, S.R. (2002) Systematics in the structure and XANES spectra of pyroxenes, amphiboles, and micas as derived from oriented single crystals. Canadian Mineralogist, 40, 1347-1365.

Gunter, M.E. and Twamley, B. (2001) A new method to determine the optical orientation of biaxial minerals: A mathematical approach. Canadian Mineralogist, 39, 1701-1711.

Knudsen, A.C. and Gunter, M.E. (2002) Sedimentary phosphates-An Example: Phosphoria Formation, Southeastern Idaho, U.S.A. In Reviews in Mineralogy and Geochemistry, Phosphates: Geochemical, Geobiological, and Materials Importance, 48, 363-389.

Petrology/Geochemistry
(John Wolff, Frank Ramos, and Charles Knaack, Geology, WSU)

The WSU GeoAnalytical Lab has a long history of providing high-quality XRF and ICPMS major and trace element rock analyses to the geological community. In 2003, the old XRF will be replaced with a current-generation instrument (ThermoARL AdvantXP+), which, in conjunction with an Agilent quadrupole ICPMS, will enable continuation of this sevice into the forseeable future.

With the recent acquisition of the Finnigan Neptune MC-ICPMS and High Resolution Element2 ICPMS and New Wave UP213 ultraviolet laser, the petrology/geochemistry group has moved into applying innovative isotope and trace element applications to constrain the petrogenetic history of volca-

nic rocks. Specifically, in-situ laser ablation, microdrilling, and single grain analysis are employed to sample phenocrysts in both mafic and silicic systems. Integration of radiogenic and stable isotopes with trace element signatures of rock components such as minerals and groundmass offers insight into the history of volcanic rocks which cannot be ascertained by conventional whole-rock analyses.

Applications have focused on single grain or laser ablation microsampling of phenocrysts in volcanic rocks to track open-system influences during petrogenesis. Current research includes identifying and constraining the effects of crustal contamination on Columbia River flood basalts using in-situ laser ablation analysis of Sr isotopes in plagioclase and clinopyroxene (Tollstrup et al, 2002). Single grain and laser ablation studies of Pb and Sr isotopes in potassium feldspar and quartz phenocrysts from high silica rhyolites at Valles caldera have been undertaken to address, and dismiss, the hypothesis that in-situ aging is responsible for highly variable Sr isotope signatures in phenocrysts (Wolff and Ramos, 2003). In addition, this group has generated the first-published Sr isotope data from single melt inclusions in olivine in continental basalts, which suggest that melt inclusion compositions are highly affected by secondary magmatic processes such as crustal contamination (Ramos and Wolff, 2002).

Ramos, F.C., Reid, M.R., and Wolff, J.A., 2002, Constraining Open-system Processes in the Generation of Basaltic Magma Using 87Sr/86Sr of Individual Melt Inclusions, Pisgah Crater, Ca, AGU Transactions, v. 83, Number 47, p F1493.

Tollstrup, D.L., Ramos, F.C., and Wolff, J.A., 2002, Short Timescales for Crustal Residence, Transport and Contamination of Flood Basalt Magma: Crystal Isotope Stratigraphy of the Columbia River Basalt Group, AGU Transactions, v. 83, Number 47, p F1460.

Wolff, J.A. and Ramos, F.C., 2003, Pb isotope variations among Bandelier Tuff feldspars: no evidence for a long-lived silicic magma chamber, Geology, submitted.

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Wolff, J.A., Ramos, F.C., and Davidson, J.P., 1999, Sr Isotope Disquilibrium among Glasses and Phenocrysts in the Otowi Member of the Bandelier Tuff (Valles Caldera, New Mexico): Insights into Crystallization and Contamination Mechanisms in a Silicic Magma Chamber; Geology, v.27, 495-498.

Radiogenic Isotope Geochemistry
(Jeff Vervoort, Geology, WSU)

This group uses an integrated isotopic approach to address a wide range of geologic problems in diverse terrestrial and extraterrestrial materials. The approach is to employ low-blank chemical separations on rocks and minerals and analyze their isotopic compositions (Lu-Hf, Sm-Nd, Rb-Sr, Pb) in elementally pure samples (or nearly so) with the ThermoFinnigan MC-ICP-MS. The group concentrates on keeping samples as free from isobaric interferences and matrix effects as possible to produce unambiguous, high-precision analyses on the MC-ICP-MS.

Current on-going research in this group includes: 1) Hf-Nd-Pb isotope and trace-element geochemistry of marine sediments and, in particular, the isotope and trace-element signature of the sediment flux into subduction zones around the world (Vervoort and Plank, 2002; Vervoort et al., 2002; collaborative NSF project with Terry Plank, Boston University); 2) High field strength element (HFSE) and Lu-Hf isotope behavior in volcanic rocks of the Aleutian arc. This NSF funded project will examine the relationship between spatial HFSE and isotopic trends in the Aleutians with tectonic setting, rates of subduction, magma output, and sediment delivery to the trench (collaborative NSF project with Gene Yogodzinski, University of South Carolina); 3)

Investigation of the combined Lu-Hf and Sm-Nd isotopic composition of ordinary and carbonaceous chondrites and their relevance for determining Hf-Nd isotopic composition of bulk silicate Earth (collaborating with Jon Patchett and Ulf S derlund, University of Arizona; Vincent Salters, Florida State University; Janne Blichert-Toft, ƒcole Normale Sup rieure, Lyon, France); 4) Lu-Hf and Sm-Nd analysis of garnet-bearing assemblages to determine the timing of metamorphism (closure); 5) Isotopic and trace-element constraints on the magmatic evolution of the Midcontinent Rift System (Vervoort et al., 2000, 2001; collaborator: Karl Wirth, Macalester College); 6) Hf-Nd isotopic composition of Earth's reservoirs (Vervoort et al., 1999; 2000) and Hf-Nd-Pb isotopic evolution of the crust and mantle through time (Vervoort and Blichert-Toft, 1999); 7) Hf isotope composition and U-Pb geochronology of zircons to provide integrated age and tracer information on single zircon grains; 8) Sr-Nd-Pb-Hf isotopic investigations to address regional petrogenetic/tectonic/geologic problems in conjunction with students at WSU and UI. In addition this group is involved as a collaborator in the following projects: a Lu-Hf and Sm-Nd isotopic study of eucrites (with Janne Blichert-Toft and Francis Albar de, ENS-Lyon); a study of the Sr and Nd isotopic composition of thermal springs (with Scott Wood, UI); and Sr-Nd-Pb isotopic constraints on petrogenesis in the Talkeetna Mountains, Alaska (with Dennis Geist, UI).

A new direction being developed at WSU (in collaboration with Bill McClelland, UI and Charles Knaack, WSU) is U-Pb geochronology using laser ablation in conjunction with the ThermoFinnigan Element2 high resolution ICP-MS. Currently it is possible to determine U-Pb zircon ages with about 2% accuracy with a 30-second laser analysis. The application for this exciting new technique will be detrital zircon geochronology and reconnaissance geochronology for quick screening of geological samples of unknown age.

Albar de, F., Blichert-Toft, J., Vervoort, J.D., Gleason, J.D., and Rosing, M., 2000, Hf-Nd isotope evidence for a transient dynamic regime in the early terrestrial mantle. Nature, v. 404, p. 488-490.

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Vervoort, J.D., Patchett, P.J., Blichert-Toft, J., and Albar de, F., Downes, H. and Rudnick, R., 2000, Hf-Nd isotopic evolution of the lower crust. Earth and Planetary Science Letters, v. 181, p. 115-129.

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U-Pb Geochronology
(McClelland, Geology, UI)

McClelland utilizes U-Pb geochronology to establish timing relationships and rate information for a variety of tectonic, base and precious metal mineralization, and petrologic processes. Both conventional U-Pb analyses using the TIMS facility at the University of California, Santa Barbara through collaboration with J. Mattinson, and ion probe analyses using the SHRIMP-RG facility at the SUMAC Laboratory, Stanford University through collaboration with J. Wooden, are employed in research projects of this group. Currently funded geochronology projects address the (1) timing of formation and exhumation of UHP and HP terranes in the northeast Greenland Caledonides, (2) timing of Early Paleozoic tectonic events in the easternmost Precordillera terrane, Argentina, (3) age and lithogeochemistry of volcanic-hosted massive sulfide deposits of the Ambler district, southern Brooks Range, Alaska, (4) deformation rates of ancient and active displacement transfer in the Central Walker Lane, Western Great Basin, and (5) timing of hydrothermal vein emplacement and gold mineralization, Venezuela.

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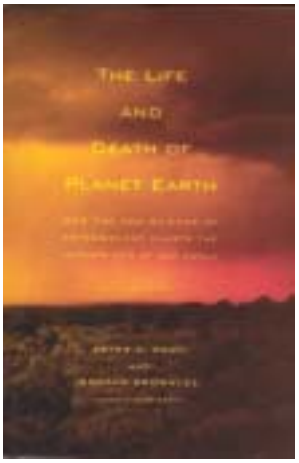


Well Done Earth

Review: *The Life and Death of Planet Earth* by Peter Ward and Donald Brownlee

Review by Johnson R. Haas

Some say the world will end in fire,
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To know that for destruction ice
Is also great
And would suffice.

- Robert Frost

Both will suffice, it seems. Perhaps better named The Slow, Lingering Death of Planet Earth, with only a touch more fatalism, *The Life and Death of Planet Earth*, by Peter Ward and Donald Brownlee, guides the reader on a Wellsian journey through the future history of our planet as portended by modern astrobiology and geochemistry. On the trip we visit a near tomorrow cowering in the dry shadows of advancing glaciers, then glide forward to a drab Earth, where the last green plants suffocate as a swelling Sun's humid heat weathers the last traces of CO2 from the air. Further still, to a quiet Earth after animal life has faded away with the last of the fossil oxygen. Forward, to a germy Earth of stromatolites and greasy bacterial mats, under a fat orange Sun and hideous heat. Forward, to a crumbling world of endless blazing saltflats, after the oceans have drifted away one hydrogen at a time. Forward, finally, to the ultimate incineration of the solid Earth by a bloated, lashing Sun.

