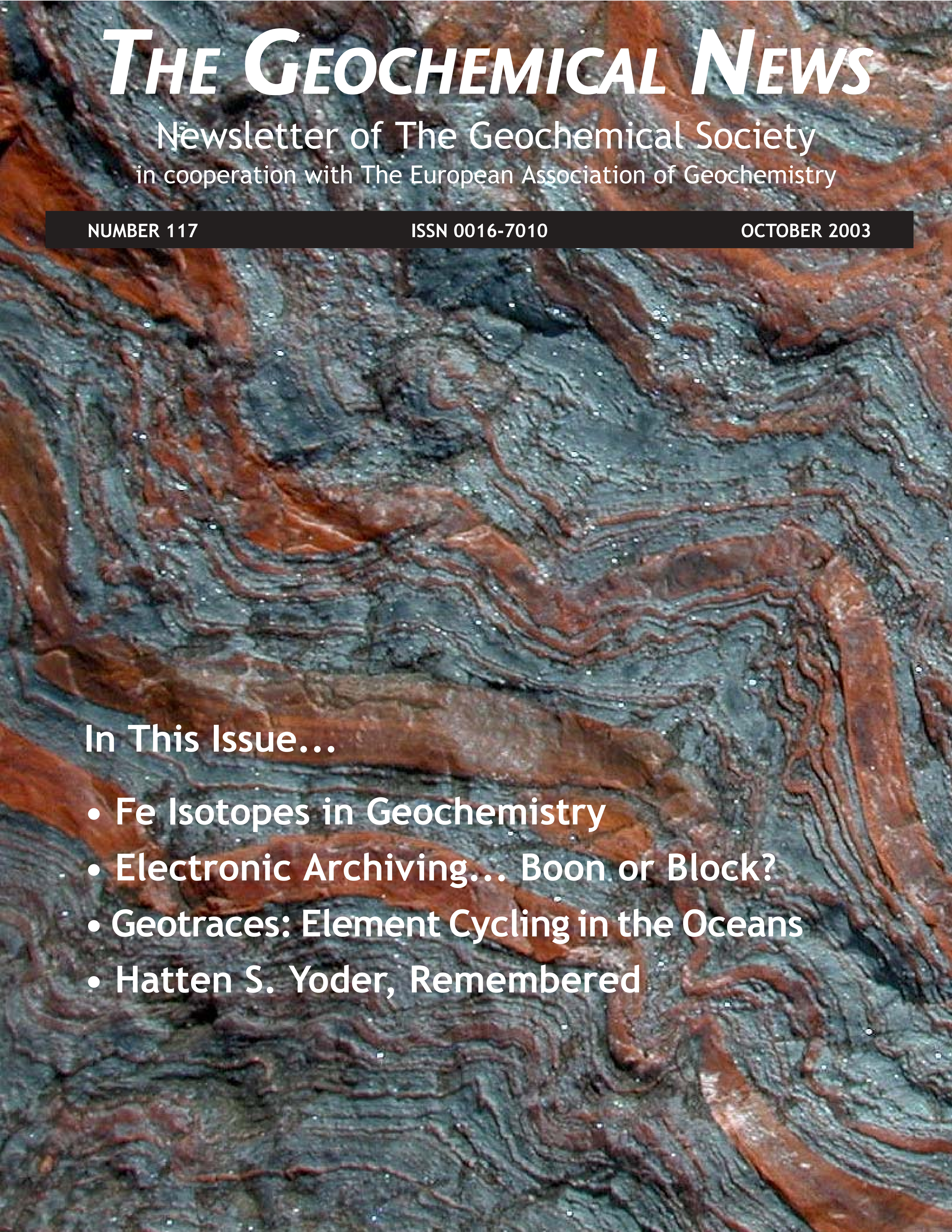
THE GEOCHEMICAL NEWS

Newsletter of The Geochemical Society
in cooperation with The European Association of Geochemistry

NUMBER 117 ISSN 0016-7010 OCTOBER 2003



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- Geotraces: Element Cycling in the Oceans
- Hatten S. Yoder, Remembered

THE GEOCHEMICAL SOCIETY

The **Geochemical Society** is a nonprofit scientific society founded to encourage the application of chemistry to the solution of geological and cosmological problems. Membership is international and diverse in background, encompassing such fields as organic geochemistry, high- and low-temperature geochemistry, petrology, meteoritics, fluid-rock interaction, and isotope geochemistry. The Society produces a ***Special Publications Series***, ***The Geochemical News*** (this quarterly newsletter), the ***Reviews in Mineralogy and Geochemistry Series*** (jointly with the Mineralogical Society of America), the journal ***Geochimica et Cosmochimica Acta*** (jointly with the Meteoritical Society), and co-publishes the electronic journal ***G^3*** (jointly with the American Geophysical Union: AGU); grants the ***V.M. Goldschmidt***, ***F.W. Clarke*** and ***Clair C. Patterson Awards***, and, jointly with the European Association of Geochemistry (EAG), the Geochemistry Fellows title; sponsors the V.M. Goldschmidt Conference, held in North America in odd years and elsewhere in even years, jointly with the EAG; and co-sponsors the Geological Society of America annual meeting and the AGU spring meeting. The Society honors our first President, F. Earl Ingerson, and our first Goldschmidt Medalist, Paul W. Gast, with the ***Ingerson*** and ***Gast Lectures***, held annually at the GSA Meeting and the V.M. Goldschmidt Conference, respectively. The Geochemical Society is affiliated with the American Association for the Advancement of Science and the International Union of Geological Sciences.

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

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THE GEOCHEMICAL NEWS
October 2003

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From the President

The 2003 Goldschmidt Conference – "Frontiers in Geochemistry"

The GN Editors' deadline for the submittal of this my final letter as GS President coincides with my return from the 13th Goldschmidt Conference held in Kurashiki, Japan from 7 to 12 September 2003. Thus, I have the opportunity to send a first-hand report on an outstanding Goldschmidt Conference, the first to be held outside of Europe or North America. Nearly 1200 geochemists were in attendance, making this the second largest Goldschmidt Conference and continuing the recent growth trend. While approximately half the delegates came from throughout Japan, the other half had travelled from far and wide, representing countries rather evenly divided among the Americas and Europe, as well as the rest of Asia and Oceania. The modern architectural setting of Sakuyo University, the site of the conference venue located amidst tropical vegetation on a hilltop above Shin-Kurashiki, offered spacious areas to meet and converse. Oral presentations (762) were divided among 10 simultaneous sessions held in modern air-conditioned lecture rooms. The organizers limited lectures to either electronic presentations or overhead transparencies. This system functioned smoothly without a serious hitch, indicating that we have fully made the transition from loading slide trays to inputting compact disks with PowerPoint presentations. The space for posters (393) was very generous, and offered a meeting point in a cool climatized setting. Indeed, adequate air conditioning was not a minor issue with daily temperatures climbing over 30 °C accompanied by extremely high humidity. Multiple beverages were offered at morning and afternoon coffee breaks to help quench the thirst brought on by the unusual late summer weather. Additionally, these beverages could be supplemented with many "interesting" drinks available from well-stocked vending machines. At lunchtime, a wide selection of Japanese dishes was served in the spacious cafeteria for a very reasonable price.

Each morning, the participants would converge on Kurashiki Station to board one of the numerous trains making the short trip to Shin-Kurashiki. Once I had mastered the rapid and efficient rail transport system, I found that the wait, either coming or going from the conference, provided me with a wonderful opportunity to refresh old acquaintances and form new ones. Pleasant conversation, punctuated with frequent comments on the weather, flowed with the continuing scientific discussions. Indeed, this year's Goldschmidt Conference was an ideal occasion to build new bridges with colleagues from diverse locations and learn about the latest developments in our state-of-the art science. The unique culture experience offered by holding the Goldschmidt Conference in Japan was truly memorable, ranging from exploring the many restaurants in the Bikan-area of the well-preserved, historical center of Kurashiki to the performance of Japanese music and dance accompanying the Monday evening welcoming. I do not hesitate to state that the Goldschmidt Conference has become a truly international meeting crossing the "Frontiers in Geochemistry" around the globe. I extend my congratulations and many thanks to the organizers for a very successful and extremely stimulating conference.

Upcoming Geochemical Events

With the Kurashiki Goldschmidt Conference behind us, it is now time to begin thinking ahead to the 2004 Goldschmidt to be hosted by a Nordic consortium in Copenhagen, Denmark from 5 to 11 June. Session topics will be centered on the theme of Processes in Geochemistry: Forces, Fluxes and Structure. For further information, check the conference web site (www.goldschmidt2004.dk).

Recognizing that it may not be possible for many members of The Geochemical Society to attend the Goldschmidt Conference each year, we have proposed to increase our presence at the GSA Annual Meeting. To this end, the Program Committee chaired by Marty Goldhaber has been actively engaged in putting a stronger geochemical emphasis in many sessions of this year's GSA Annual Meeting, to be held in Seattle, WA on 2-5 November. Additionally, there will be a GS booth in the Exhibition Hall displaying the benefits of GS membership. If you plan to be at GSA this year, please stop by the booth and talk with Seth Davis, the GS Business Manager, who will be happy to help you renew your GS membership on site. Also, plan to meet your geochemical colleagues at the ticketed MSA/GS reception on Tuesday evening.

Changing of the Guard

My two-year term as President of The Geochemical Society will end on 31 December 2003. Although I will still serve a few more months, this will be my last "From the President" letter. Therefore, I would like to take this opportunity to tell you how much I have enjoyed my time in office. Through my participation as a GS officer at the last four Goldschmidt Conferences, I have become newly or re-acquainted with many of you and have greatly valued the opportunity I have had to serve the GS community. I have enjoyed the personal contacts with members of the various committees, working together to achieve the numerous deadlines. One of my greatest pleasures as President has been to inform the new medallists and fellows of their awards. I would like to recognize the members of the Board of Directors whose wise and timely input, mainly via e-mail, has been much appreciated during my term. Since joining the Board as Vice President in 2000, I have watched the importance of the Goldschmidt Conference grow and personally feel that nurturing future conferences has become an increasingly important duty of the Board. I would like to especially thank Carla Koretsky and Johnson Haas for their fine production of The Geochemical News, which is an excellent reflection of our lively field of geochemistry. Finally, I would like to gratefully acknowledge the general and frequent assistance of Jeremy Fein, GS Secretary, and Seth Davis, GS Business Manager, who together keep the daily business of The Geochemical Society on track.

I will be pleased to turn the presidency over to our current Vice President, Tim Drever, who will be joined by our new Vice President, Susan Brantley. I wish them success and will look forward to working with them as Past President during the next two years. With the approach of the 50th anniversary of The Geochemical Society, to be celebrated at the 2005 Goldschmidt Conference in Idaho, there will be much work to do. We can, however, be proud of our accomplishments, while always aiming to better promote the field of geochemistry and increase its visibility and strength internationally.

With best wishes,

Judith A. McKenzie
GS President

Judith A. McKenzie

COVER:
A sample from the banded iron formations of northern Michigan, showing the gnarled and twisted texture of these laminated, metamorphosed rocks. The photo scale shows ~5 cm of the rock face in vertical dimension. Photo credit: Johnson R. Haas

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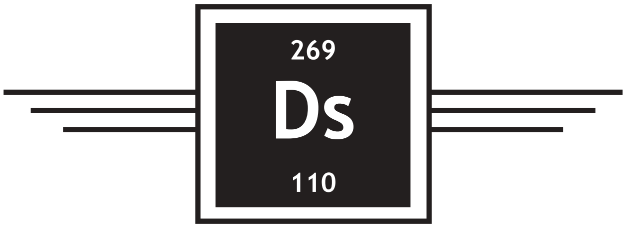
EDITOR'S CORNER...

