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 Ingrerson 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.

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THE GEOCHEMICAL NEWS

July 2003

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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 started informing 97 national committees about the 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 stimulating 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.

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 14C 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.

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 Boudureaux (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
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.

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 Winnat’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.

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.
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.

Vala: You were in Glasgow then?

Geoff: Yes.

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, there weren’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
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 to 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 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...
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.

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 Oludai 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 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.

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 Brasseil, 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?

Newsletter of the Geochemical Society
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 300°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 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 asbestos-form 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).


Cosmochemistry

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.

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 (“peepers”) 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.

Environmental Soil Chemistry
(Daniel G. Strawn, Soil Science, UI)
35, 31-38.

Environmental Biogeochemistry
(Matt Morra, Soil Science, UI)

Figure 3. Taking samples from “peepers” installed in sediments in Lake Coeur d’Alene, Idaho.
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.


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 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.


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.


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 representational 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.

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.


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 ratios 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.
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.


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...
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.


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.
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 (Tolstropp 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).


**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 minerals and inorganic glasses and to 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 isotopic 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 isotopic 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 petrogenetic, focusing on the role of subduction, magma output, and sediment delivery to the trench (collaborative NSF project with Gene Yegozdinski, 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 UIF Sereldun, University of Arizona; Vincent Salters, Florida State University; Janne Blichert-Toft, Jcde Normale Sup riure, 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/tertiogenic/geoletic 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); b) a study of the Sr and Nd isotopic composition of the Cretaceous-Tertiary boundary (with Scott Wood, UI); c) new research on petrogenesis of volcanic rocks 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.


**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.


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, Lingerin...
Thirty Years of Water-Rock-Human Interactions

Yousif K. Kharaka
Chairman, Working Group on Water-Rock Interaction
U. S. Geological Survey, 345, Middlefield Road
Menlo Park, California 94025, USA
ykharaka@usgs.gov

The Eleventh International Symposium on Water-Rock Interaction (WRI-II), 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-I 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).

Vision 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 Lomonov 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-I would set the focus needed for the next three decades by launching a series of triennial WRI Symposia.

WRI-I through WRI-X

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.

<table>
<thead>
<tr>
<th>Symposium</th>
<th>Year</th>
<th>Participants</th>
<th>Venue</th>
<th>Secretary General</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRI-1</td>
<td>1974</td>
<td>148</td>
<td>Prague (Czechoslovakia)</td>
<td>Tomas Paces</td>
</tr>
<tr>
<td>WRI-2</td>
<td>1977</td>
<td>236</td>
<td>Strasbourg (France)</td>
<td>Yves Tardy</td>
</tr>
<tr>
<td>WRI-3</td>
<td>1980</td>
<td>145</td>
<td>Edmonton (Canada)</td>
<td>Brian Hitchon</td>
</tr>
<tr>
<td>WRI-4</td>
<td>1983</td>
<td>210</td>
<td>Misasa (Japan)</td>
<td>Hitoshi Sakai</td>
</tr>
<tr>
<td>WRI-5</td>
<td>1985</td>
<td>250</td>
<td>Reykjavik (Iceland)</td>
<td>Hallor Armannsson</td>
</tr>
<tr>
<td>WRI-6</td>
<td>1989</td>
<td>350</td>
<td>Malvern (United Kingdom)</td>
<td>Mike Edmunds</td>
</tr>
<tr>
<td>WRI-7</td>
<td>1992</td>
<td>579</td>
<td>Park City (USA)</td>
<td>Yousif Kharaka</td>
</tr>
<tr>
<td>WRI-8</td>
<td>1995</td>
<td>260</td>
<td>Vladivostock (Russia)</td>
<td>Oleg Chudaev</td>
</tr>
<tr>
<td>WRI-9</td>
<td>1998</td>
<td>287</td>
<td>Taupo (New Zealand)</td>
<td>Brian Robinson</td>
</tr>
<tr>
<td>WRI-10</td>
<td>2001</td>
<td>480</td>
<td>Cagliari, Sardinia (Italy)</td>
<td>Luca Fanfani</td>
</tr>
</tbody>
</table>

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 46 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.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>08/03</td>
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</tr>
<tr>
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<td>Email letter only, reminding participants about specific symposia, giving details for extended abstracts, and advertising speakers and keynote titles.</td>
</tr>
<tr>
<td>10/15/03</td>
<td>Extended abstract and early registration deadline</td>
</tr>
<tr>
<td>02/03/04</td>
<td>Late registration deadline</td>
</tr>
<tr>
<td>03/15/04</td>
<td>Third circular with tentative program posted on web</td>
</tr>
<tr>
<td>06/04</td>
<td>Fourth circular given out at meeting as the Program (print)</td>
</tr>
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</table>
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.
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.

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 al., 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 come to 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.

References Cited

WRI Proceedings
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
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
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