Fun stuff. And it gets better: there's no escape, because the voids of interstellar space are nearly impossible for our species to cross, and no local refuge will suffice when, some 6 billion years from now, the Sun's livid corpse finally erupts in a scorching wave of incandescent plasma bright enough to evaporate Pluto. Off to the beach, shall we?

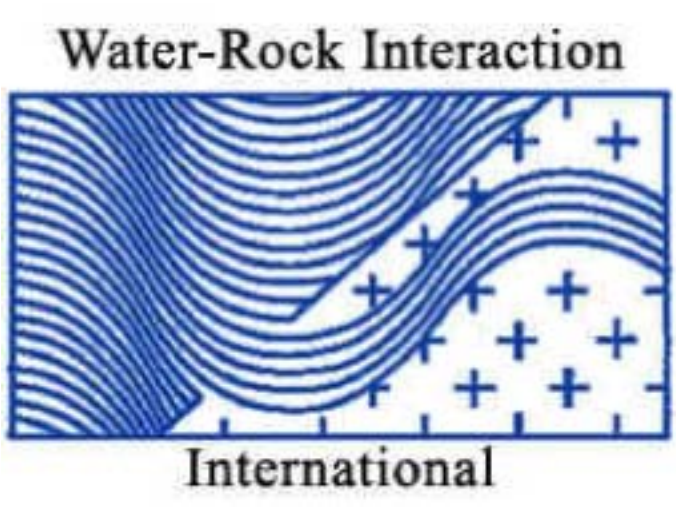
As a sequel of sorts to *Rare Earth*, in which the authors hold up a pretty good case why complex, i.e. metazoan, life should be highly exceptional in the Universe, this offering essentially cements the authors' developing reputations as pessimists. At least to some readers. To those of us who are far more interested in nature's plot, rather than whether our species gets billing above the title, this book is a provocative and entertaining story of how this place winds up. The tight focus on our own solar system and our own world over geologic time makes this book unusual and valuable. Any bookshop can supply a load of popular titles discussing dark matter, cosmic inflation, or the fate of the universe: interesting topics, but remote from our Earthly concerns. Conversely, popular environmental writings tend to focus on the near-term, giving readers a strong sense of how our species has ruined things, but little grasp of how anthropogenic havoc stacks up against the slings and arrows that Nature herself has used before in deep history and will use again in the high future.

In *Life and Death*, Ward and Brownlee show us that the story of Earth is an arc, not a ladder. The world began in a seething inferno of impacts and gouting brimstone, matured through a long bacterial childhood, and recently bloomed into a heady springtime of frantic metazoan evolution, just lately coming up with a talking primate that can make stuff and do a little math. But it's later than you think. Ward and Brownlee make a strong case that instead of early springtime, our species has come along just at the end of the high season, and the cafes are about to close.

First, we've built our civilization between glacial episodes, like a desert nomad building his house in a dry wash, without acknowledging the spring floods will come back. When the glaciers come back – and they will – most of our achievements will be scrubbed away by the planing ice. But that's just the near future. Eventually the ice will melt, but then can we look forward to a Postanthrozoic Era of steadily climbing biodiversity and ecological productivity? No. Because biological productivity likely reached its zenith back during the Carboniferous, when amospheric CO2 was at its Phanerozoic height, and since then it has leaked away permanently into limestone. Worse, our brightening Sun has forced CO2 levels to steadily drop, through the CO2-silicate weathering system. In a few hundred million years CO2 will drop too low to maintain even C4 oxygenic photosynthesis, and our green world will muddy. Literally, because as plants recede so will their roots, and muddy runoff will wash away the world's soil. Without plants or soil or oxygen, animals will simplify and then die back, until the Earth looks like it did during the Precambrian; desolate, rocky, lurid with bacterial mats, and really alive only at sea. But without CO2, phytoplanktonic photosynthesis will wind down, too, leaving only bacteria to populate the planet. Eventually, two or three billion years from now, the expanding Sun will warm the Earth enough to dramatically accellerate the escape of water vapor to space. From that point on, the oceans will vanish away, making Earth a temporary haven for hyperthermophilic extreme halophiles. At that point we'll either broil in a runaway water-vapor greenhouse, or parch into a glistening planet of crystalline salt. Either way, once the air temperature reaches the critical point for water, life ends. Forever. Then it's a just a long wait until Earth is physically swallowed by a growing red Sun.

All this is laid out in a series of chapters devoted to each major biogeochemical or astrobiological 'death' our world experiences. As the authors point out, our world will not end all at once, but bit by bit, as biogeochemical systems fall apart from age or perturbation. Ward and Brownlee comment on the possibility that a big future impact could finish life at a stroke, as could any number of exotic threats, such as passing neutron stars or nearby supernovae. But their intent is to focus not on possible catastrophes, but on inescapable ones. The popular imagination seems to hold that Earth has a natural history of some violence, but that's essentially over now that we're in charge, and we'll take care of things from now on, thank you very much. At best, the public accepts that weird things like the K-T impact could happen again, but that the Earth (and us) would heroically survive anything Nature throws at us. This book argues that natural history is not over yet, but that it will eventually end, and in a series of whimpers that we will be utterly powerless to remedy.

In the final chapter, the authors make a brief but cogent argument that not only is the planet nearing retirement, but that it's really not very likely we'll be moving off to a condo at Alpha Centauri. Science-fiction thrives on interstellar colonization fantasies, but the stark reality is that if we can't stop ecological collapse, end starvation, and enrich the lives of six billion humans right now, with the prodigious technologies already in hand, it's pretty foolish to fantasize about colonial starships, whose design and construction would require financing by most of the world's industrial economic output, and whose destinations would likely include only dead, distant, hostile worlds. What would we do there? After all, there aren't too many thriving self-sufficient cities on Ellesmere Island, or Antarctica. And colonization would be easy compared with actually terraforming a sterile rock like Mars. Perhaps, the authors artfully suggest, we ought to first re-terraform our own planet, and enjoy it while we can.



Thirty Years of Water-Rock-Human Interactions

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The Eleventh International Symposium on Water-Rock Interaction (WRI-11), with Prof. Susan L. Brantley (Penn State University) as Secretary General, will be held June 27-July 2, 2004, in Saratoga Springs, New York, USA. We are expecting 400-500 geochemists, geologists, hydrologists and other earth scientists and close to 100 accompanying members from about 40 countries to attend this symposium. Almost 30 years earlier (9-14 September, 1974), WRI-1 was convened in Prague (Czech Republic), with Dr. Tomas Paces as Secretary General. Nearly 150 participants from 21 countries that included many students attended the four days of technical sessions and close to 100 also visited thermal and mineral springs on three days of field trip to northwestern Bohemia. The combination of excellent technical sessions, printed proceedings, and interesting and well-organized field trips lasting several days, together with enjoyable social and cultural programs for the scientists and the accompanying members created an atmosphere of informality and easy communication among the participants. As pointed out by Brian Hitchon (the Group Chairman, 1974-1986), the "spirit of WRI"-encouraging scientific communications and human interactions among the international participants - "was born in Prague and has ensured the continuation and expansion of WRI" (Hitchon, 1989).

Viission of Water-Rock Interaction

As related by Hitchon (1989), the idea for a Working Group on Water-Rock Interaction (WRI) within the International Association of Geochemistry and Cosmochemistry (IAGC) originated with the late Prof. Mikhail G. Valyashko, who held the Chair of Geochemistry at Lomonsov State University, Moscow. During the International Symposium on Hydrogeochemistry and Biogeochemistry (Tokyo, Japan, September 1970), he organized a small group of interested geochemists and proposed setting up six working groups, including WRI to "study water-rock interaction under various temperature and pressure conditions, compile key programs, develop methods, and determine transportation forms of components."

The late Donald E. White (USA) (Fig. 1) was appointed the first Chairman of the Working Group on WRI. He initiated a mailing campaign, and by June 1971 had contacted more than 260 geochemists worldwide to ascertain their interests in a wide variety of topics under the broad heading "water-rock interaction." This resulted in the creation of nine Interest Groups: On the four PT environments in which water-rock interaction takes place, on active geothermal systems, on membrane filtration, and three groups concerned with experimental and theoretical approaches. These Interest Groups were to serve WRI for more than a decade. Although each Interest Group chairman exchanged information with members of his group, contacts between the Interest Groups were generally lacking, and WRI itself lacked cohesion and focus. It was Tomas Paces (Czech Republic) who put that focus into place.

During the 24th IGC (Montreal, Canada), Drs. White and Hitchon convened an informal meeting of WRI (known as WRI-0) on 23 August 1972, and 16 people met to discuss the future of WRI, including Earl Ingerson (President, IAGC), Ken Sugawara (Secretary, IAGC) and M.G. Valyashko (USSR.). There was no agenda, and this informality has been characteristic of WRI ever since. Discussions were held on the future directions of WRI, and on the desirability of a publication and the need for specialized meetings on hydrogeochemistry. Josef Cadek (Czech Republic) presented a proposal suggested by Tomas Paces to hold an international symposium on water-rock interaction in Prague. As discussed above, WRI-1 would set the focus needed for the next three decades by launching a series of triennial WRI Symposia.

WRI-1 through WRI-10

The main function of the Working Group on WRI is to organize international symposia that are held every three years, generally in different countries and are co-sponsored by various national earth-science associations, universities, academies of sciences, private and governmental agencies, as well as the IAGC, the parent organization that is affiliated with the International Union of Geological Sciences (IUGS). The symposia are organized by National WRI Organizing Committees, headed by the Secretary General, who is nominated by the Working Group, but selected by the vote of all the members present at the general business meeting of WRI. The names of the Secretary Generals for the past Symposia, venues, etc., are listed in Table 1. These scientists, together with Brantley comprise the Executive Members of the Working Group on WRI, with the author as the present Chairman. For more details about our Working Group, please visit WRI web site at: "http://wwwrcamnl.wr.usgs.gov/wri/index.html".