As we compile this issue of *Geochemical News*, the 2003 V. M. Goldschmidt Conference in Kurashiki, Japan draws to a close. We hope, and fully expect, that this year's Goldschmidt Conference - the first ever held in Asia - was a huge success for all involved. The editors of *GN* would like to offer congratulations to the program committee, organizers, supporters, and attendees who helped to promote the science of Geochemistry at this year's Goldschmidt event. With you, we look forward to the 2004 Goldschmidt in historic Copenhagen, Denmark.

In this issue, we examine the growing field of iron isotope geochemistry, in a timely and informative review by Brian Beard and Clark Johnson, both pioneers in this exciting new field of study. Innovations drive science forward, and so the GS now seeks your nominations for the 2003 awards cycle: it's time once again to recognize the leaders who have enriched and advanced our discipline.

Until next issue...

Johnson R. Haas
Carla Koretsky
Editors



Element 110 is named Darmstadtium

At the 42nd General Assembly in Ottawa, Canada, the IUPAC Council officially approved the name for element of atomic number 110, to be known as darmstadtium, with symbol Ds.

In 2001, a joint IUPAC-IUPAP Working Party (JWP) confirmed the discovery of element number 110 and this by the collaboration of Hofmann et al. from the Gesellschaft für Schwerionenforschung mbH (GSI) in Darmstadt, Germany (Pure Appl. Chem. 73, 959-967 (2001)). The most relevant experiment resulted from the fusion-evaporation using a ^{62}Ni beam on an isotopically enriched ^{208}Pb target, which produced four chains of alpha-emitting nuclides following the presumed formation of $^{269}110 + 10n$. (S. Hofmann et al., Z. Phys. A350, 277-280 (1995)).

In a soon-to-be-published second report, the JWP has re-endorsed the confirmed synthesis of element 110 by the team at GSI led by Sigurd Hofmann. In accordance with IUPAC procedures, the discoverers at the GSI were invited to propose a name and symbol for element 110 to the IUPAC Inorganic Chemistry Division. Hofmann's team proposed the name darmstadtium, with the symbol Ds. This name continues the long-established tradition of naming an element after the place of its discovery.

IUPAC was formed in 1919 by chemists from industry and academia. For nearly 85 years, the Union has succeeded in fostering worldwide communications in the chemical sciences and in uniting academic, industrial and public sector chemistry in a common language. IUPAC is recognized as the world authority on chemical nomenclature, terminology, standardized methods for measurement, atomic weights and many other critically evaluated data. More information about IUPAC and its activities is available at www.iupac.org.

For specific questions regarding the discovery and naming of Element 110, contact Prof. John Corish <jcorish@tcd.ie> or Dr. Gerd Rosenblatt <grosenblatt@lbl.gov>

From The Geochemical Society Business Office

Currently all memberships to the Geochemical Society are calendar year. If you have a 2003 membership, it will be up for renewal soon. Starting October 1st, I will begin sending out e-mail notices and processing memberships for the 2004 calendar year. To save time and money and so that you can get the most from your membership, please renew early, and encourage your peers and colleges to join. I will be accepting memberships and renewals at the GSA- Seattle Meeting this November. If you will be attending, you may drop by the GS exhibit booth and renew there.

New Membership Benefit: 20% Discount on Jossey-Bass publications. Thanks to negotiations between the Special Publications Editor, Scott Wood, and the Jossey-Bass Marketing Manager, the Geochemical Society is now able to add yet another reason to be a Geochemical Society Member. To take advantage of this discount, please provide the following promotional code when ordering: **JBNPD**. Orders must be through Jossey-Bass, but may be submitted by phone at: **1-800-956-7739**, or on-line at: http://www.josseybass.com/WileyCDA/

Each issue, I will reference a featured Jossey-Bass book. This issue it is "Getting Science Grants" by Tom Blackburn. For more information or to order your copy, visit: http://www.josseybass.com/WileyCDA/WileyTitle/productCd-0787967467.html

I would like to take a moment to thank these donors for their additional financial contributions to the Geochemical Society's general fund:

Philip H. Abelson
Edward Sholkovitz
C. John Suen
Robin Brett

The general fund goes to support such programs as the Meeting Assistance Program (up to $10,000/yr) and the Student Travel Grants Program (up to $15,000/yr). Please feel free to make a donation to the Geochemical Society when you renew your membership and/or subscription.

Back issues of Geochemical News: If you are missing an issue of your Geochemical News subscription and would like one sent to you, please let me know. I will fill requests for issues until I run out. Also note, that you can view and download a copy of Geochemical News from the GS website at: http://gs.wustl.edu/archives/#NewsLett

GCA Back Issue Orders: Elsevier has recently undergone a restructuring of their back issue orders department. As a result their response and turn-around time has improved remarkably. If you have made a request before June 2003 and still have not received your issues, please let me know and I will get your issues to you. Check your subscription to make certain all of your issues are there; I can only process back issue requests from v.65/1 (January 2001) to date.

It is not too soon to start thinking about the 2004 Goldschmidt held in Copenhagen, Denmark on June 5 – 11, 2004 For more information log on to: http://www.goldschmidt2004.dk/

Best regards,
Seth Davis
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The Geochemical Society 2003 Awards Nominations

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

Please take the time to honor your deserving friends and colleagues! It is up to you, as members of the Geochemical Society, to ensure that all of geochemistry is recognized, and all geochemists are considered!

Important Notice!
The Chairs of the Goldschmidt, Clarke and Geochemistry Fellows Committees have requested that nominations be sent by e-mail when ever possible and that submissions include a nomination cover sheet. These coversheets are available for download from the GS website at: ***http://gs.wustl.edu/archives/nominations.html***

V.M. Goldschmidt Award

The V. M. Goldschmidt Award shall be made for major achievements in geochemistry or cosmochemistry, consisting of either a single outstanding contribution, or a series of publications that have had great influence on the field. The award will normally be given annually at the V.M. Goldschmidt Conference. Current members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination. Nominations should include (1) a completed Cover Sheet, (2) a brief CV for the candidate, (3) an additional page, if necessary, listing the candidate's publications, and (4) up to three supporting letters. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society. To be considered for the 2004 award, nominations must be received by **November 15, 2003**. Nominations received later will be considered for the 2005 award. Nominations should be submitted to:

Lee R. Kump
Department of Geosciences
The Pennsylvania State University, 535 Deike Building
University Park, PA 16802 USA
Tel: 814-863-1274 Fax: 814-865-3191
Email: lkump@psu.edu


V. M. Goldschmidt

Past Recipients: P.W. Gast (1972), R.M. Garrels (1973), H.E. Suess (1974), H.C. Urey (1975), H.P. Eugster (1976), S. Epstein (1977), G.J. Wasserburg (1978), H. Craig (1979), C.C. Patterson (1980), R.N. Clayton (1981), K.B. Krauskopf (1982), S.S. Goldich (1983), A.O. Nier (1984), J.B. Thompson (1985), C.J. All gre (1986), W.S. Broecker (1987), H.C. Helgeson (1988), K.K. Turekian (1989), E. Anders (1990), A.E. Ringwood (1991), S.R. Hart (1992), S.R. Taylor (1993), H.D. Holland (1994), R.A. Berner (1995), A.W. Hofmann (1996), D. Lal (1997), W. Stumm (1998), J.L. Bischoff (1999), G. Eglinton (2000), I. Kushiro (2001), J. Hayes (2002), B.J. Wood (2003)

F. W. Clarke Award

The F. W. Clarke Award shall normally be made annually at the V. M. Goldschmidt Conference to an early-career scientist for a single outstanding contribution to geochemistry or cosmochemistry, published either as a single paper or a series of papers on a single topic. Eligibility for this award is met if either of the following criteria is satisfied on the first day of the year in which the award is given: (a) the candidate must have received a recognized doctorate or its equivalent within the last six (6) years; or (b) must not have celebrated their thirty fifth (35th) birthday. Current members of the Board of Directors and past recipients of the award are ineligible for nomination. The Clarke and Patterson medals cannot be awarded for the same accomplishment.

Nominations should include (1) a completed Cover Sheet, (2) a letter from the nominator containing a brief explanation of the significance of the nominee's work, (3) a brief CV for the nominee, (4) a copy of the paper(s) for which the nominee is being considered for the award, and (5) up to three supporting letters. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society. To be considered for the 2004 award, nominations must be received by **November 15, 2003**. Nominations received later will be considered for the 2005 award. Nominations submitted (as pdf, MS Word, or text files) by email to the committee chair are encouraged. Nominations should be submitted to:

Craig M. Bethke
Department of Geology, University of Illinois, 1301 West Green Street
Urbana, IL 61801, USA
Tel: 217-333-3369 Fax: 217-244-4996 Email: bethke@uiuc.edu


F. W. Clarke

Past Recipients: D.A. Papanastassiou (1972), H. Ohmoto (1973), L. Grossman (1974), D. Walker (1975), J.R. Wood (1976), B. Mysen (1977), D.J. DePaolo (1978), A.C. Lasaga (1979), R.W. Potter (1980), J.F. Minster (1981), P.J. Patchett (1982), E.B. Watson (1983), A. Mackenzie (1984), E.M. Stolper (1985), M.D. Kurz (1986), E. Takahashi (1987), F.M. Phillips (1988), R.J. Walker (1990), D. Sherman (1991), E. Klein (1992), Y Zhang (1993), C. Agee (1994), R. Lange (1995), P.M. Dove (1996), J. Blundy (1997), M. Humayun (1998), A.M. Scheidegger (1999), J. Farquhar (2000), C.C. Lundstrom (2001), R. Blake (2002), P.D. Asimow (2003).

Clair C. Patterson Award

The Clair C. Patterson Award, for a recent innovative breakthrough in environmental geochemistry of fundamental significance, published in a peer-reviewed journal, will normally be made annually at the V.M. Goldschmidt Conference. The award has no age or career stage restrictions, but the Clarke and Patterson medals cannot be awarded for the same accomplishment. Current members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination.

Clair C. Patterson

Nominations should include the name, address, and chief fields of specialization of the nominee, and be accompanied by a curriculum vita of not more than two pages, a list of no more than 10 peer-reviewed publications relevant to the accomplishment being recognized, and up to three support letters. Nominators should include a letter of not more than two pages, giving name, address, phone number, signature, and a brief description of the nominee's contribution to environmental geochemistry. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society. To be considered for the 2004 award, nominations must be received by **November 15, 2003**. Nominations received later will be considered for the 2005 award. Nominations should be submitted to:

F.J. Millero
RSMAS / MAC, University of Miami
4600 Rickenbacker Causeway, Miami, FL 33149-1098, USA
Tel: 305-361-4707 Fax: 305-361-4144
Email: fmillero@rsmas.miami.edu

Past Recipients: M.L. Bender (1998), R.L. Edwards (1999), E.A. Boyle (2000), F. M.M. Morel (2001), H. Elderfield (2002), W.F. Fitzgerald (2003).