Table 1- Pertinent data on the completed WRI Symposia.

Symposium	Year	Participants	Venue	Secretary General
WRI-1	1974	148	Prague (Czechoslovakia)	Tomas Paces
WRI-2	1977	236	Strasbourg (France)	Yves Tardy
WRI-3	1980	145	Edmonton (Canada)	Brian Hitchon
WRI-4	1983	210	Misasa (Japan)	Hitoshi Sakai
WRI-5	1986	250	Reykjavik (Iceland)	Halldor Armannsson
WRI-6	1989	350	Malvern (United Kingdom)	Mike Edmunds
WRI-7	1992	576	Park City (USA)	Yousif Kharaka
WRI-8	1995	260	Vladivostock (Russia)	Oleg Chudaev
WRI-9	1998	287	Taupo (New Zealand)	Brian Robinson
WRI-10	2001	480	Cagliari, Sardinia (Italy)	Luca Fanfani

Our Group strives to increase participation of attendees at WRI Symposia, especially students and earth scientists from developing countries. Brian Hitchon (Group Chairman, 1974-1986) in particular was instrumental in increasing WRI membership, which reached nearly 1000 registrants from about 50 countries in 1983. The attendees of the general business meeting of WRI-4 in Misasa (Japan) however, voted to discontinue the registration rosters, as well as the Interest Groups and the National Contacts - members wanted the Group to remain informal and to concentrate its efforts on the WRI Symposia.

After Misasa (1984), the number of participants at WRI Symposia continued its upward trend (Table 1). This increase, undoubtedly, results from the tremendous efforts of the Secretary Generals and their National Organizing Committees. Every Secretary General has been able to raise funds, at times substantial amounts, from private and governmental sources to offer complete or partial scholarships to students and participants from developing countries. I believe we are making progress on these issues, judging from attendance at WRI-10 that attracted participation from 45 countries and about 15% students. I also believe that

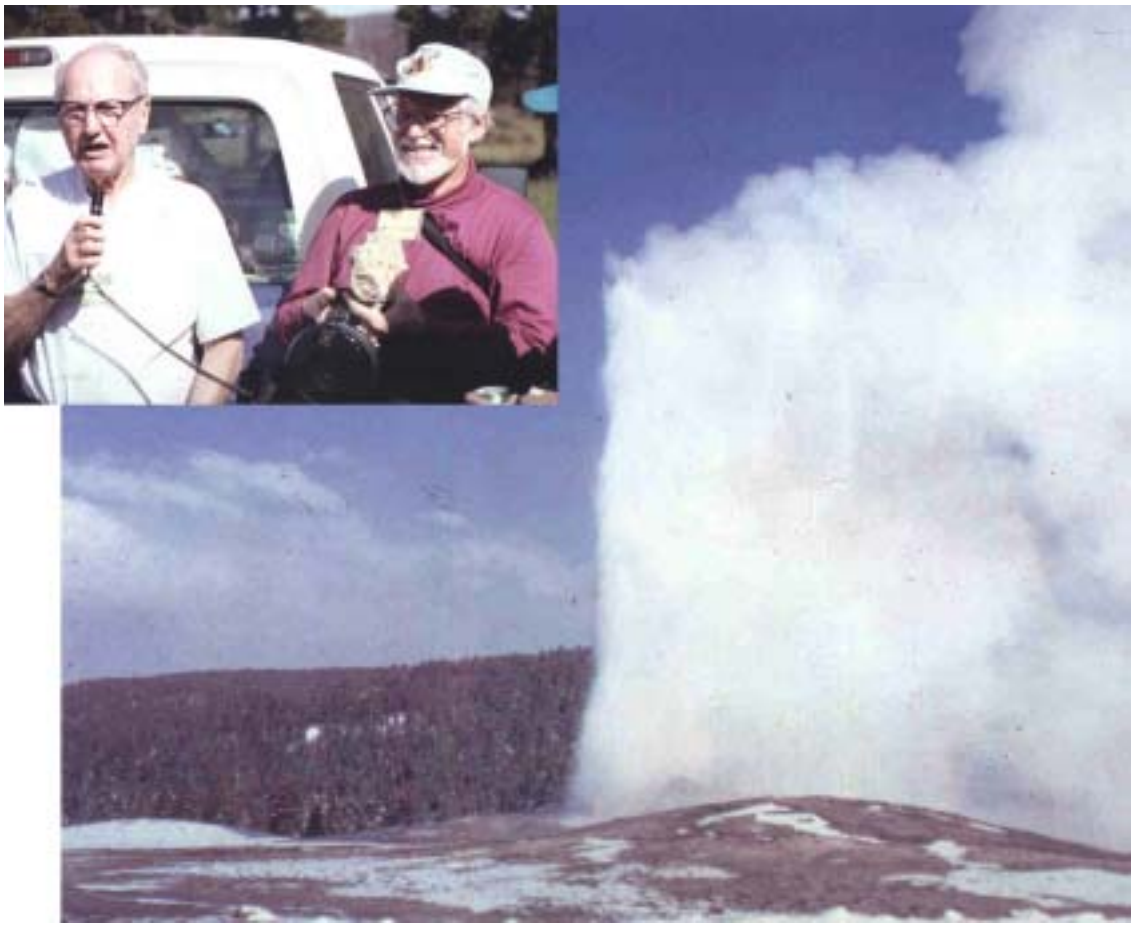

Figure. 1. Photo of the late Donald E. White, one of the founding fathers of the Working Group on Water-Rock Interaction and the first Group Chairman, explaining the thermal features of Norris Geyser Basin to the attendees of WRI-7 field trip to Yellowstone National Park, July 1992. Robert Fournier, the field-trip leader, is clearly satisfied with Don's remarks. The photo is superimposed on an eruption of the Old Faithful, one of Don's favorite Yellowstone geysers.

more effort is needed, especially with regard to attracting more participants from Africa, South America and the Arab countries.

Each WRI has had its highlights and its national flavor, but as the Secretary General, WRI-7 held in 1992 at Park City, USA, will always be my favorite Symposium. Of the remaining seven that I have attended, WRI-4, held at Misasa, Japan, in 1983, with Hitoshi Sakai as Secretary General, was probably the most memorable Symposium. Science, scenery, sake, sushi, sashimi and the sincerity of our hosts set the scene (Hitchon, 1989). There was a large-format daily newspaper, the Misasa Messenger, a mid-session field trip to the Daisen Volcano, and a post-session field trip that included visits to the Ningyo-toge uranium mine, the Hakone and Fuji Volcanoes and a host of temples, shrines and spas.

WRI-8, held September 1995 in Vladivostok, Siberia, with Oleg Chudaev as Secretary General, was the most challenging to organize as it happened at the same time that the Soviet Union was unraveling. Chudaev and his Organizing Committee, with some support from members of the Working Group, however, managed to stage one of the most satisfying WRIs for 260 attendees from 30 countries. For me the highlights were the field trips to the magical Lake Baikal, Siberia and the breathtaking scenery and hydrothermal features of Uzon Caldera and Geyser Valley Kamchatka.

The last Symposium (WRI-10) was held at the Mediterranean resort "Tanka Village" Congress Center in Villasimius (Sardinia, Italy), with Luca Fanfani as Secretary General. As expected, this was a popular Symposium, attracting about 500 participants from 45 countries. At registration, we received two hard-cover proceeding volumes, edited by Prof. Rosa Cidu (U. of Cagliari) and published by A. A. Balkema, that include a record 380 papers and a total of 1607 printed pages. The Symposium was preceded and followed by three different field trips to the famous geological, volcanic and mining sites in and around Sicily, North Sardinia and Naples. Those participating in the post-session field trip were treated to spectacular eruptions of Mount Etna (Fig. 2) and the dazzling night time fireworks of Stromboli. Also, several one-day long mid-session field trips to the geological and mining sites in southern Sardinia were organized for all WRI-10 attendees.

Invitation to WRI-11, June 27-July 2, 2004

Susan Brantley, The Secretary General for WRI-11 invites all of you to join us in beautiful Saratoga Springs, NY to discuss all aspects of Water-Rock Interaction. She is being assisted in planning the Symposium by Penn State Conferences & Institutes, which will coordinate registrations, marketing and program logistics, the Saratoga Convention and Visitors Bureau, which will handle hotel reservations, and members of the WRI-11 Organizing Committee.

The important dates to remember (Table 2) and information about the proposed sessions, field trips, etc. may be obtained from the WRI-11 web site at: "http://www.outreach.psu.edu/C&I/WRI". Note in particular the date of 15 October 2003, the deadline for submission of extended abstracts and early registration. For additional information about conference registration, please contact: "ConferenceInfo2@outreach.psu.edu".

Table 2. WRI-11 Proposed Schedule.

08/03	Second circular distributed as pamphlet and email. Circular will contain information about extended abstract, deadlines, and specific symposia.
09/03	Email letter only, reminding participants about specific symposia, giving details for extended abstracts, and advertising speakers and keynote titles.
10/15/03	Extended abstract and early registration deadline
02/03/04	Late registration deadline
03/15/04	Third circular with tentative program posted on web
06/04	Fourth circular given out at meeting as the Program (print)
6/27/04	Books of extended abstracts distributed at registration

Extended abstracts and early registration are due October 15, 2003. Rich Wanty and Robert Seal (USGS) are in charge of the abstract submission and review. The extended abstracts are reviewed and published in hardcopy volumes that are often highly cited. Publication is by A. A. Balkema, now a WRI tradition that was started by Mike Edmunds (WRI-6). The preferred method of submission is on-line, although a mailing option will be available.

Fundraising letters have been mailed and follow-up phone calls are being made to potential donors. Fundraising chair is Ann Maest of Buka Environmental (Amaest@aol.com).

The Scientific Program Committee is led by Martin Schoonen (SUNY-Stony Brook). Special sessions will include the following topics: Geomicrobiology: A Symposium in Honor of Henry Ehrlich; Weathering Studies at All Space and Time Scales, CO2 Sequestration, Radionuclide Interactions with Minerals and Microbes; Advances in Spectroscopic and Microscopic Techniques for the Study of Water-Rock Interactions; and Reactivity of Organic Compounds during Water-Rock Interactions. A complete listing of oral and poster sessions is attached (Tables 3 and 4). A special session in honor of WRI founder and the first Group Chairman, the late Donald White is also planned for the disciplinary area of volcanic and geothermal water-rock interaction.

The city of Saratoga Springs and the nearby Adirondack Mountains will provide an interesting backdrop for the symposium. Mineral springs helped popularize Saratoga as a resort destination in the late 1800s, and today visitors can still sip the mineral waters at the springs and fountains that dot the town. Saratoga Springs is named for the many springs, which discharge throughout the town along a fault system. Some of these form significant precipitates (Figure 3) and some are naturally carbonated. The town, developed around the spring waters as a spa town along the lines of European spa towns, comprises a community of people interested in the arts, in thoroughbred horseracing, and in health issues related to spas. Some of the original spa facilities are still located at the Lincoln Baths in Saratoga Springs.

Table 3. WRI-11 Special Oral and Poster Sessions:

Session Title
Organizer(s)

1. Geomicrobiology: A Symposium in Honor of Henry Ehrlich
Jun Abrajano

2. Radionuclide Interactions with Minerals and Microbes
Rich Reeder Francis

3. Advances in Spectroscopic and Microscopic Techniques for the Study of Water-Rock Interactions
Brian Phillips Borda, Wayne Nesbitt

4. Reactivity of Organic Compounds during Water-Rock Interactions
Everett Shock

5. Carbon Dioxide and Hydrogen Sulfide Sequestration
Martin Schoonen

6. Weathering Studies at All Space and Time Scales
Lee Kump, Lou Derry

7. Complexity of Mineral Surfaces: Experimental and Theoretical Studies
Kathy Nagy, Pat Brady, Patricia Maurice

8. Volcanic-Geothermal Water-Rock Processes and Degassing: A Symposium in Memory of Donald White, Jen Lewicki, Bill Evans

9. New Isotope Techniques in Water-Rock Interaction
Gray Bebout, Ariel Anbar

10. Iron Biogeochemistry
Jon Chorover

11. Crustal Fluid-Rock Interactions, Mass Transfer, and Cycling of Volatiles
Gray Bebout, Jay Ague

Table 4. WRI-11 General Oral and Poster Sessions:

Session Title
Organizer(s)

12. Geochemical Modeling from Molecular to Global Scales
Jim Kubicki, Carl Steefel

13. Environmental Geochemistry

Figure 2. Those participating in the post-session field trip of WRI-10 were treated to the spectacular eruptions of Mount Etna that started on 17 June 2001. Photo courtesy of Alan M. Jacobs.

Janet Herman

14. Thermodynamics and Kinetics of Water-Rock Systems
Martin Schoonen
Sue Brantley

15. Redox Processes: From Bugs to Wastes to Ore Deposits
Martin Schoonen, Sue Brantley

16. Biogeochemistry
Martin Schoonen, Sue Brantley

17. Water-Rock Interaction Processes in Groundwater and Sedimentary Systems
Martin Schoonen, Sue Brantley

18. Water-Rock Interaction Processes in Watersheds
Martin Schoonen, Sue Brantley

19. Aqueous Geochemistry
Martin Schoonen, Sue Brantley

The area offers many opportunities for scientific exploration. Proposed pre-session field trips include Weathering Consequences of Acid Rain in the Adirondacks; Niagara Falls, the Finger Lakes and Lake Seneca Geophysical Research Vessel Cruise: Wisconsin Ice-Water- Rock Interactions; Mining in the Adirondacks; and Impact of Copper Mining Around Eli, Vermont.

Proposed mid-session fields trips (all one day long, on Tuesday June, 29, 2004) include Gore Mountain Garnet, Stromatolites in Reef Park; NYCO Wollastonite Mine and Processing Plant, Paradox Lake Outdoor Environmental Work Shop: Biology and Geochemistry; Weathering in the Adirondacks; Visit to Corning Glass Center Museum and Research Labs; Bus and Walking Tour of Saratoga Springs; and Visit to Howe Caverns / Speleological Hydrology to Honor William B. White. WRI-11 also hopes to host a geological field trip through the Hudson River gorge by rafts.

Field trips for accompanying members are also being planned and will include a walking tour of Saratoga Springs, a scenic train ride, horseback riding in the Adirondacks, and trips to nearby museums. The social program for all participants will include a dinner reception in the historic Canfield Casino, a banquet in the beautiful Hall of Springs at Saratoga Spa State Park and a dinner cruise on a ferry on scenic Lake George.

WRI-12 and Beyond

The Executive Committee of WRI met on 14-16 August, 2002 at the British Geological Survey (Wallingford, England) to discuss plans for WRI-11 (2004) and to make a preliminary selection of a venue for WRI-12 (2007). With regard to WRI-12, we had received proposals from Australia, China and Mexico. Most of the discussion centered on China (Yanxin Wang) and Australia (Ian Cartwright), because it was clear that Mexico (Ignacio Torres Alvarado) needs more time to develop a critical group of scientists for the Organizing Committee. The proposals from Australia and China were both impressive and detailed and all the attendees felt that either country would be an excellent venue for WRI-12. As has been customary in the past, we decided to submit the names of both Australia and China to the WRI-11 Business Meeting. It is the delegates present at the WRI-11 Business Meeting who ultimately will decide the venue for WRI-12.

Future venues beyond WRI-12 always start with Israel, which was a strong contender to host WRI-11, but security issues arising from the serious conflicts in the region persuaded us to move to Saratoga Springs (USA). Strong future contenders also include Mexico, Germany, Norway and ultimately South America and North Africa.

The Evolving Field of Water-Rock Interaction

Comparison of topics and themes covered during WRI-1 with those proposed for WRI-11 (Tables 2 and 3) clearly shows the vastly expanded tools, methodologies and scientific disciplines now used to investigate water-rock interaction. Thirty years ago an investigator would have been satisfied to obtain 10-20 water samples from his or her research site and subject these to time consuming chemical analysis for major cations and anions and use the results to indicate the one or two major processes controlling the chemistry of water at his site. At WRI-10 a similar study would have required 10 to 100 times more water samples, with a gridded spatial and temporal distribution together with an equal number of rock samples. The water samples would have been subjected to detailed organic and inorganic chemical analyses as well as to an array of stable and radioactive isotopes of water and solutes. An equally detailed data set would be collected on the solid phases before water-rock interactions are examined using sophisticated geochemical modeling. We now realize that natural systems are both heterogeneous and complex and require multidisciplinary teams and multi-tracer and multi-phase approaches to understand the details of water-rock interactions.

Figure 3. Hathorn #1 Spring, Saratoga Springs NY.

Over the last 20 years, new methodologies for laboratory analysis of cations and metals include the use of inductively coupled plasma emission spectrometry (ICP/ES) or the combination of ICP with mass spectrometry (ICP/MS) (e.g., Ivahnenko et al., 2001). The advantages of plasma techniques include: (1) they have a wide and linear dynamic concentration range, (2) they have multi-element capability, and (3) they are relatively free from matrix interferences. The use of ion chromatography (IC), gas chromatography (GC) and GC/MS has greatly improved the analysis of anions and dissolved organics (Kharaka et a., 2000; Ivahnenko et al., 2001). Two sessions at WRI-11 will highlight advances in techniques: one session will highlight new spectroscopic techniques including the use of synchrotron radiation, and the second will highlight the use of multi-collector ICPMS to investigate new isotope systems.

These latter dramatic advances in isotope analytical techniques over the last decade have greatly expanded our knowledge of the isotopic composition of natural waters and solutes (Bullen et al., 2001). Not only is high precision information available for H, O, C, and S isotopic compositions, but there is now a large body of data available for Sr, B, and noble gas isotopes as well. More recent has been the development of Li, Fe, Ca, Cl, Br, and I isotope systematics for natural waters. Applications of isotope geochemistry have included identifying sources of solutes and of H2O, quantifying the degree of rock-water exchange, tracing fluid flow paths, determining paleotemperatures, and calculating ages

and residence times of fluids. The systematics of many isotopic systems, such as those of Sr, have been well worked out for natural waters. Some systems, such as Br, are in their infancy, and others, such as the stable isotopes of Cl, have unresolved questions regarding their interpretation.

Studies investigating the role of bacteria on water-rock interactions and the field of microbiology, including geomicrobiology have increased dramatically, especially in the last 5 years (Shock, 2001). This topic was only marginally mentioned before WRI-9, but three sessions related to microbiology are proposed for WRI-11, indicating its importance not only at low temperature and salinity conditions, but also in brines and high TP environments (Shock, 2001). Other themes proposed for WRI-11 that would have been unthinkable for the early WRIs, include CO2 sequestration, reactive organic species and possibly environmental geochemistry.

Final Perspective

For 30 years the Working Group on Water-Rock Interaction has continued to organize successful triennial WRI Symposia. I believe we are successful because we have developed an informal format that attracts students and the leading geochemists, geologists, hydrologists and other earth scientists from many developed and developing countries to commune on a broad field of science. The field trips, the social and cultural programs for the scientists and the accompanying members result in creating an atmosphere of informality and easy communication among the participants. Cooperative projects and deep friendships have developed between scientists from many countries. I invite you all to attend WRI-11 in Saratoga Springs June 27-July 2, 2004. Be warned, however that if you attend you will be hooked, because WRI has a very contagious spirit. The best definition of that spirit is that articulated by Yasue Oki (Japan) as “water-rock-human interaction”.