Geochemistry Fellows

The European Association of Geochemsitry (EAG) and the Geochemical Society(GS) established in 1996 the honorary title of Geochemistry Fellow, to be bestowed upon outstanding scientists who have, over some years, made a major contribution to the field of geochemistry. Existing and new Urey, Goldschmidt, and Treibs Medal winners become Fellows automatically. Up to 10 new Fellows will be elected each year. Membership in either organization is not a factor in consideration of Fellows candidates. Current members of the Fellows Selection Committee, the GS Board of Directors, and the EAG Council are ineligible for nomination. Any member of either organization may nominate Fellows by right.

Nominations should include (1) a completed Cover Sheet, (2) a brief CV for the nominee, (3) an additional page for citations, if necessary, and (4) up to three supporting letters. Awards are based solely on scientific merit, without regard to citizenship or membership in either Society. To be considered for the 2004 award, nominations must be received by **November 15, 2003**. Nominations received later will be considered for the 2005 award. Nominations submitted (as pdf, MS Word, or text files) by email to the committee chair are encouraged, although signed originals of documents must also be submitted by conventional mail. Nominations should be submitted to:

Dr. Lynn Walter
Dept. of Geological Sciences
University of Michigan, 2534 C.C. Little Building
Ann Arbor, MI 48109 USA
Tel: 734-763-4590 Fax: 734-763-4690
Email: lmwalter@umich.edu

Geochemistry Fellows (excluding Urey, Goldschmidt, and Treibs Medalists)

1996 – W. Compston, W. Dansgaard, J. Edmond, J.M. Hayes, M. Javoy, H.-K. Mao, S. Moorbath, J. Reynolds, J.-G. Schilling, N. Shackleton, M. Tatsumoto, W. Stumm, G. Tilton, G. Turner, H. W nke, W. White. **1997 –** P. Abelson, J. Bottinga, I. Carmichael, D.J. DePaolo, B.J. Giletti, T. Krogh, I. Kushiro, G.W. Lugmair, F.T. Mackenzie, A. Navrotsky, M. O'Hara, K. O'Nions, D.M. Shaw, E.M. Stolper, G.W. Wetherill, D. York. **1998 –** T.J. Ahrens, F. Albarede, M.L. Bender, E.A. Boyle, E.M. Galimov, J.I. Hedges, M. Kastner, Y. Kolodny, C.H. Langmuir, J.R. O'Neil, G. Parks, J.C.G. Walker, D. Walker, E.B. Watson, B.J. Wood, J. Veizer, E. Zinner. **1999** – H.L. Barnes, G.E. Brown, C.W. Burnham, W.S. Fyfe, N. Shimizu. **2000 –** H. Elderfield, G. Faure, F.A. Frey, G. Hanson, F.J. Millero, F.M. Morel, M. Ozima, D. Rumble II, T.M. Seward, G.A. Zindler. **2001 -** A. Halliday, C.J. Hawkesworth, W.J. Jenkins, B.B. Joergensen, I. Tolstikhin, R. Wollast. **2002 -** D. Des Marais, M. Drake, I. Friedman, C. Martens, P. Meyers, G. Sposito, and J. Wasson. **2003** – R.C. Aller, R.W. Carlson, M. Fogel, S. Krishnaswami, J.W. Morse, H. Palme, D. Rickard

Information for Contributors

Geochemical News **publishes timely and informative articles, announcements, letters, and reviews relevant to geochemists and geochemistry. Contributions are welcome from professionals, students, and other interested parties. Please send all communications to geochemical-news@wmich.edu.**

Text contributions should be in Microsoft Word format. Graphics submitted as figures to accompany articles MUST be submitted as separate individual files, in one of the following formats only: GIF, JPG, or TIFF. No PDF files for graphics! Publication-ready, graphically-designed contributions (i.e. advertisements, announcements) may be submitted as PDF files, and must fit within one page having the dimensions 18.4 cm wide by 22.9 cm tall (or smaller).

Thanks again for your contributions!

In Memoriam: Hatten S. Yoder, Jr. (1921-2003)

Hatten S. Yoder, Jr., internationally known experimental petrologist and geochemist, and Emeritus Director of the Carnegie Institution of Washington's Geophysical Laboratory in Washington, DC, died on August 2, 2003, following complications from surgery. He was a founding member of the Geochemical Society, served on its Council (1956-1958), and was a member of the Editorial Board of Geochimica et Cosmochimica Acta from 1958 to 1968.

Hat was born on March 20, 1921 and raised in Cleveland, Ohio. He obtained his B.S. degree at the University of Chicago in 1940, and his PhD at the Massachusetts Institute of Technology in 1948. Hat was the recipient of honorary doctorate degrees from the University of Paris VI (France) and from the Colorado School of Mines.

In addition to his membership and services to the Geochemical Society, Hat was a member of the National Academy of Sciences, The American Philosophical Society, and a Fellow of the American Academy of Arts and Sciences. He held honorary memberships or was a fellow of 10 professional national and international associations. He was the recipient of numerous national and international awards including the Arthur L. Day Prize of the National Academy of Sciences, the Arthur L. Day Medal (American Geological Society), The Roebling Medal (Mineralogical Society of America), the A. G. Werner Medal (German Mineralogical Society), and the Wollaston Medal (Geological Society of London)

Hatten S. Yoder, Jr. spent his 55-year scientific career at the Geophysical Laboratory of the Carnegie Institution of Washington. Here, he held positions as Experimental Petrologist (1948-71), Director (1971-86), and Emeritus Director until his death (1986-2003). In addition, he was visiting professor at CalTech (1958), University of Texas (1964), University of Colorado (1966), and University of Cape Town (1967).

Prior to 1948, when Hat arrived at the Geophysical Laboratory, high-pressure experiments were limited to the uppermost portions of the Earth's crust. Because of the obvious experimental need to reach the pressure and temperature conditions of the crust and the mantle, Hat immediately set out to design an apparatus that could reach the necessary pressure and temperature conditions. The resulting instrument, the internally-heated, high-pressure apparatus, is still in use.

This new apparatus was used in Hat's early work on jadeite stability relations in 1950 and on the effect of pressure on the melting point of diopside in 1952. Those investigations were followed by several experimental studies on the stability relations of micas (with H. P. Eugster and J. V. Smith). The interest in mica stability relations culminated in a detailed study of the melting relations of phlogopite (with I. Kushiro). This was the first experimental demonstration that a hydrous mineral such as phlogopite was stable at upper mantle pressures to its melting point. Hat established, therefore, about 35 years ago, that phlogopite could be a principal mineral in which H_2O could be recycled from the Earth's crust into its deeper interior. His interest in phase relations of H_2O-bearing systems also led Hat to conclude, as early as in his 1968 studies of plagioclase-H_2O and enstatite-H_2O (with I. Kushiro and M. Nishikawa), that H_2O has profound effects on high-pressure magmatic processes including andesite petrogenesis in the upper mantle.

Inspired by Normal L. Bowen and Frank Schairer, Hat focused on melting relationships among silicates. This interest is reflected in a number of simple-system experimental studies published in the 1950's. Those, in turn, led to the classic study on the origin of basalt magmas (with C. E. Tilley) published in 1962. It was here that the now-classic basalt tetrahedron first appeared. The phase relations within the basalt tetrahedron remain the guiding light for anyone interested in basalt petrogenesis to this day. There is hardly a topic in modern experimental petrology and geochemistry where he was not involved. More often than not, he led the way.

One might surmise that Hat would be content working at the Geophysical laboratory with the unique research circumstances offered by this organization. This was not, however, Hat's style. He used his success as a scientist to help other people and to influence public policy. In addition to his services in the numerous professional societies, he was, for example, a member of the National Research Council's Executive Committee, as well as the U. S. National Committees for Geochemistry, and for History of Geology. He has served on a dozen departmental visiting committees across the country and the world. Hat advised Congress on issues ranging from natural resources to the hazards of asbestos.

Hatten S. Yoder, Jr. was beloved husband of his wife of 42 years, Elizabeth Marie Yoder, who died in February, 2001, and father to Hatten S. Yoder, III who died in November, 1998. Survivors include his daughter, Karen M. Wallace Yoder, Son-in-law, Keith A. Wallace, and granddaughter, Brianna Elizabeth Wallace.

High and Low Temperature Applications of Fe Isotope Geochemistry

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The field of Fe isotope geochemistry has experienced considerable growth since the first high precision Fe isotope data were published (Beard and Johnson, 1999; Beard et al., 1999; Mandernack et al., 1999), and isotopic studies of Fe join a rapidly growing field of "non-traditional" stable isotope systems (Johnson et al., 2004). There are over 20 different labs pursuing Fe isotope studies devoted to low and high temperature processes, ranging from planetary accretion, the effects of weathering in different environments, to biological cycling. The strong interest in the field of Fe isotopes is largely driven by the possible geochemical application of Fe isotopes in tracing Fe fluxes that are part of the Fe biogeochemical cycle. Moreover, the redox changes that occur for Fe are accompanied by large changes in Fe isotope compositions, suggesting that Fe isotopes may provide insight into redox conditions of modern and ancient environments. This review discusses the current state of knowledge in Fe isotope research, which is rapidly changing. We focus on terminology and analytical methods used in Fe isotope research, a summary of isotopic variations produced by high temperature processes in planetary bodies, the origin of Fe isotope fractionations at low temperatures, and experimental and theoretical determination of Fe isotope fractionation factors.

Nomenclature and Analytical Methods

Iron is the fourth most abundant element in the earth's crust and has four naturally occurring stable isotopes ^{54}Fe (5.84%), ^{56}Fe (91.76%), ^{57}Fe (2.12%), and ^{58}Fe (0.28%). Iron isotope data in the literature have been reported in both standard δ notation (part per 10^3), as well as in ε (parts per 10^4) notation and workers have reported data in terms of ^{57}Fe/^{54}Fe, ^{57}Fe/^{56}Fe, or ^{56}Fe/^{54}Fe ratios. The low abundance of ^{58}Fe limits its usefulness in describing mass-dependent variations, although ^{58}Fe is important for evaluating non-mass dependent effects (V lkening and Papanastassiou, 1989). In standard per mil notation, the δ^{56}Fe and δ^{57}Fe values are most commonly defined as:

$$\delta^{56}\mathrm{Fe} = (^{56}\mathrm{Fe}/^{54}\mathrm{Fe}_{\mathrm{sample}}/^{56}\mathrm{Fe}/^{54}\mathrm{Fe}_{\mathrm{standard}} - 1)*10^3,$$

and

$$\delta^{57}\mathrm{Fe} = (^{57}\mathrm{Fe}/^{54}\mathrm{Fe}_{\mathrm{sample}}/^{57}\mathrm{Fe}/^{54}\mathrm{Fe}_{\mathrm{standard}} - 1)*10^3.$$

Epsilon notation is defined similarly, although the deviations are in parts per 10,000. Comparison between these numbers is straightforward where, for example, an ε^{57}Fe value of +10.0 would be approximately equal to a δ^{56}Fe value of +0.67, as defined here, assuming normalization to an identical reference reservoir.

The choice of the reference reservoir for calculating δ or ε values is quite variable among different groups. At U.W. Madison, we have chosen to normalize Fe isotope values to the average of igneous rocks (Beard et al., 2003a), and this method follows the approach of other stable isotope systems such as oxygen, which reference δ values relative to a significant planetary reservoir such as Standard Mean Ocean Water. It is also an approach used in radiogenic isotopes where, for example, $\varepsilon_{\mathrm{Nd}}$, $\varepsilon_{\mathrm{Hf}}$, and γ_{Os} values are defined relative to a bulk earth or planetary reference value. Several other groups report Fe isotope composition relative to an igneous basaltic rock or iron meteorite (Mandernack et al., 1999; Sharma et al., 2001; Bullen et al., 2001; Brantley et al., 2001; Kehm et al. 2003). Other laboratories use the Fe isotope composition of the IRMM-014 standard (available from the Institute of Reference Materials and Measurements, Belgium; Taylor et al., 1992; 1993) as their reference value (e.g., Belshaw et al., 2000; Zhu et al., 2000; 2001; 2002; Matthews et al., 2001; Walczyk and von Blanckenburg, 2002). Interlaboratory comparison of Fe isotope ratios can be made by normalizing through a common standard such as IRMM-014. On our igneous rock scale, the δ^{56}Fe value of IRMM-014 is -0.09 ‰ and the δ^{57}Fe value is -0.11 ‰ (Beard et al., 2003a).

Iron isotope measurements are made by both the double-spike method using a thermal ionization mass spectrometer (TIMS) and by multi-collector inductively-coupled plasma mass spectrometry (MC-ICP-MS) (e.g., Johnson and Beard, 1999; Bullen et al., 2001; Belshaw et al., 2000, Beard et al., 2003a). The biggest difficulties using TIMS methods are the lengthy amount of time required for each analysis (4-8 hours per analysis) and the low ionization efficiency of Fe, which limits TIMS Fe isotope analyses to working with microgram quantities of Fe. Most workers are pursuing Fe isotope studies by MC-ICP-MS because of the high ionization efficiency and rapid sample throughput, and instrumental mass bias corrections are generally made using bracketing standards (e.g., Belshaw et al., 2000; Beard et al., 2003a). However, Fe isotope analysis made

using MC-ICP-MS presents special challenges because of isobars that are produced by the Ar plasma, including $^{40}Ar^{14}N$ on ^{54}Fe, $^{40}Ar^{16}O$ on ^{56}Fe, and $^{40}Ar^{16}OH$ on ^{57}Fe. Many workers have dealt with these isobars by using very large quantities (~20 mg) of Fe during an isotope analysis to minimize the abundance of Ar isobars, or have employed cool plasma techniques to eliminate Argides at the expense of decreased sensitivity (e.g., Belshaw et al., 2000; Kehm et al., 2003). Other workers have utilized a collision cell to eliminate or greatly reduce Ar isobars, and this approach provides very high sensitivity, where high precision Fe isotope analyses can be made on samples as small as 100 ng (Beard et al., 2003a). MC-ICP-MS analyses generally produce an external precision (2-S.D.) of 0.1 to 0.15 ‰ for $^{56}Fe/^{54}Fe$ or $^{57}Fe/^{54}Fe$.

Iron Isotope Variation in the Solar System

Figure 1 summarizes 185 Fe isotope analyses of high temperature rocks from the solar system. These data include Fe isotope analyses from five laboratories, and inter-laboratory bias has been corrected by normalization to a constant $\delta^{56}Fe$ value of –0.09 ‰ for IRMM-014, which places Fe isotope variations relative to the average of terrestrial igneous rocks (e.g., Beard et al., 2003a). The average $\delta^{56}Fe$ value of 43 terrestrial igneous rocks is 0.00 ± 0.05 ‰, and there are no discernable differences in the Fe isotope composition of different composition igneous rocks. Lunar rocks define a range of Fe isotope compositions that is similar to that of terrestrial igneous rocks, whereas the lunar regolith is shifted to higher $\delta^{56}Fe$ values (Figure 1), and the higher $\delta^{56}Fe$ values are probably a result of space weathering and Fe loss during vaporization and production of nanophase Fe metal (Wiesli et al., 2003). The SNC group of meteorites (Shergottites, Nakhlites, Chassignites, from Mars) has a narrow range of $\delta^{56}Fe$ values, and these tend to have $\delta^{56}Fe$ values that are ~0.1 ‰ less than terrestrial rocks (Zhu et al., 2001; Poitrasson et al., 2002). The HED meteorite group (Howardites, Eucrites, Diogenites) defines a range of Fe isotope compositions that is similar to that of terrestrial samples (Figure 1), but the distribution of $\delta^{56}Fe$ values is slightly skewed to lower values (by ~0.05 ‰) relative to terrestrial samples (e.g., Poitrasson et al., 2002; Mullane et al., 2003a). Iron meteorites and Fe metal from Pallasites have similar Fe isotope compositions; the average $\delta^{56}Fe$ value of 10 analyzed Iron meteorites is -0.03 ± 0.04 ‰, which is indistinguishable from that of terrestrial rocks (Zhu et al., 2001; Kehm et al., 2003). Metal from Iron meteorites and Pallasites, however, do show a similar distribution as the HED group, where there appears to be an overall shift to slightly lower $\delta^{56}Fe$ values as compared to terrestrial igneous rocks.

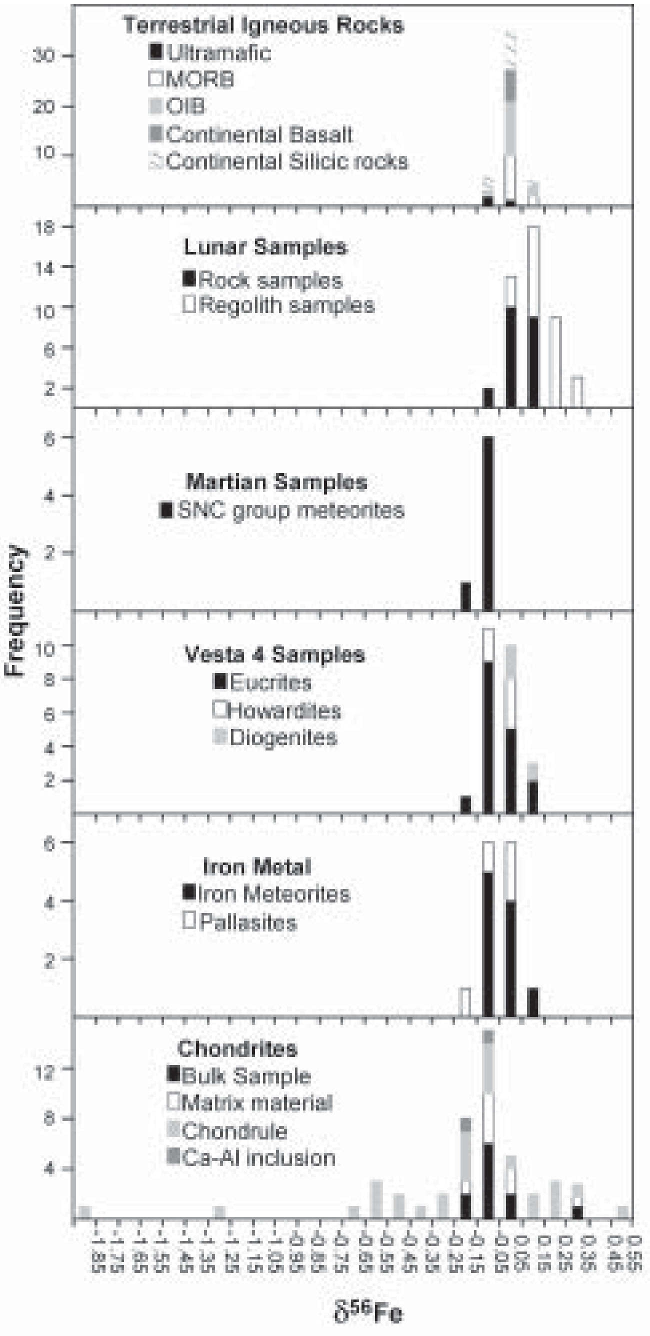

Figure 1: Frequency diagram of Fe isotope compositions measured in igneous rocks from terrestrial and extraterrestrial samples. Inter-laboratory bias in Fe isotope measurements have been corrected by normalizing to a $\delta^{56}Fe$ value of -0.09 ‰ for the IRMM-014 standard, which places Fe isotope measurements relative to the average of terrestrial igneous rocks. Data sources are: terrestrial igneous rocks from Beard et al. (2003a); lunar rock and regolith samples from Poitrasson et al. (2002; 2003); and Wiesli et al. (2003); SNC meteorite data from Zhu et al., (2001) and Poitrasson et al. (2002); HED meteorite data from Zhu et al. (2001); Poitrasson et al. (2002); and Mullane et al. (2003a); Iron and Pallasite meteorite data from Zhu et al. (2001) and Kehm et al. (2003); chondrite meteorite data from Zhu et al. (2001); Mullane et al. (2003b; c) and Kehm et al. (2003).

The most variable Fe isotope compositions occur in chondrites (Figure 1). For example, individual chondrules define a range of $\delta^{56}Fe$ from -1.9 to +0.5 ‰ (Zhu et al., 2001; Kehm et al., 2003; Mullane et al., 2003b; c). Even bulk chondritic meteorites define a significant range in Fe isotope compositions, where 8 bulk chondritic meteorites span a range from -0.24 to +0.29 ‰ in $\delta^{56}Fe$ values (Zhu et al., 2001; Kehm et al., 2003; Figure 1). The origin of the approximately 0.5 ä variations in bulk chondrites and chondrite matrices has been inferred to be a product of alteration processes on chondritic parent bodies, in particular aqueous alteration (Kehm et al., 2003). The origin of the 2.5 ‰ range in $^{56}Fe/^{54}Fe$ of chondrules has been inferred to result from evaporation and condensation during chondrule formation, alteration processes, and intrinsic mass-dependent isotopic heterogeneities in the starting material of individual chondrules (Kehm et al., 2003; Mullane et al., 2003b; c). Because the Fe isotope variations measured in these terrestrial and extraterrestrial samples all plot along a single mass-dependent fractionation line in terms of $^{56}Fe/^{54}Fe$-$^{57}Fe/^{54}Fe$ and $^{56}Fe/^{54}Fe$-$^{58}Fe/^{54}Fe$, it appears that the solar nebula was initially well homogenized with respect to Fe (Zhu et al., 2001; Kehm et al., 2003). This stands in marked contrast to the O isotope composition of extraterrestrial materials, where different meteorite groups tend to have unique $^{17}O/^{16}O$ - $^{18}O/^{16}O$ variations, and includes ^{16}O-rich components that do not reflect mass-dependent fractionations (Clayton, 1993).

There may be some subtle differences in the Fe isotope composition of different planetary bodies. For example, the average $\delta^{56}Fe$ value of bulk chondritic meteorites, excluding the Fe isotope composition of Orgueli analyzed by Zhu et al. (2001; see discussion in Kehm et al., 2003), is -0.11 ± 0.07 ‰. Moreover, Poitrasson et al. (2002) has noted that the SNC and HED meteorite groups have Fe isotope compositions that are less than terrestrial igneous rocks (approximately -0.07 ‰ in $^{56}Fe/^{54}Fe$). These observations led Poitrasson et al. (2002) to suggest that the heavy Fe isotope compositions of the Earth-Moon system were produced by vaporization and loss of Fe from the Earth-Moon system during formation of the moon by a giant impactor. However, these differences in Fe isotope composition are small and are based on a limited database. Demonstration of distinct Fe isotope contrasts among different planetary bodies caused by vaporization during planetary accretion will require extremely high-precision Fe isotope analyses and should include isotopic analysis of elements that have different volatility so that robust constraints may be made on their accretion history.