Acknowledgements

A great deal of this summary was extracted from Hitchon (1989), the Secretary General for WRI-3 and Group Chairman (1974-1986). The information about WRI-11 was provided (I made minor changes) by Brantley and other members of WRI-11 Organizing Committee. I thank Jim Thordsen for formatting the final copy.

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Fifth International Symposium on Water-Rock Interaction Reykjavik, Iceland, 8-17 August 1986, Extended Abstracts, (edited by J. Olafsson and M. Olafsson), 1986, 692p.

Proceedings of the 6 th International Symposium on Water-Rock Interaction, Malvern, UK, 3-8 August 1989, (edited by D. L. Miles), 819p. A. A. Balkema Publisher.

Proceedings of the 7 th International Symposium on Water-Rock Interaction - WRI-7, Park City, Utah, USA, 13-18 July 1989, (edited by Y. K. Kharaka and A. S. Maest). Volume 1- Low Temperature Environments, 858p; volume 2- Moderate and High Temperature Environments, p. 861-1685. A. A. Balkema Publisher.

Proceedings of the 8 th International Symposium on Water-Rock Interaction - WRI-8, Vladivotok, Russia, 15-19 August 1995, (edited by Y. K. Kharaka and O. V. Chudaev), 911p. A. A. Balkema Publisher.

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Employment Opportunities

Sierra Nevada Research Institute
University of California, Merced
Postdoctoral Research Positions Available
Job # 522-03A

The Sierra Nevada Research Institute (SNRI) at The University of California, Merced seeks scientists to conduct research aimed at improving basic knowledge about climate, hydrology and biogeochemistry in the greater Southwest and other areas of interest to faculty affiliated with SNRI. Each postdoctoral researcher will have a specific project focus, with opportunities to also work as a member of a multidisciplinary team focused on broader research questions in the region. A Ph.D. in a relevant discipline is required for all positions. Also desirable is an interest in applying natural science principles to important societal research needs, within the context of the institute. Good communication skills are likewise required.

The SNRI is an organized research unit of U.C. Merced, which is being developed as the 10th campus of the University of California. At present SNRI has 5 affiliated faculty from multiple disciplines, with more expected to join over the next year. A list of inaugural faculty and the Founding Director of the SNRI can be found http://www.ucmerced.edu/

All positions are year-to-year; we expect, but do not guarantee, extension of these positions beyond one year. The specific focus of each position is provided below.

Snow hydrology: The person filling this position must have demonstrated interest and expertise in blending remote sensing and ground-based data to address water resources issues in the Sierra Nevada and other mountains of the greater Southwest. Some experience in both hydrologic modeling and field work are desirable. Requires a Ph.D. in hydrologic science or a related discipline.

Biogeochemistry of mountain catchments: Research will have a particular focus on the integration of the physical, geochemical and ecological aspects of hydrology in the Sierra Nevada and other mountains of the greater Southwest. Ability to both carry out fieldwork and develop/use biogeochemical and hydrologic models, including a familiarity with computer programming, are desirable.

Riparian biogeochemistry: This project explores the linkages between biogeochemical cycles and hydrologic flowpaths in riparian systems in arid and semi-arid climates over a variety of spatial and temporal scales. An understanding of nutrient cycling and hydrologic fluxes in riparian systems, as well as an ability to carry out field research is required. Will involve development of innovative sampling equipment.

Sensor development and innovative monitoring of solutes in unsaturated soils: This project aims to develop novel chemical microsensors (e.g., nitrate) and to explore the use of large, dense sensor networks to solve monitoring problems in spatially heterogeneous soils. Applications included precision agriculture, artificial groundwater recharge with reclaimed wastewater, and others. Experience with data acquisition hardware/software (LabView) and basic knowledge of soil hydraulics are required. Experience with electrochemical fabrication procedures is desirable.

Molecular mechanisms of contaminant uptake and release: Two positions in this area will involve complementary spectroscopic and microscopic studies probing mechanisms of uptake and release of inorganic contaminants by environmental materials. Experience with X-ray absorption spectroscopy or related techniques is desirable.

Hydrology and K-12 science education: This position involves 50% research in water quality and/or snow hydrology, and 50% providing science support to the international K-12 GLOBE program (www.globe.gov). There are a number of possible research projects, depending on the interest of the person filling the position. Requires a background in a relevant earth science discipline, and an interest in K-12 education.

Greenland climate and glaciology: This position requires expertise necessary to interpret ice core and instrumental records of snow accumulation and atmospheric chemistry in this cold snow-covered region. A background in both atmospheric chemistry, meteorology and/or glaciology is required.

The University of California, Merced, is an affirmative action/equal opportunity employer with a strong institutional commitment to the achievement of diversity among its faculty, staff, and students.

Applications
Interested scholars should send a cover letter, curriculum vitae, and the names and addresses of three references to:

Academic Personnel Office
University of California, Merced
P.O. Box 2039
Merced, CA 95344-0039

Materials may be submitted electronically to: ucmsearch@ucop.edu with the job number, 522-03A, in the subject line. All of the above positions are contingent upon funding and will be filled beginning on June 1, 2003. Review of applications is ongoing.

Employment Opportunities

Ph.D. Assistantships

The new Environmental Sciences Ph.D. Program at Wright State University has assistantships available to qualified applicants who are accepted into the program. The assistantships are for a minimum of $17,000 with tuition and fee waivers and are awarded for two years. Year one is a research assistantship and year two is a teaching assistantship. Research assistantships are then provided by the student's major professor for the remainder of their degree study period. The program provides a strong interdisciplinary focus both in the course work and dissertation research, with a focus on contaminant fate and effects in three areas of faculty expertise: environmental toxicology and chemistry, environmental stressors, and environmental geophysics and hydrogeology. There are over two dozen ES program faculty from the departments of Biology, Chemistry, Geology and Physics. For more information on the curriculum, faculty research areas and application materials see http://www.wright.edu/academics/ieq.

The Yellow Springs Instruments Environmental Sciences Ph.D. Fellowship

Wright State University is pleased to announce a new YSI Environmental Sciences Ph.D. Fellowship. The Research Fellowship is for $25,000 with tuition and fee waivers. This prestigious award will be given to a qualified applicant accepted into the new Environmental Sciences Ph.D. program at WSU. Students may apply with either a B.S. or M.S. degree from a relevant major (e.g., biology, chemistry, geology, physics, toxicology, environmental health sciences). The program provides a strong interdisciplinary focus both in the course work and dissertation research, with a focus on contaminant fate and effects in three areas of faculty expertise: environmental toxicology and chemistry, environmental stressors, and environmental geophysics and hydrogeology. Review of applications for the 2003-2004 Academic Year will begin in June, 2003, and continue until the position is filled. For more information on the curriculum, faculty research areas and application materials see http://www.wright.edu/academics/ieq.

Meetings Announcements

2003 Goldschmidt Conference
Kurashiki, Japan
September 7-12, 2003

www.ics-inc.co.jp/gold2003/

Goldschmidt 2003

The Goldschmidt Conference is now the premier annual meeting for geochemistry. The conference covers a wide range of topics in geochemistry and cosmochemistry, including cosmic substances and the solar system, early earth, substances and processes in the earth's interior, material circulation on the earth's surface, climate change, earth's environment, biogeochemical processes, and technological advancement. The past Goldschmidt Conferences have been organized through the collaboration of the Geochemical Society and European Association of Geochemistry. In 2003, the Geochemical Society of Japan will join this collaboration, and the 13th Goldschmidt Conference will be held in Kurashiki, Japan, from September 7th to 12th. For the first time, the meeting will be held in the western Pacific region.

Kurashiki, where you will meet old Japan

The city of Kurashiki is located approximately 200km west of Osaka, easily accessible by the bullet train (Shinkansen) from Tokyo, Osaka, or Fukuoka. Kurashiki was a local trading center in western Japan in the 17th to 19th centuries, preserving the medieval Japan atmosphere in its old town area. Many attractive tourist cities such as Kyoto, Nara, Himeji, Okayama, and Hiroshima can be reached by Shinkansen.

Important Dates

September 7-12, 2003 Goldschmidt 2003 in Kurashiki, Japan

Meetings Announcements

13th V. M. Goldschmidt Conference
Pre-conference Short Course on ICP-Mass Spectrometry
September 6-7, 2003

Sponsored by: Agilent Technologies, New Wave Research, Marubun Corporation, Seki-Technotron, Gemmological Association of All Japan.

A short course on Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) will be held from September 6th to 7th, 2003, just before the Goldschmidt Conference at Kurashiki. The short course will cover the entire range of ICP-MS techniques, including basic principles of ICP-MS, laser ablation sample introduction techniques, and applications for earth and planetary sciences. The course will also cover basic theoretical aspects of the mechanisms of isotopic fractionation.

Program of the Short Course
Day 1 (September 6th, 2003)
12:30 - 13:20 Registration (Okayama Terrsa)
13:30 - 15:00 Lecture 1: Gunther Detlef (ETH, Switzerland): Principles of ICP-Mass Spectrometry
15:00 - 15:30 Coffee Break
15:30 - 17:00 Lecture 2: Alex Halliday (ETH, Switzerland): Application on Isotopic Chronology
18:00 - 20:00 Party
20:00 - Night Session (Free Discussion)

Day 2 (September 7th, 2003)
9:00 - 10:30 Lecture 3: Toshiyuki Fujii (Kyoto Univ., Japan): Principles of Isotopic Effect
10:30 - 12:00 Lecture 4: Simon E. Jackson (GEMOC, Australia): Laser Ablation and MC-ICP-MS Techniques
13:15 - 14:45 Lecture 5: Keith O'Nions (Oxford Univ., UK): Isotope Geoscience for Biochemistry

Location of the Short Course
Okayama Terrsa, Yao 793, Hayashima Town, Okayama 701-0301, Japan (Approx. 1 hour from the place of the 2003 Goldschmidt Conference). Details of the location will be announced by second circulation on web-site.
For further information, see: http://www.geo.titech.ac.jp/epss/ss2003/index.htm

Subscription and Registration Fee
April 1, 2003 - June 30, 2003: 12,000 yen* (10,000 yen per person for twin room)
July 1, 2003 - August 31, 2003: 14,000 yen* (12,000 yen per person for twin room)
* Only Japanese-yen in cash is acceptable. *Neither credit card nor check will be accepted.*
Fare includes accommodations, conference dinner and 5%VAT.
Payment will be made at the registration desk.