High Temperature Inter-Mineral Fe Isotope Fractionation

Zhu et al. (2002) reported that olivine, orthopyroxene, and clinopyroxene from three mantle xenoliths record inter-mineral equilibrium high temperature Fe isotope fractionation. Such a finding is surprising considering the lack of Fe isotope variation in igneous rocks (Beard et al., 2003a). In order to test if these reported Fe isotope fractionations are indeed a result of equilibrium fractionation or rather some type of disequilibrium process, olivine, orthopyroxene and clinopyroxene from eight spinel peridotites have been analyzed for major element and Fe isotope compositions (Beard and Johnson, 2003). Olivine compositions range from Fo_{92} to Fo_{89}, orthopyroxene compositions range from En_{92} to En_{88}, and clinopyroxene compositions range from Di_{86} to Di_{65}. The Fe isotope compositions of olivine, clinopyroxene, and orthopyroxene are variable and $\delta^{56}Fe$ values range from -0.52 to 0.00 ‰. On plots of the $\delta^{56}Fe$ value of olivine relative to that of orthopyroxene or clinopyroxene (Figure 2A and 2B, respectively), the $\delta^{56}Fe$ values of the phases are positively correlated. The difference between the $\delta^{56}Fe$ value of orthopyroxene and olivine ($\Delta^{56}Fe_{opx\text{-}ol}$) ranges from -0.15 to +0.13 ‰, but there is no correlation between Fe isotope composition of olivine or orthopyroxene and $\Delta^{56}Fe_{opx\text{-}ol}$ values. The difference between $\delta^{56}Fe$ value of clinopyroxene and olivine ($\Delta^{56}Fe_{cpx\text{-}ol}$) ranges from -0.01 to +0.21 ‰, and in this case $\Delta^{56}Fe_{cpx\text{-}ol}$ increases as the $\delta^{56}Fe$ value of clinopyroxene or olivine decreases. Moreover, $\Delta^{56}Fe_{cpx\text{-}ol}$ values are somewhat negatively correlated with the forsterite content of olivine (molar Mg/(Mg+Fe) ratio; Figure 2C).

Because of the inverse correlation between $\Delta^{56}Fe_{cpx\text{-}ol}$ and $\delta^{56}Fe$ values, it seems unlikely that the inter-mineral fractionations in these spinel peridotites are a result of equilibrium exchange of Fe isotopes at high temperature. Rather, we interpret the $\delta^{56}Fe_{clinopyroxene}$ and $\delta^{56}Fe_{olivine}$ variations to reflect open-system processes, drawing on analogous relationships that have been observed in oxygen isotope studies (e.g., Gregory and Criss, 1986). The $\Delta^{56}Fe_{cpx\text{-}ol}$ fractionations we observe correlate with mineral composition, where $\Delta^{56}Fe_{cpx\text{-}ol}$ fractionations are largest when the most Fe rich phase has the lowest $\delta^{56}Fe$ value.

Low Temperature Environments

The Fe isotope variations recorded in some extra terrestrial samples, as well as in some mantle materials (Zhu et al., 2001; 2002; Beard and Johnson, 2003), are apparently homogenized during magma generation, as recorded in the constant Fe isotope composition of a wide variety of igneous rocks ($\delta^{56}Fe=0.00 \pm 0.05$ ‰, 1s; Figure 1; Beard et al., 2003a). The homogenous Fe isotope composition of igneous rocks suggests that juvenile continental material will have $\delta^{56}Fe$ values of zero, and this provides a robust baseline with which to compare Fe isotope variations in low-temperature environments. The Fe isotope homogeneity of igneous rocks is generally reflected

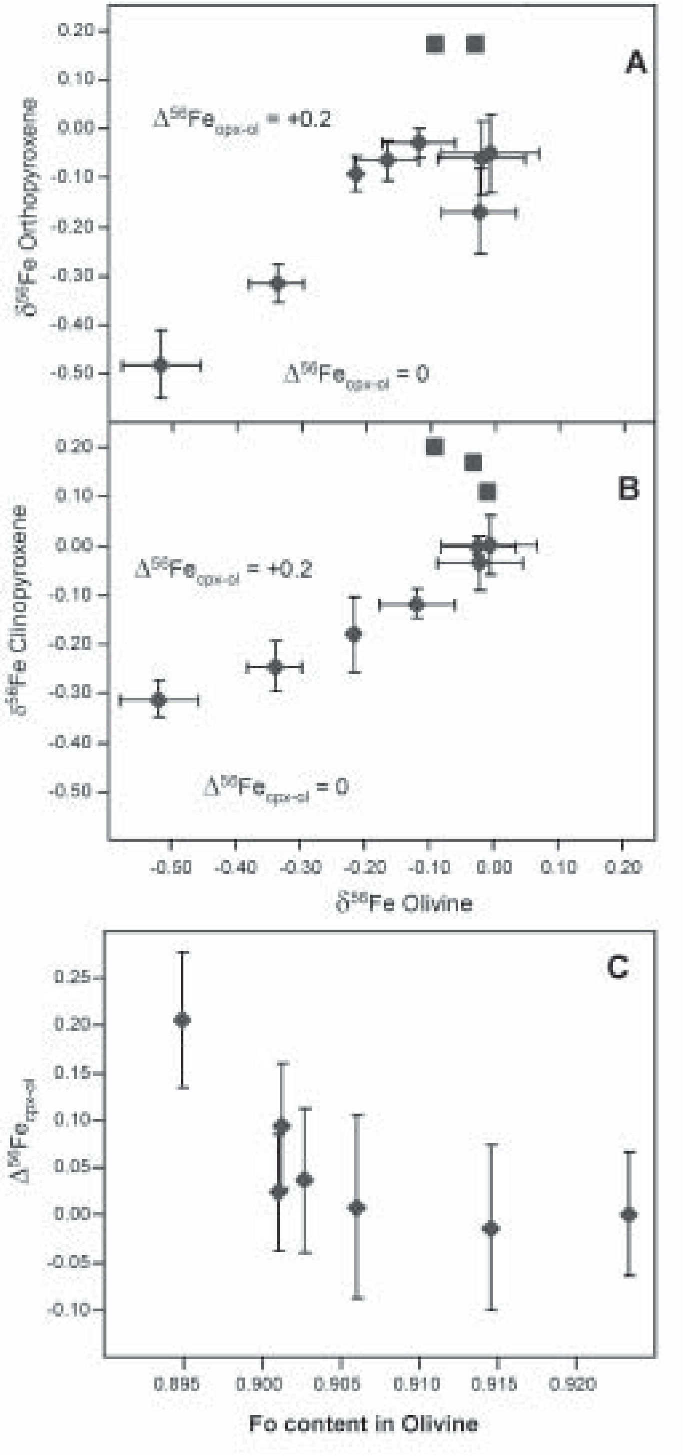

Figure 2: Inter-mineral Fe isotope fractionations among olivine, orthopyroxene, and clinopyroxene in spinel peridotite mantle xenoliths. **A)** Olivine-orthopyroxene fractionation. Error bars are the external 1-SD of the mean determined from two or more replicate analyses. Data are from Beard and Johnson (2003) (diamonds) and Zhu et al. (2002) (squares). There are no significant differences between the Fe isotope composition of olivine and orthopyroxene for the samples analyzed by Beard and Johnson (2003), although the data of Zhu et al. (2002) appear to show a significant isotopic fractionation between olivine and orthopyroxene. **B)** Olivine-clinopyroxene fractionations. The difference in the Fe isotope composition between clinopyroxene and olivine is a function of their $\delta^{56}Fe$ values. **C)** Plot of $\Delta^{56}Fe_{cpx\text{-}ol}$ versus the forsterite content of olivine. $\Delta^{56}Fe_{cpx\text{-}ol}$ is larger as the Mg content of olivine decreases.

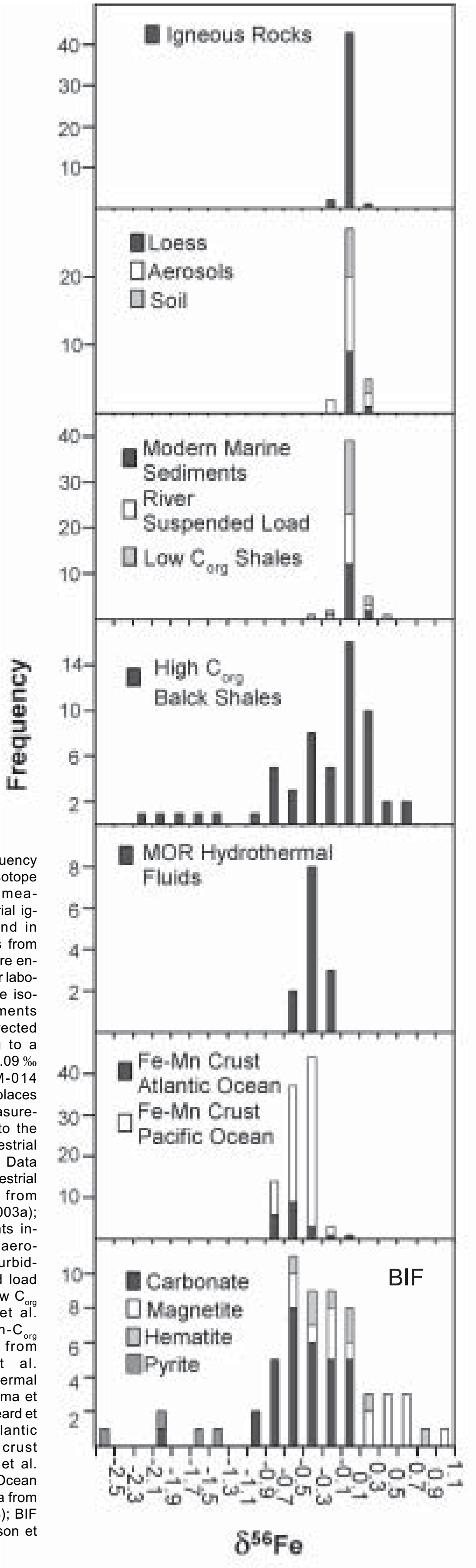

Figure 3: Frequency diagram of Fe isotope compositions measured in terrestrial igneous rocks and in rocks and fluids from lower temperature environments. Inter laboratory bias in Fe isotope measurements have been corrected by normalizing to a δ^{56}Fe value of -0.09 ‰ for the IRMM-014 standard which places Fe isotope measurements relative to the average of terrestrial igneous rocks. Data sources are: terrestrial igneous rocks from Beard et al. (2003a); clastic sediments including loess, aerosols, modern turbidites, suspended load of rivers, and low C_{org} shales Beard et al. (2003b); high-C_{org} black shales from Yamaguchi et al. (2003); hydrothermal fluids from Sharma et al. (2001) and Beard et al. (2003b); Atlantic Ocean Fe-Mn crust data from Zhu et al. (2000), Pacific Ocean Fe-Mn crust data from Chu et al. (2003); BIF data from Johnson et al. (2003).

in clastic sedimentary materials including loess, modern aerosol particles, modern oceanic turbidites, and the suspended load from rivers (Figure 3, Beard et al., 2003b). Low organic-C (C_{org}) shales from the Proterozoic and Phanerozoic are slightly more variable in their Fe isotope compositions, with δ^{56}Fe values ranging from -0.36 to +0.39 ‰; however, all of these clastic sedimentary rocks have a normal distribution of δ^{56}Fe values that is the same as that of terrestrial igneous rocks (Figure 3; Beard et al., 2003a;b). This observation suggests that the processes of sedimentary transport, diagenesis, and lithification did not greatly modify bulk-rock Fe isotope compositions. At current levels of atmospheric oxygen, soluble aqueous Fe(II) is not present in significant quantities, and therefore a mobile Fe component cannot be lost from the bulk Fe inventory during weathering. This is well illustrated, for example, in river particulates, which, despite large increases in Fe oxide components relative to their source regions (Canfield, 1997), their Fe isotope compositions remain unchanged (Beard et al., 2003b). Therefore, Fe is conserved in the bulk rock, and no net change in Fe isotope compositions may occur in clastic sediments, at least in an oxic atmosphere.

In contrast, black shales (C_{org} > 0.5 wt. %) define a large range of δ^{56}Fe values -2.28 to +0.64 ‰; Figure 3). The Fe isotope variations of C_{org}-rich black shales is likely to reflect redox cycling of iron in an anoxic environment, where Fe may be removed as soluble Fe(II), or Fe minerals may be precipitated from pore fluids that had high Fe(II) contents. The relative roles of bacterial Fe(III) reduction, relative to reduction by H_2S or other inorganic reducing agents, remains unclear in their contribution to producing the Fe isotope variations of black shales, although it appears that the lowest δ^{56}Fe values are well explained through bacterial Fe reduction (Yamaguchi et al., 2003). Similarly, large isotopic variations are found in chemically precipitated sediments that formed at low temperatures. Pliocene to Recent Fe-Mn crusts from the North Atlantic and the Pacific Oceans typically have Fe isotope compositions that are shifted to lower δ^{56}Fe values as compared to igneous rocks (Figure 3). Hydrothermal vent fluids from Mid-Ocean Ridges (MOR) have δ^{56}Fe values that are shifted to lower values as compared to terrestrial igneous rocks (Figure 3). Late Archean to Early Proterozoic Banded Iron Formations (BIFs) define a significant range of δ^{56}Fe values from -2.5 to +1.0 ‰ (Figure 3). The large Fe isotope variations recorded in BIFs are generally correlated with the dominant Fe-bearing mineral in individual BIF layers (Johnson et al., 2003), where δ^{56}Fe values increase in the order pyrite-Fe carbonate-oxides (Figure 3). These isotopic differences likely reflect a combination of equilibrium Fe isotope fractionations that are intrinsic to specific minerals, as well as the effects of biological processing of Fe.

Iron Isotope Variations in Marine Settings

Well-dated layers of an Fe-Mn crust from the Atlantic Ocean have been analyzed for their Fe isotope compositions (Zhu et al., 2000); layers that span an age from 6 to 1.7 Ma have a constant Fe isotope composition (δ^{56}Fe = -0.69 ±0.10 ‰), but layers that are less than 1.7 Ma have increasing d^{56}Fe values with decreasing age, to a value of +0.13 ‰ at 0.15 Ma. Moreover, ^{206}Pb/^{204}Pb ratios and δ^{56}Fe values are positively correlated. Zhu et al. (2000) inferred that the correlation of Pb and Fe isotopes was a result of changes in the composition of lithologic material that delivered Fe and Pb to the Atlantic Ocean. Based on the constant Fe isotope composition measured in clastic sedimentary rocks, modern aerosol particles, and the suspended load of rivers, changes in source lithologies are unlikely to produce changes in Fe isotope compositions. Beard et al (2003b) suggested that the origin of the Fe isotope variability in Fe-Mn crusts may be a result of changes in the relative fluxes of Fe delivered to the oceans which can be simplified as an atmospheric Fe flux with a δ^{56}Fe value of 0 ‰ and a hydrothermal Fe flux with a δ^{56}Fe value of -0.5 ‰, and the relative proportions of these components may change during major climatic events such as glaciation. Based on this simple two-component mixing calculation, the North Atlantic Ocean is predicted to have a δ^{56}Fe value of -0.1 ‰, whereas the South Pacific is predicted to have a δ^{56}Fe value of -0.3 ‰. These predicted values agree well with recent layers from some Fe-Mn crusts, where, for example, the crust analyzed by Zhu et al. (2000) from the North Atlantic has a δ^{56}Fe of +0.13 ‰ and a crust studied by Chu et al. (2003) from the south-central Pacific Ocean has a δ^{56}Fe value of -0.47 ‰. However, isotopic provinciality may be a characteristic of Fe isotope variations in Fe-Mn crust, where distinct temporal trends in Fe isotope compositions may occur in crusts that are only 10's of km apart (Chu et al., 2003).

A simple two-component model for the Fe isotope composition of open ocean seawater does not consider the effects of the Fe isotope composition of dissolved Fe from rivers or from rain. Although the dissolved Fe fluxes are small, the dissolved fluxes may have an important control on the overall Fe isotope composition of the oceans if their isotopic compositions were extreme. Moreover, the dissolved flux may be highly reactive Fe and therefore of greater importance than would be suggested by its relatively small flux. In particular, riverine components may be very important in the Pacific Ocean where a significant amount of Fe is delivered from rivers that drain oceanic islands (Sholkovitz et al., 1999). An additional uncertainty lies in how Fe from particulate matter is utilized in seawater. For example, does the solubilization of Fe from aerosol particles result in a significant Fe isotope fractionation, and does Fe speciation lead to Fe isotope fractionation and separation of Fe into isotopically distinct pools? Crucial to unraveling these uncertainties are Fe isotope analyses of the dissolved load from rivers and rainwater, as well as direct analysis of seawater. Direct analysis will be very challenging, where, for example, 3 to 20 liters of seawater will be required to obtain ~100 ng of Fe; this is sufficient for Fe isotope analysis following the methods of Beard et al. (2003a), and analytical methods that require mg quantities of Fe will require significantly larger quantities of seawater.

Iron Isotope Fractionation Factors

Based on spectroscopic data of Fe minerals and Fe salts, Polyakov and Mineev (2000) and Schauble et al. (2001) have calculated Fe isotope fractionation factors. In general, ferric Fe-bearing minerals and aqueous species are predicted to have relative high ^{56}Fe/^{54}Fe ratios, and ferrous Fe species are expected to have lower ^{56}Fe/^{54}Fe ratios, and this generally agrees well with data from natural samples (Johnson et al., 2003). An important exception to this is pyrite, which has low δ^{56}Fe values in BIFs (Johnson et al., 2003), but is predicted to have high δ^{56}Fe values (Polyakov et al., 2000). However, the magnitude of these calculated Fe isotope fractionation factors are significantly larger than the Fe isotope compositions that have been measured in experiments, where, for example, at 22 °C Schauble et al. (2001) predict a +5.5 ‰ fractionation in ^{56}Fe/^{54}Fe ratios between $[Fe^{III}(H_2O)_6]^{3+}$ and $[Fe^{II}(H_2O)_6]^{2+}$. In contrast the experimentally measured fractionation between hexaquo Fe(III) and Fe(II) is 2.9 ‰ at 22°C (Johnson et al., 2002; Welch et al., 2003). In addition, the fractionation between hexaquo Fe(III) and hematite is predicted to be 2.8 ‰, although Skulan et al. (2002) estimate the fractionation to be -0.1 ‰ based on experiments.

Experiments in Abiological Systems

Experimental determination of Fe isotope fractionation factors is complicated because at the low temperatures at which Fe isotope variations are largest, solid-state diffusion rates are so slow that isotopic equilibrium cannot be attained in mineral-fluid systems through pure isotope exchange reactions. As has been well documented in experimental studies of the light stable isotopes, at low temperatures the determination of mineral-fluid fractionation factors rely on synthesis experiments in which it is very difficult to establish if the measured fractionation factor is a result of laboratory-induced kinetic isotope fractionation, or indeed represents a true equilibrium fractionation factor. It is extremely easy to produce kinetic isotope fractionations in the laboratory, but such pathway-dependent processes are difficult to extrapolate to general cases. Some of the largest fractionation factors, however, are inferred to exist between aqueous Fe species, and here the challenge is separation of the different Fe species, where the separation technique must be more rapid than rate of Fe isotope exchange (Johnson et al., 2002). For example, Matthews et al. (2001) found that kinetic isotope effects dominated their investigation of Fe(II) and Fe(III) complexed with 2, 2'-bipyridine and chloride ions, reflecting the combination of relatively slow separation process as well as breakdown of $[Fe^{II}(bipy)_3]^{2+}$ in the 6M HCl solution. Although, as noted by Matthews et al. (2001), the measured isotopic fractionations do not reflect equilibrium isotope partitioning, they do highlight the importance of highly covalent bonds, where, in this case, ferrous Fe is enriched in ^{56}Fe/^{54}Fe ratios relative to ferric Fe chloro complexes.

Investigation of Fe isotope fractionation between Fe(III) and Fe(II) using a rapid precipitation technique in which the ferrous and ferric species are separated at a rate much greater than their Fe isotope exchange rate reveals that at 22°C, $\Delta^{56}Fe_{Fe(III)-Fe(II)}$= 2.9 ‰ (Johnson et al., 2002). Using the same separation technique, Welch et al. (2003) investigated the fractionation between Fe(III) and Fe(II) over a range of chloride concentration from 0 to 111 mM at 22 and 0 °C. Schauble et al. (2001) predicted that a significant effect on Fe isotope fractionation occurs if chloride replaces water in the inner hydration sphere, but the studies of Welch et al. (2003) suggest that Cl^- substitution, at least up to levels where $[Fe^{III}(H_2O)_5Cl]^{2+}$ becomes the dominant ferric Fe species, has no measurable isotopic effect relative to $[Fe^{III}(H_2O)_6]^{3+}$. Moreover, Welch et al. (2003) determined that the aqueous Fe(III)-Fe(II) fractionation at 0°C was +3.5 ‰; this allows the temperature dependence for the Fe(III)-Fe(II) fractionation to be estimated at low temperatures (<100°C), which produces a slope that is similar to the slope predicted by Schauble et al. (2001), but displaced by 2 ‰. Perhaps the most important finding of the experimental study of Welch et al. (2003) is recognition that the aqueous Fe(III)-Fe(II) fractionation is invariant at a given temperature over a wide range in Cl^- content, allowing these results to be applied to a wide range of natural fluids.

Additional studies that have measured Fe isotope fractionation in the laboratory include those of Anbar et al (2000) and Roe et al. (2003), who investigated isotopic fractionation on anion exchange columns under conditions suitable for separation of Fe isotopic analysis. In addition, Bullen et al. (2001) investigated Fe isotope fractionation during abiotic oxidation of aqueous Fe(II), followed by precipitation of ferrihydrite in batch and flow-through reactor experiments.