Capacity
45 persons: Fifteen single rooms and 15 twin rooms have been reserved. Due to the limitation of the capacity of accommodations, you maybe asked to share a twin room with one of the attendance of the short course. Sorry for this inconvenience, but this saves the registration cost. Your kind assistance is greatly appreciated.

Submission: Send Registration Form to: sc2003gold@geo.titech.ac.jp
Organizing Committee: Takafumi Hirata (Tokyo Institute of Technology, Tokyo, Japan)

Call for Papers

Vibrational Spectroscopy in the Earth and Environmental Sciences

at the 227th ACS National Meeting
Anaheim, CA
March 28 - April 1, 2004

Vibrational spectroscopy encompasses several analytical tools, primarily infrared and raman spectroscopy, that probe molecular vibrations. Recently, technological advances in instrumentation, data analysis, molecular modeling and technique development have expanded the utility of vibrational spectroscopy to study both solution phase species and species at the solid-water interface. This new generation of vibrational spectroscopic techniques, coupled with more traditional methods, has placed vibrational spectroscopy on the forefront of analytical methods used to investigate aqueous and interfacial geochemistry.

We solicit presentations on the application of vibrational spectroscopy to the study of geochemical materials and processes. This symposium will concentrate on the development and application of emerging experimental techniques of interest to researchers studying the solid-water interface as well as chemistry in the aqueous phase.

It is anticipated that the symposium will focus on the following areas:

- ATR-FTIR and Raman studies of geochemical reactions at the solid-water interface and in aqueous solutions
- Applications of FTIR and Raman spectromicroscopy to geochemical systems
- Advances in the use of synchrotron radiation for vibrational spectroscopy
- Producing theoretical vibrational spectra with molecular modeling.

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e-mail: mike@pbisotopes.ess.sunysb.edu

Meetings Calendar

July 23-31, 2003: XVI INQUA Congress "Shaping the Earch: A Quaternary Perspective", Division of Hydrologic Sciences, Desert Research Inst., Reno, U.S.A. Web site: http://www.dri.edu/DEES/INQUA2003/inqua_home.htm

June 30-July 11, 2003: XXIII General Assembly of the IUGG, Sapporo, Japan. Web site: http://www.jamstec.go.jp/jamstec-e/iugg/index.html

July 9-15, 2003: Workshop "Teaching Petrology in the 21st Century", Montana State University, Bozeman MT, USA. Deadline has passed. Web site: http://serc.carleton.edu/NAGTWorkshops/petrology03/index.html

July 13–16, 2003: Workshop "The Next Generation of in situ Biological and Chemical Sensors in the Ocean", Redfield Auditorium, WHOI, Woods Hole, Massachusetts 02543, U.S.A. Co-sponsored by the WHOI Ocean Life Institute and Deep Ocean Exploration Institute, the National Science Foundation, and the Office of Naval Research. Web site: http://www.whoi.edu/institutes/oli/activities/symposia_sensors.htm

July 14-18, 2003: Summer school on isotope geochemistry, Czech Republic. Deadline has passed. Web site: http://www.natur.cuni.cz/school2003/

July 16-18, 2003: NEAR - The Impact of Global Environmental Problems on Continental & Coastal Marine Waters, Geneva, Switzerland. Web site: http://www.unige.ch/sciences/near/

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, NH.Web site: http://www.grc.uri.edu/programs/2003/forest.htm

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

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

Jul 30-Aug 1, 2003: IX Colombian Geological Congre, Medellin, Columbia. Contact: Michel Hermelin; E-mail: hermelin@eafit.edu.co; Web site: http://www.congresocolombianodegeologia.org

Jul 30-Aug 14, 2003: Basalts, 'Beests, Bee-Eaters: Geology of the Kenya Rift GeoTrip, Kenya and Northern Tanzania, Africa, by the Geological Society of America. Contact: Edna Collis, GSA, P.O. Box 9140, Boulder, CO 80301; Phone: +1 303 357-1034; Fax: +1 303-357-1072; E-Mail: ecollis@geosociety.org; Web site: http://www.geosociety.org/meetings/gv CANCELED

Aug 10-14, 2003: GeoSciEd IV, University of Calgary, Calgary, Alberta, Canada, by the International Geoscience Education Organization. Contact: Godfrey Nowlan, 3303 - 33rd Street NW, Calgary, AB, T2L 2A7, Canada; Phone: +1 403 292 7079; Fax: +1 403 292 6014; E-mail: gnowlan@nrcan.gc.ca; Web site: http://www.geoscied.org

Aug 10-15, 2003: Chemistry at the interfaces, 39th IUPAC Congress and 86th Conference of The Canadian Society for Chemistry, Ottawa, Canada. Web site: http://www.nrc.ca/confserv/iupac2003

Aug 10-15, 2003: Chemical Oceanography - Gordon Research Conference, Tilton, NH, USA. Web site: www.grc.uri.edu/

Aug 10-16, 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). Web site: http://www.nitg.tno.nl

Aug 16-18, 2003: SCANDIUM 2003 - An International Symposium on the Mineralogy and Geochemistry of Scandium, Natural History Museums and Botanical Garden, University of Oslo, Norway. Web site: http://www.toyen.uio.no/geomus/scsymp/

Aug 16-21, 2003: State-of-the-Arc (SOTA) 2003, Cascades, U.S.A. Contact: William P. Leeman Department of Earth Science, Rice University, Houston, TX 77251-1892, U.S.A.; Phone: +1 713 348 4892; Fax: +1 713 348 5214; E-mail: leeman@ruf.rice.edu; Web site: http://www.ruf.rice.edu/~leeman/SOTA2003/info.html

Aug 19-21, 2003: The Geological Society's 2003 Fermor Flagship Meeting "World Class Mineral Deposits and Earth Evolution", Cardiff, U.K. Web site: http://www.mdsg.org.uk

Aug 24-27, 2003: Fourth South American Symposium on Isotope Geology (IV SSAGI), Salvador, Bahia, Brazil. Web site: http://www.cbpm.com.br/ivssagi/index.htm

Aug 24-27, 2003: 3rd International Workshop: "Basement Volcanoes Interplay and Human Activities" and Field Workshop, Petropavlovsk-Kamchatsky, Russia. Contact: Dr Vera Ponomareva or Prof. Alessandro Tibaldi, Institute of Volcanic Geology and Geochemistry, Piip Blvd. 9, Petropavlovsk-Kamchatsky, Russia; E-mail: ponomareva@geo.tv-sign.ru or alessandro.tibaldi@unimib.it; Web site: http://www.geo.unimib.it/IGCP455.htm

Aug 24-29, 2003: 5th International Conference on f-elements (ICFe), Geneva, Switzerland. Web site: http://ereswww.epfl.ch/icfe/

Aug 24-30, 2003: ECM-21 - XXI European Crystallographic Meeting, Durban, South Africa. Web site: http://www.ecm21-africa.co.za/

Aug 25-29, 2003: Penrose Conference, PLUME IV: Beyond The Plume Hypothesis, Hveragerdi, Iceland. Contact: Gillian R. Fuolger, U.S. Geological Survey, 345 Middlefield Road, MS 910, Menlo Park, CA 94025-3591, USA; Phone: +1 650 329 4143; Fax: +1 650 329 5203; E-mail: foulger@swave.wr.usgs.gov; Web site: http://www.mantleplumes.org

Aug 29-Sept 3, 2003: 21st IGES (International Geochemical Exploration Symposium), Dublin, Ireland This meeting will immediately precede the 6th ISEG (International Symposium on Environmental Geochemistry) to be held in Edinburgh 7-11 Sept. This meeting is also co-sponsored by the AEG. Web site: http://www.conferencepartners.ie/igesandnams2003/

Aug 31-Sept 5, 2003: The 16th International Mass Spectrometry Society Conference (IMSC), Edinburgh, Scotland, UK. Web site: http://www.imsc-edinburgh2003.com/

Aug 31-Sept 4, 2003: EAGE/EEGS, 9th European Meeting of Environmental and Engineering Geophysics, Prague, Czech Republic. Web site: http://www.guarant.cz/EEGS/

Aug 31-Sept 9, 2003: NSF/Ridge 2000-NORDVULC Workshop and Summer School on Magmatic-Tectonic Interaction, Iceland. Contact: Tim Dixon; Phone: +1 305-361-4660; E-mail: tdixon@rsmas.miami.edu; Web site: http://ridge2000.bio.psu.edu/devel/WorkshopInfo.php?workshop=iceland03

Sept 2-6, 2003: Fifth Hutton Symposium on the Origin of Granites, Toyohashi City, Japan. Contact: Hutton V office; E-mail Hutton-V@m.aist.go.jp; Web site: http://www.gsj.jp/Info/event/hutton

Sept 2-6, 2003: ECNS 2003 European Conference on Neutron Scattering, Montpellier, France. Contact: E-mail: rene@ldv.univ-montp2.fr; Web site: http://www.ecns2003.org/

Sept 6-11, 2003: EuroConference on Multi-Disciplinary Studies of the Mantle and Core - "The Deep Earth: Theory, Experiment and Observation", Acquafredda di Maratea, Italy. Web site: http://www.esf.org/euresco/03/lc03125

Sept 6-7, 2003: Pre-conference Short Course on ICP-Mass Spectrometry, Hayashima Town, Okayama, Japan. Sponsored by Agilent Technologies, New Wave Research, Marubun Corporation, Seki-Technotron, Gemmological Association of All Japan. The short course will cover the entire range of ICP-MS techniques, including basic principles of ICP-MS, laser ablation sample introduction techniques, and applications for earth and planetary sciences. The course will also cover basic theoretical aspects of the mechanisms of isotopic fractionation. Web site: http://www.geo.titech.ac.jp/epss/ss2003/index.htm

Sept 7-11, 2003: 6th International Symposium on Environmental Geochemistry (ISEG), Edinburgh, UK. Contact: Dr. John G. Farmer, Department of Chemistry, University of Edinburgh, West Mains Road, Edinburgh EH9 3JJ, UK; E-mail: J.G.Farmer@ed.ac.uk. Web site: http://www.iseg2003.com/

Sept 7-11, 2003: 226th ACS National Meeting, New York, NY. Includes: Interfacial Biogeochemistry: Biogeochemical processes that occur at interfaces and implications toward environmental processes, Molecular environmental surface chemistry: Techniques and methods for determining structural role of adsorbed and coprecipitated contaminants, Advances in Arsenic Research: Integration of Experimental and Observational Studies and Implications for Mitigation, Application of NMR spectroscopy to geochemistry, and CO2 sequestration: advanced technologies for predicting and monitoring isolation performance. Web site: http://membership.acs.org/g/geoc/upcoming.html

Sept 7-12, 2003: 13th V.M. Goldschmidt Conference, Kurashiki, Japan. Web site: http://www.ics-inc.co.jp/gold2003/

Sept. 8-10, 2003: UK Luminescence and ESR Research Meeting, Aberystwyth, U.K. Web site: http://www.aber.ac.uk/quaternary/uk2003/

Sept 8-12, 2003: 21st IMOG meeting, Krak—w, Poland. Web site: http://www.imog.agh.edu.pl/.

Sept 8-12, 2003: 18th Colloquium on High Resolution Molecular Spectroscopy, Dijon, France. Web site: http://www.u-bourgogne.fr/LPUB/HRMS

Sept 9-13, 2003: Association of European Geological Societies (13th Annual Biennial Meeting) and Raw Materials Symposium of the Hannover Geocenter (MEAGS) , Hannover, Germany. Contact: Dr. Volker Steinbach,; E-mail: v.steinbach@bgr.de; or Dr. Heinz-Gerd R hling; E-mail: gerd.roehling@bgr.de; Web site: http://www.uni-essen.de/geologie/aegs.htm

Sept 13-18, 2003: 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics, Castle of Hruba Skala, Czech Republic. Contact: O. Cadek; E-mail: oc@karel.troja.mff.cuni.cz; Web site: http://geo.mff.cuni.cz/workshop

Sept 15-17, 2003: 3-day short course on "fluid-rock interaction and mineralisation", Department of Geology, University of Pretoria, Republic of South Africa. By Nick Oliver, Professor of Economic Geology, Program Coordinator (Fluids) Predictive Mineral Discovery CRC, Economic Geology Research Unit, School of Earth Sciences, James Cook University, Townsville 4811 Australia. Contact: Dr. Hassina Mouri; E-mail: hmouri@postino.up.ac.za

Sept 17-20, 2003: South Aegean Active Volcanic Arc: Present Knowledge and Future Perspectives, Milos Island, Greece. Contact: Georges Vougioukalakis, Institute of Geology and Mineral Exploration, Dept of Hydrogeology and Environment, 70 Messogion street, 115 27, Athens, Greece; Phone: +30 10 748 6915; Fax: +30 10 748 8262 ; E-mail: gevagel@otenet.gr or ismosav@otenet.gr; Web site: http://www.heliotopos.net/conf/saava2003

Sept 18-21, 2003: International Symposium on Mineralogy, Cluj-Napoca, Romania. Contact: Prof. Bogdan P. Onac; E-mail: bonac@bioge.ubbcluj.ro; Web site: http://bioge.ubbcluj.ro/~bonac/smr.htm

Sept 21-24, 2003: 20th Annual Meeting of the Society for Organic Petrology (TSOP), Washington DC, U.S.A. Web site: http://www.tsop.org/mtgdc.htm

Sept 22-26, 2003: Specialist Group in Structural Geology and Tectonics (SGTSG), Kalbarri,Australia. Organization: The Geological Society of Australia. Contact: Alan Collins; E-mail: Alanc@lithos.curtin.edu.au

Sept 22-26, 2003: Chapman Conference on The Role of Diatom Production and Si Flux and Burial in the Regulation of Global Cycles, Paroikia, Paros, Greece. Web site: http://www.agu.org/meetings/cc03dcall.html

Sept 22-26, 2003: 7th International Conference on Gas Geochemistry ICGG 7, Freiberg, Germany. Contact: Local Organizer Dr. Jens Heinicke / ICGG7, TUBAF / SAW, Bernhard-von-Cotta Str. 4, 09596 Freiberg, Germany; Phone: +49 3731 39 2212; Fax:+49 3731 39 2212; E-mail: heinicke@physik.tu-freiberg.de.

Sept 30 - Oct 3, 2003: Fourth International Conference on Arctic Margins (ICAM IV), Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada. Web site: http://www.icamiv.org/welcome.html

Oct. 4-9, 2003: Polar Regions and Quaternary Climate - EuroConference on the Comparison of Ice Core Records with Marine Sediments and Climate Models, San Feliu de Guixols, Spain. Deadline has passed. Web site: http://www.esf.org/euresco/03/lc03115

Oct 5-8, 2003: Subsurface Science Symposium, Salt Palace Convention Center, Salt Lake City, Utah, U.S.A., by the Inland Northwest Research Alliance (INRA). Contact: BethAnn Melad, PO Box 587, Meridian, Idaho, 83680; Phone: +1 208 288 0290; Fax: +1 208 288 0291; E-mail: inquire@meetingsystems.com; Web site: http://www.b-there.com/breg/inra

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

Oct 6-10, 2003: International Conference on Mechanisms and Regulation of Organic Matter Stabilisation in Soils, Schloss Hohenkammer, Munich, Germany. Web site: http://www.wzw.tum.de/bk/hk/

Oct 13-14, 2003: Ridge 2000 Workshop -Establishment of a Mid-Atlantic Ridge Integrated Studies Site, Providence, RI, , U.S.A. Web site: http://ridge2000.bio.psu.edu/devel/interest.php?prews=MAR03

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

Nov 15-28, 2003: GSA GeoTrip The Great Barrier Reef in Time and Space, Townsville, Far North Queensland, Australia. Scientific Leader: Robert Burns, Mid-Ocean Marine Sciences, Townsville, Australia. Web site: http://www.geosociety.org/geoventures/

Nov 30-Dec 03, 2003: Copper 2003 - Cobre 2003, Santiago, Chile. Organized by the Instituto de Ingenieros de Minas de Chile and Canadian Institute of Mining, Metallurgy and Petroleum. Contact: E-mail: info@cu2003.cl; Web site: http://www.cu2003.cl

Dec 6-7, 2003: Biomineralization Short Course, Silverado Resort, 1600 Atlas Peak Road, Napa Valley, California, 94558, U.S.A. Organizers: Patricia Dove, James J. DeYoreo and Steve Weiner.

Meetings Calendar

Sponsored by Mineralogical Society of America. Web site: http://www.minsocam.org/MSA/SC/BioSC_descrptn.html

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

Dec 8-10, 2003: From Mallik to the Future - an International Symposium on results from the Mallik 2002 Gas Hydrate Production Research Well, Mackenzie Delta, Canada, Hotel New Otani Makuhari, Chiba (Tokyo area), Japan. By the Mallik International Partnership: Geological Survey of Canada (GSC), Japan National Oil Corporation (JNOC), GeoForschungsZentrum Potsdam (GFZ), United States Geological Survey (USGS), United States Department of Energy (USDOE), India Ministry of Petroleum. Contact: Scott Dallimore, Program Chair, GSC-Pacific, 9860 West Saanich Road, Sidney, BC V8L 4B2 Canada; Phone: +1 250 363 6423; Fax: +1 250 363 6565; E-mail: sdallimo@NRCan.gc.ca; Web site http://gashydrate.nrcan.gc.ca/mallik2002/home.asp and http://www.mh21japan.gr.jp

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

Dec 10-13, 2003: ACE 2003 - 4th European meeting on environmental chemistry, Plymouth, UK. Contact: Dr. Mark Fitzsimons, Dept. of Environmental Sciences, University of Plymouth, Plymouth, PL4 8AA, UK; E-mail: mfitzsimons@plymouth.ac.uk. Web site: http://www.emec4.org.uk/

Jan 12-16, 2004: Penrose Conference, Neogene Continental Margin Volcanism, Mexico. Contact: Gerardo J. Aguirre-D'az, Centro de Geociencias, Campus UNAM-Juriquilla, Quer taro, Quer taro, 76230 M xico; E-mail; ger@geociencias.unam.mx; Fax: + 525 623 4105; Phone: + 525 623 4116, ext 107; Jos Luis Mac'as, Instituto de Geof'sica, UNAM, Coyoac‡n 04510, M xico D.F.; E-mail: macias@tonatiuh.igeofcu.unam.mx; Fax: +52 55502486; Phone: + 52 56224124 ext. 19; Claus Siebe, Instituto de Geof'sica, UNAM, Coyoac‡n 04510, M xico D.F.; E-mail: csiebe@tonatiuh.igeofcu.unam.mx Fax: +52 55502486; Phone: +52 56224124 ext. 17; Web site: http://tepetl.igeofcu.unam.mx/penrose/index.html

Jan 18-22, 2004: Penrose Workshop, Neogene Continental Margin Volcanism; see above.