Experiments in Biological Systems

Several biological systems have been studied in terms of Fe isotope fractionations produced during biological cycling of Fe including: (a) dissimilatory Fe(III)-reducing bacteria (Beard et al., 1999; 2003a), (b) anoxygenic Fe(II)-oxidizing bacteria (Croal et al., 2003), (c) magnetotactic bacteria (Mandernack et al., 1999), and (d) mineral dissolution in the presence of organic ligands (Brantley et al., 2001). The experiments involving intracellular magnetite produced by magnetotactic bacteria suggested that there was no difference in Fe isotope composition between the Fe in magnetosomes and Fe in the growth media, either when ferrous or ferric Fe sources were used (Mandernack et al., 1999). This result is surprising given the large Fe(III)-Fe(II) fractionation measured experimentally. Experiments involving organic Fe ligands to promote dissolution of hornblende indicate that the organically complexed Fe is up to 0.8 ä lower in ^{56}Fe /^{54}Fe ratios relative to Fe in hornblende (Brantley et al., 2001), suggesting that during incongruent dissolution of minerals, which in this case resulted in formation of an Fe-poor outer leach layer, may produce significant Fe isotope fractionation. For comparison, congruent dissolution of minerals does not fractionate Fe isotopes (Skulan et al., 2002; Beard et al., 2003a). The magnitude of the Fe isotope fractionation during dissolution in the experiments by Brantley et al. (2001) correlates with the binding constant of the chelating agent, where higher binding strength ligands produce larger differences in isotope composition between the aqueous Fe and solid Fe substrate (amphibole).

Aqueous Fe(II) produced by the Fe(III)-reducing bacteria *S. algae* grown on both ferrihydrite and hematite substrates has a ^{56}Fe/^{54}Fe ratio that is 1.3 ‰ lower than that of the ferric substrate (Beard et al., 1999; 2003a). Croal et al. (2003) measured the isotopic fractionation produced by Fe (II)-oxidizing phototrophs under anaerobic conditions, and the ^{56}Fe/^{54}Fe ratios of the ferrihydrite precipitate were increased by 1.5 ‰ relative to the aqueous Fe(II) source. Isotopic fractionation did not correlate with oxidation rates, as varied by changes in light intensity, suggesting that kinetic isotope effects were not an issue, assuming that changing the light intensity controlled the rate-limiting step. The net Fe isotope fractionation is remarkably similar to that obtained for dissimilatory Fe(III)-reducing bacteria, where the ferric component has δ^{56}Fe values that are ~ 1.3 ‰ higher than those of the ferrous component, suggesting a common process by which Fe isotopes are fractionated during bacterial Fe reduction and oxidation. It may be for example, that unique biological ligands are involved in binding Fe, which may account for the similar fractionation during reduction and oxidation, and the fact that biologically produced fractionation is distinct from the Fe(III)-Fe(II) fractionation measured in abiologic solutions (Johnson et al., 2002; Welch et al., 2003).

Conclusions and Future Directions

The field of Fe isotope geochemistry is rapidly becoming established. Numerous laboratories are making Fe isotope measurements and the emerging picture is that redox processes by both abiologic and biologic means produce some of the most significant Fe isotope variations in nature. The first-order variations in the rock record are now relatively well established by over 500 analyses of bulk rocks including many types of low and high temperature rocks. Terrestrial igneous rocks and low-C_{org} clastic sedimentary rocks have a narrow range in δ^{56}Fe values, reflecting the homogenizing process of magmatism and conservative behavior of Fe during weathering in an oxygenated atmosphere. Organic-C rich sedimentary rocks and chemically precipitated sediments have variable δ^{56}Fe values, reflecting partitioning between minerals and Fe(II)-rich fluids. Our ability to understand measured Fe isotope variations, however, is limited because the database of well-characterized Fe isotope fractionation factors is small. Determination of equilibrium fractionation factors provides the broadest application to different environments, although kinetic effects are also important, particularly in cases where reactions in nature may be rapid. It is critical that experimental investigations take a mechanistic approach to determining isotope fractionation, given the approaches that must be taken in experimental studies at low temperatures. Additionally, as a check on these laboratory investigations, it is important to conduct studies on modern natural samples where the Fe isotope compositions of the fluids and minerals may be determined. The analysis of fluids that have low Fe contents, but overall high ionic strengths (such as pore fluids or seawater) will be analytically challenging, requiring superb chemical purification techniques and mass spectrometry methods that only require nanogram quantities of Fe for a mass analysis.

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Virtual Vaults: The Future of Digital Archiving

THE EXPANDING POPULARITY OF ELECTRONIC JOURNALS means more and more science is published and archived digitally. Unlike paper libraries, electronic archives are gated by their publishers, and access can come at a premium. Who should decide how e-journals are stored, shared, and maintained for posterity? In two columns, FRISO VEENSTRA of Elsevier and HUBERT STAUDIGEL of the Scripps Institute of Oceanography present two views of how tomorrow's virtual vaults of knowledge should be built.

Digital Archiving at Elsevier

by Friso Veenstra

As the research world moves toward an all-electronic future, there has been considerable concern whether publishers will accept responsibility for the preservation of their digital publications. For instance, at the recent GERM meeting in Lyon worries were expressed that Elsevier, as contrasted with a society such as AGU, would only keep the electronic files accessible so long as there was a market for them. What happens if Elsevier gets taken over? Or worse, goes out of business altogether? How do you guarantee that an electronic archive will still be accessible in 100 years time? These are appropriate concerns, particularly for geochemistry where Elsevier is the major publisher with titles such as *GCA*, *EPSL*, and *Chemical Geology*.

Given the wealth of scientific research amassed in our journals, Elsevier has a duty to its authors, libraries and future generations of researchers to ensure the preservation of archives and to make archiving policies clear to all. Elsevier currently has many different electronic products and services that offer access to journals, abstracting & indexing services, books, and other databased information. They range from websites for individual titles to community portals to large-scale services such as ScienceDirect, which is the primary online service for our refereed journals. We have made a formal commitment to ensuring the preservation of the electronic editions of the Elsevier journals distributed on ScienceDirect.

Elsevier has been aware of the archiving issue for many years and has participated in industry projects, conferences and discussions. As the largest science publisher, there is particular responsibility to set standards and lead where appropriate. In 1999, shortly after the launch of ScienceDirect, Elsevier established a formal archiving policy and added a clause to our customer license that guaranteed that we would archive everything ourselves and assume responsibility for migrating the files as technology changed. Elsevier's internal archive is in its "electronic warehouse," which is also our principal production storage facility. This warehouse assures the data is available should the system need to be recreated in case of catastrophic failure.

In addition to making the commitment to maintain the internal archive, the policy and license language also said that should Elsevier be unable or unwilling to meet this commitment for any reason, the archive would be turned over to a repository chosen in consultation with library advisers. First, Elsevier started working with the National Library of the Netherlands (the Koninklijke Bibliotheek or KB) with a view to making it an official external archive. The KB's credentials made it the ideal candidate. It is a recognised leader in archiving research and development, and Elsevier had been voluntarily depositing Dutch imprint titles with the library in electronic form for years. Elsevier and the KB reached a formal agreement in 2002 that made the KB an official archival agent for all Elsevier journals on ScienceDirect.

Coincident with its discussions with the KB, Elsevier worked with Yale University on a project to explore electronic archiving issues. Funded by the Mellon Foundation, Yale chose Elsevier as its project partner because the university had had good experiences as a ScienceDirect licensee. When the project ended in 2002, there were important insights as to what we were talking about in terms of an electronic archive. Some of the assumptions included:

- A digital archive must last more than 100 years
- The intent is to archive the content, not the format or functionality of the online service
- The archival institution is responsible for assuring the integrity of the content and its permanent accessibility, even as technology of storage and retrieval change
- The archive should not compete commercially with the publisher
- The archive should not be totally "dark" – i.e., some use is needed to ensure the continuing technical soundness
- An archive is not a mirror of the publisher's site
- The intent is to archive the electronic edition, not to preserve an electronic version of the paper edition
- It is highly desirable for the publisher to provide needed archival metadata
- Standards are key
- While not a "hot back-up", the archive can play a role in disaster recovery.

The work with Yale helped in developing an official archive in the Netherlands. The KB will receive every journal Elsevier makes available on ScienceDirect. These deposits are permanent – i.e., Elsevier cannot ask for a return of the material at some later date. With funding from the Dutch Ministry of Education, the library will set up and maintain the archive, and it has undertaken to migrate or reformat or otherwise ensure access as technology changes.

In making this commitment to become an archive, the KB is honouring what it sees as its mission as the Dutch national library. The size of the commitment is significant, as Elsevier publishes over 1,600 journals with close to 300,000 new articles a year. The current database has more than 4 million articles and it will grow quickly to over 7 million articles as back files are added. Elsevier is currently retrodigitizing its journals back to volume 1, no. 1, a project of enormous scale. For all geochemistry journals, by the way, the project has just been completed.

One of the issues of regular discussion with respect to digital archives is what are the conditions for access to the archive. Elsevier's agreement with the KB provides for the library to provide only limited access as long as the material is still commercially available. On a current basis, the archive can be used on-site by researchers who go to the library. The library can only allow remote access to the archive if and when Elsevier or its successor no longer offers the database on a commercial basis. It's hard to imagine a point where the archive would have no value, but it could happen and if it did, the archive could become openly available.

This question of when an archive could be made available to the public was a major point of discussion in the project with Yale. The project partners tried to identify other "trigger points" at which Elsevier would no longer have an interest in the archive and access could be automatically be opened to all, but could not identify such points. Some have tried to set a post-publication time (six month, a year, five years), but as we are in the process of creating comprehensive electronic back files, it is premature to try to identify such fixed time-points. We would like to recover the cost of creating the back files first.

In addition to the internal electronic warehouse and the formal archiving agreement with the KB, we are pursuing other archive-like arrangements. First, Elsevier has many customers around the world who, rather than accessing ScienceDirect on the web, have chosen to take delivery of the electronic files and host them locally. These customers (ScienceDirect OnSite or SDOS libraries) include about a dozen that get all Elsevier journals on ScienceDirect. These include consortia or institutions such as OhioLINK, Los Alamos National Labs, the University of Toronto and CSIRO. These customers are *de facto* archives. Elsevier has no official archiving relationship with these institutions at the moment, but the fact that they hold all the files should offer peace of mind to other libraries.

There are also archiving discussions with some other libraries, including some central or otherwise major libraries in countries that want to have a copy of the archive on their home soil. This becomes a variation on the SDOS customer. If the library (often a national library) simply wants to hold the files for security reasons and offer very limited access (e.g., walk-in users only), then the pricing can be adjusted accordingly. If the library wants to combine its archival activities with widespread remote access, it effectively becomes a normal SDOS customer, with the normal pricing model.

Finally, there has to be redundancy in the formal archival system. As talented and committed as the KB is, Elsevier feels a need to provide additional archival assurances. Elsevier would like a network of about three or four official archives around the world and have had discussions with institutions in North America and Asia, as well as with the British Library. What is needed is a library (or other institution) that has the commitment, resources, experience and motivation to ensure that they will keep the files on a permanent basis and would, should it be necessary, be prepared to serve an international research community.

What about issues of disaster recovery? September 11th cast a long shadow. One question that came up was: what would have happened had ScienceDirect been running not out of *LexisNexis* in Dayton, OH, but out of the World Trade Center? Because of the complexity of the ScienceDirect system and the cost of creating a mirror site, Elsevier had not yet created a fully functional back-up facility.

We now have a policy as to a catastrophic failure, and we are creating that mirrored back up. The policy is that, should there be a catastrophe, we would ask all SDOS customers who were willing to expand their service to open their host services to all, without the need for access controls. Elsevier would compensate these libraries for any services provided until such time as Elsevier was again able to meet customer needs. This “catastrophe-relief” provision is part of our agreement with the National Library of the Netherlands and has been discussed informally with a number of the larger SDOS customers.

At this point Elsevier feels it has taken the lead among publishers in trying to meet archival requirements for its electronic journals. But there are still many issues and questions remaining. These include:

- What is the best financial model for archiving? In the case of the KB the funding comes from the Dutch Ministry of Education. What will happen in other parts of the world? What if the Dutch Ministry changes its mind with respect to support of this effort?