Jan 26-30, 2004: AGU Ocean Sciences Meeting, Portland, Oregon. Web site: http://www.agu.org/meetings/meetings.html

Feb 10-12, 2004: Second International Symposium "Dynamics of Fluids in Fractured Rock", Lawrence Berkeley National Laboratory, Berkeley, California, U.S.A. Web site: http://esd.lbl.gov/fluidsinrock/

March 28-April 1, 2004: 227th ACS National Meeting, Anaheim, CA. Will include: Arsenic Geochemistry, Fate and Transport of Colloids, Environmental Chemistry of Bacterial Mn(II) oxidation, Scaling issues: Application of molecular geochemistry to field scale transport, and Chemistry of metals in terrestrial and aquatic systems. Web site: http://membership.acs.org/g/geoc/upcoming.html

April 5-6, 2004: Seventh Nederlands Aardwetenschappelijk Congres VII. More information forthcoming.

April 6-7, 2003: The 8th international conference of Jordanian Geologist Association, Faculty of Engineering, University of Jordan, Amman, Amman, Jordan. Contact: Dr. Ahmad Al-Malabeh, Jordanian Geologist Association; Phone: +962 6 5652310; Fax: +962 6 5652312; E-mail: jga@joinnet.com.jo; Web site: http://www.jo-geologists.com

April 26-30, 2004: European Geophysical Society XXIX General Assembly, Nice, France. Contact: EGS Office, Max-Planck-Str. 13, 37191 Katlenburg-Lindau, Germany; Phone: +49 5556 1440, Fax: +49 5556 4709; E-mail: EGS@COPERNICUS.ORG; Web site: http://www.copernicus.org/EGS/EGS.html

May 15-16, 2004: Short course Stable Isotopes of Intermediate to Heavy Mass Elements, Montr al, Canada. Organizers: Clark Johnson (Univ. of Wisconsin - Madison) (E-mail: clarkj@geology.wisc.edu), Francis Albar de (Univ. of Lyon), Brian Beard (Univ. of Wisconsin - Madison). Sponsor: Mineralogical Society of America.

May 17-21, 2004: joint meeting - 2004 AGU Spring meeting and the Canadian Geophysical Union annual meeting, Montreal, Canada. Contret: meetinginfo@agu.org.

May 20-24, 2005: Goldschmidt Conference 2005. University of Idaho, Moscow, Idaho, USA. www.gold2005.uidaho.edu. Contact: gold2005@uidaho.edu

May 26-June 6, 2004: Polymorphism: Solvates and Phase Relationships, Erice, Italy. Contact: E-mail: Yoel@bgumail.bgu.ac.il; Web site: http://www.geomin.unibo.it/orgv/erice/olderice/bernstei.htm

June 6-12, 2004: 14th V.M. Goldschmidt Conference, Copenhagen, Denmark. Web site: http://www.goldschmidt2004.dk/

June, 2004: Short Course Epidote Group Minerals. At XIVth Goldschmidt Conference in Copenhagen (Denmark) sponsor: Mineralogical Society of America Organizer: Axel Liebscher; E-mail: alieb@pop-server.gfz-potsdam.de

June 27-July 2, 2004: 11th International Symposium on Water-Rock Interaction, Saratoga Springs, New York, U.S.A. Contact: Cheryl Corman, Phone: +1 814-863-1738; Web site: http://www.outreach.psu.edu/C&I/WRI/ and http://wwwrcamnl.wr.usgs.gov/wri/future_meetings.htm

June 28-30, 2004: 4th BGA Geoenvironmental Engineering Conference, Stratford-upon-Avon, UK. The main conference theme is "Integrated Management of Groundwater and Contaminated Land". Organized by the Geoenvironmental Research Centre (Cardiff School of Engineering, Cardiff University) and the National Groundwater & Contaminated Land Centre (Environment Agency) on behalf of the British Geotechnical Association. Web site: http://www.grc.cf.ac.uk/4bga/

July 4-9, 2004: 16th International Conference on Phosphorus Chemistry (ICPC 16), Birmingham, England. Contact: Prof. Pascal Metivier, Rhodia, R&D for Phosphorous and Performance Derivatives Oak House, reeds Crescent Watford, WD24 4QP, UK; Phone: +44 1923 485609; E-mail: pascal.metivier@eu.rhodia.com; Web site: http://www.icpc2004.com

July 12-16, 2004: GEOSCIENCE AFRICA, International Conference, University of the Witwatersrand, Johannesburg, South Africa. Web site: http://www.wits.ac.za/geoscienceafrica.

July 25-29, 2004: 11th International Symposium on Solubility Phenomena, Including Related Equilibrium Processes (11th ISSP), Aveiro, Portugal. Contact: Prof. Clara Magalhaes, Department of Chemistry, University of Aveiro, P-3810-193 Aveiro, Portugal; Phone: +351 234 401518; Fax: +351 234 370084; E-mail: mclara@dq.ua.pt; Web site: http://www.dq.ua.pt/11th_issp

July 25-30, 2004: 7th INTECOL International Wetlands Conference, Utrecht University, Utrecht, The Netherlands. Web site: http://www.bio.uu.nl/INTECOL

Aug 1-6, 2004: Gordon Research Conference "Water & Aqueous Solutions". Holderness School. Web site: http://www.grc.uri.edu/04sched.htm

Aug 8-13, 2004: Gordon Research Conference "The Role of Water in Rock Deformation", Mount Holyoke College, South Hadley, MA, U.S.A. This conference will emphasize the chemical and physical roles of aqueous fluids in deformation, the sources and transport of fluids in deforming rock bodies and faults of the crust and mantle, and the importance of fluid-rock interactions to tectonics. Contact: Andreas Kronenberg, Chair, or Mark Jessell, Vice-chair; E-mail: a-kronenberg@tamu.edu or mjessell@lmtg.ups-tlse.fr; Web site: http://www.tectonique.net/grc/

Aug 8-13, 2004: Gordon Research Conference Organic Geochemistry, Holderness School. Web site: http://www.grc.uri.edu/04sched.htm

Aug 20-28, 2004: 32nd International Geological Congress (IGC), Florence, Italy. Geochemical Society/IUGS. Also: 6-day post-congress field trip to the blueschists, eclogites and tectonics of northwest Turkey (modified version of the successful 1998 Metamorphic Studies Group field trip). See second circular. In addition: post-congress field workshop n¡ PWO 01: "Low-angle normal faulting ... twenty years after". This workshop will be a 6-day excursion from Corsica (France) to Elba Island, Tuscany and western Umbria (Italy). Conveners PWO0-1: Giusy Lavecchia, Dipartimento di Scienze della Terra - Chieti University, Italy (glavecchia@unich.it), Gordon S. Lister, Department of Earth Science - Monash University, Australia (gordon@mail.earth.monash.edu.au), and Laurent Jolivet, Lab. de Tectonique - P.& M. Curie University - Paris, France (laurent.jolivet@lgs.jussieu.fr). Web site: http://www.32igc.org/

Aug 22-26, 2004: 228th ACS National Meeting, Philadelphia, PA, U.S.A. Web site: http://membership.acs.org/g/geoc/upcoming.html

Aug 30-Sept 3, 2004: 2nd International Conference on Recrystallization and Grain Growth, Annecy, France. Primarily for and by metallurgists. The themes of the conference include: fundamentals of recrystallization and grain growth, dynamic recrystallization and elevated temperature deformation, computer simulation and modeling, microstructure and texture, structure, thermodynamics and kinetics of interfaces, and new experimental methods and techniques. Chairpersons of the Organizing Committee: Julian Driver and Brigitte Bacroix; Web site: http://www.rex-gg-2004.org/

Aug, 2004: 67th annual meeting of the Meteoritical Society, Rio de Janeiro, Brazil. Contact: E-mail: congrex@congrex.com.br

Sept 3-5, 2004: 4th International Symposium on Chemistry and Biological Chemistry of Vanadium, Szeged, Hungary. Contact: Prof. Tamas Kiss, University of Szeged, Department of Inorganic and Analytical Chemistry, PO Box 440, H-6701 Szeged, Hungary; Phone.: +36 62 544337; Fax: +36 62 420505; E-mail: tkiss@chem.u-szeged.hu; Web site: http://www.staff.u-szeged.hu/~vanadium/

Sept 6-12, 2004: EUROSOIL 2004, Freiburg, Germany. Web site: http://www.forst.uni-freiburg.de/eurosoil/

Sept 19-22, 2004: 8th International Congress on Applied Mineralogy (ICAM 2004), Aguas de Lindoia, Aguas de Lindoia, Sao Paolo, Brazil. Contact: Dogan Paktunc, Phone: +1 613 947 7061; Fax: +1 613 996 9673; E-mail: dpaktunc@nrcan.gc.ca; Web site: http://www.icam2004.org

Sept 20-24, 2004: 2nd Mid-European Clay Conference, Miskolc, Hungary. Contact: Dr I. Viczian; E-mail: viczian@ludens.elte.hu or Dr T.G. Weisburg; E-mail: weiszburg@ludens.elte.hu

Nov 14-19, 2004: IAVCEI 2004 General Assembly Volcanism and its Impact on Society, Puc—n, Chile. Contact: Jos A. Naranjo or Jorge Clavero, General Secretariat IAVCEI 2004 GA, Av. Santa Maria 0104, Providencia, Santiago, Chile; Phone: +56-2-737 50 50; Fax: +56-2-777 19 06; E-mail: iavcei@sernageomin.cl; Web site: www.sernageomin.cl/iavcei

Dec, 2004: ACE 2004 - 5th European meeting on environmental chemistry, Bari, Italy. Contact: Dr. Michele Aresta, METEA Research Center, University of Bari, via Celso Ulpiani 27, 70126 Bari, Italy; E-mail: resta@metea.uniba.it

Dec 13-17, 2004: AGU Fall Meeting, San Francisco, California, USA. Contact: meetinginfo@agu.org.

Aug, 2005: IUCr-20 - XX Meeting and General Assembly of the International Union of Crystallography, Florence, Italy.

Feb 20-24, 2006: AGU Ocean Sciences Meeting, Honolulu, Hawaii.

July, 2006: IMA-2006 - XIX General Meeting of the International Mineralogial Association, Kobe, Japan.

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