- One of the assumptions of the Yale-Elsevier study was that you archive content, not form and functionality. This is a critically important assumption. But there are those who ask: what is “content”? Are live links content or functionality? To date we have judged these to be functionality and they are not being archived. Indeed, including them in the archive would not be easy, as the ScienceDirect links are created on the fly and do not exist in the underlying files in the electronic warehouse or the ScienceDirect servers.

- What guarantees are there really now that all of the promises made will result in an archive from which things can be retrieved and used in 100 or 200 years? There are none, of course. We are all operating on good faith and best efforts.
- Finally, what about all of the electronic products and services other than the journals on ScienceDirect? For example, we will be adding significant numbers of reference works to ScienceDirect, including the *Treatise on Geochemistry* early next year. These may differ from journal articles in that they may change either when new editions are posted or on a continuously updated basis. What about the chemistry preprints on our ChemWeb or the more informal information on services such as BioMedNet? What do you archive? We have not even begun to develop policies in these areas and look to librarians for advice.

For the moment, Elsevier’s efforts are focused on getting the first official archive up and running and on establishing redundancy in other locations. When an external journal electronic archive system is in place and properly maintained, authors and editors will have a reasonable assurance that their work will be preserved forever and be retrievable by future generations of researchers. Elsevier has often been accused of being too commercial in its approach to scientific literature but the electronic archive initiative underlines our wider commitment to the research community. We welcome your input in these initiatives.

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The Transition to Electronic Publication: the need for the scientific community to work with publishers and librarians

by Hubert Staudigel

The transition to electronic publication has fundamentally changed our science infrastructure within a very short time. Some of the changes have been quite beneficial, yet others brought problems that have not been effectively addressed by the science community. The long-term consequences may be severe. Moreover, important opportunities of electronic publishing remain largely unexploited. To maximize benefits and to mitigate problems, all involved parties, scientists, librarians, editors and publishers, must work together, on behalf of their respective constituency. Publishers and librarians have been working on these problems quite intensely, but the science community has played a relatively minor role. This letter is a call to the community to take action. We encourage all geochemists to become engaged in using e-publishing to its fullest and to help shape institutional, societal and commercial e-publishing policies and procedures. We are the producers and the prime users of this information.

In May 2003, the NSF/CNRS sponsored GERM IV (the Geochemical Earth Reference Model workshop in Lyon/ France, http://earthref.org/GERM/main.htm) discussed many aspects of the transition to electronic publications. GERM IV was attended by almost 100 geochemists and some computer scientists, including editors from five major geochemical journals and publishers of two geochemical journals. Of particular importance, an Editors’ Round Table (F. Podosek, Chair; Editor in Chief, Geochimica Cosmochimica Acta) discussed the use of data supplements, and data/metadata formats. An open forum addressed issues of long term archiving of electronic materials and other aspects of electronic publishing. The following reviews some key points made in these discussions. In a separate article, Friso Veenstra from Elsevier earth science publications follows up on some questions raised at GERM IV regarding the long term archival of electronic contents in Geochimica Cosmochimica Acta, Chemical Geology and Earth and Planetary Science letters.

New Opportunities for publishing data, metadata, and functional elements: One of the biggest opportunities of electronic publication includes the direct digital publication of data, and supporting data (metadata) and functional elements like websites, spreadsheet calculations or software. The advantages of electronic publication for these materials are clear but the actual use of electronic features remains limited in the geochemical literature and disclosure of data and metadata is still incomplete in most papers published in geochemistry (GERM Steering Committee, 2001). Key stumbling blocks include the need for widely accepted, open and interoperable, standard formats for data and metadata and probably the limited awareness in the scientific community of the benefits of data supplements and their availability in most journals.

The GERM IV Editors Round Table reviewed a recent proposal for data and metadata formats (e.g. Staudigel et al., 2003; Helly et al., 2003) and drafted a resolution to encourage the use of data supplements with such consistent data formats and complete metadata characterizations of samples and analytical techniques. These changes will soon be reflected in the editorial guidelines of major journals publishing geochemistry. Key open questions at this point include the role of functional and format elements in publication and archival of electronic journals (see also Veemstra's article).

Publication of files with functionality is relatively straightforward as long as underlying software and operating systems are current, but maintaining this functionality in an archive can be expensive. However, it is important to recognize that functionality in electronic documents is a major advantage of electronic publication, and some of it may be archived at low costs, while some may be not. Would it be acceptable to publish functional elements that can be expected to be functional for five to ten years, enough to have an impact on the current science? Expired functional elements in electronic papers may be "fixed" through updates or comments published later and forward referenced with the original paper.

The electronic medium evolves at a very rapid pace, in terms of mass storage, speed of data transmission, and development of new technologies. Should electronic publication use these opportunities at the leading edge of technology or should it be conservative?

Long Term Archiving of electronic journals and contents: Long term document archiving and distribution are serious problems that haunt the electronic publication industry. Traditional library archives have relied on the proven stability of print on acid-free paper and the redundancy of multiple print copies in libraries. A global network of libraries is operated by devoted librarians keep the collections complete and accessible, with loyalties only to the users of the libraries. Electronic media are not nearly as long-lived as print media; formats change, electronic publications are not widely distributed and are typically archived centrally by the publisher which may abandon electronic contents for financial reasons with disastrous consequences for the science community.

Veenstra from Elsevier writes in this issue of Geochemical News, expressing Elsevier's commitment to archive and keep alive all of its contents, and promises future migration to new formats and media as long as Elsevier supports these journals. He also writes about Elsevier's ongoing effort of maintaining a copy of all of its science journal contents at the Dutch National Library (the Koninglijke Bibliotheek, or "KB"). The KB archive is mostly "dark" to the science community, i.e. not openly accessible on the internet to protect the publisher's commercial interests, but it is open and freely usable by the local visitor to the KB which assures its funcitonality. This dark archive changes into a public and open archive as soon as Elsevier fails to offer commercial access to their contents, by corporate decision or due to catastrophic failure. Veenstra expresses the intention that the KB cooperation is likely to be expanded to other organizations in Great Britain, North America and/or Asia, in order to obtain some redundancy.

Elsevier made an important step towards secure archival of its contents, and assumes a leadership role for the archival of electronic journals. However, this concept should be further evaluated by the science community. Is this level of redundancy sufficient, given the volatility of the electronic archival medium? Should we work towards much wider distribution of archives and encourage university libraries to carry electronic contents locally? This would come closer to the redundancy of paper publications.

The cost of scientific journal subscriptions: With the advent of electronic publication, the finances of publishing have been turned upside down. Libraries find themselves in a major financial struggle to maintain their service to scholarly science. For many years, libraries have had to cope with annual increases in journal subscriptions that are above inflation rates and well above budget increases of libraries. These yearly increases in cost have been burdening libraries for over a decade, forcing them to drop more titles every year and substantially limiting their service to their users. Some major libraries already cannot afford the licensing fees for the higher priced journals and this is particularly severe for libraries in Third World countries. The present trends cannot be sustained and ultimately will result in a major re-alignment of the market. In the end, which journal will survive the competition? These financial concerns increase the risk of catastrophic termination of some electronic publications and add substantial weight to the problems of long term preservation of science publications. At some point, scientists have to decide together with the librarians which journals they wish to support through their universities' budget *as well as* through submission of their papers.

Electronic publication has to pay attention to copyright issues. It is clear that publishers have to hold the copyright to all materials they publish to protect their commercial needs, and to be authorized to reprint material on an as-needed basis. However, copyright policies have to be designed to promote the dissemination and longevity of science, in particular for the underlying scientific data. The commercial interests of publishers cannot be the only criteria. Publishers and scientists have to engage in a dialogue about creating copyright policies that help disseminate science and allows for the successful commercial publication of science journals. Important questions remain. Is the exchange of electronic reprints any different from swapping of MP3 music files on the internet? If you own a music CD you can have a copy on your computer, but you are not supposed to pass it on to others who do not own this CD. What is the equivalent in journal terms? Should publically financed data be exempt from copyright? In fact, can commercial journals claim copyright on data that were acquired through public funding? Should data, metadata, or functional files be placed in community data bases rather than electronic data annexes to scientific papers?

An interesting new concept of copyright policy was implemented with the new electronic journal G-cubed, that is jointly published by the Geochemical Society and the American Geophysical Union (http://www.agu.org/journals/gc/about/copyright.shtml). G-Cubed, does not claim copyright for data, and distribution of G-cubed articles is permitted for educational purposes. There is a provision that articles with reference data can be freely accessible through the GERM website. However, it has to be born in mind that the AGU is a non-commercial, society publisher that can afford to be more flexible with copyright or financial matters than a commercial publisher. In fact commercial publishers have shown some flexibility in copyright interpretations. Elsevier, for example has permitted organizations like GERM and EarthRef.org to carry substantial fractions of its publications verbatim on their websites. Encouraged by GERM IV, commercial and non commercial publishers are currently exploring the potential for direct and automated links between community data bases and science journals. These are the first significant steps of scientific journals to become a meaningful and active participant in Cyber-Infrastructure in geochemistry.

The potential benefits of our transition to electronic publications are substantial, but the potential for problems is also very large. Anyone involved can gain or lose from the transition to electronic publication, and it is important that all interested parties participate in this change. Publishers have led this transition so far, but scientists have to join in to make this a win-win situation (rather than win-lose). The community of scientists can have a major impact on what roles the libraries will play in future, how many journals will be on the market, how securely science will be archived, how we publish and exchange scientific papers, and how we use the transition to electronic publications to make the science better.

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The author is chair of the GERM Steering Committee, and the Chair of the AGU Volcanology, Geochemistry and Petrology Publications committee.

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Geotraces

Trace Elements and Isotopes in our Oceans

by Angie Souren

If you attended the recent Goldschmidt meeting in Japan, you probably noticed special symposium S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II).

GEOSECS II - dubbed that way after the successful Geochemical Ocean Section Studies program of the 1970s - has meanwhile officially been named Geotraces. Recent advances in seagoing technologies and analytical capabilities as well as new insights have created a need for a new coordinated research program. A number of meetings at which scientists from various countries and disciplines exchanged ideas led to a workshop exclusively dedicated to this issue. It took place in Toulouse, France in April of this year and was supported by the NSF's Chemical Oceanography Program, the CNRS, the Observatoire Midi-Pyrenees and the Universite Paul Sabatier. A proposal to form a SCOR working group was submitted two weeks later (http://www.jhu.edu/scor/GEOTRACES.PDF) and when you read this, has been evaluated at the annual SCOR meeting in Moscow (September 16-19). SCOR, by the way, stands for Scientific Committee on Oceanic Research.

Geotraces will take shape as a global study of several ocean sections complemented with regional process studies along those sections. Ultimate goals are to achieve a more complete view of the global biogeochemical cycles of trace elements and isotopes that play a role in the oceans and to build a strong group of marine scientists with a profound understanding of the aspects involved. Geotraces will probably be one of the core projects of the IGBP program IMBER (Integrated Marine Biogeochemistry and Ecosystem Research; see http://www.igbp.kva.se/obe/recentupdates.html). Geotraces will also seek interaction with other ongoing programs, such as MARGINS, RIDGE and SOLAS.

Iron

One of the trace elements Geotraces will be targeting is iron, which has been gaining more and more attention among marine biogeochemists. SCOR working group 109 finalized its activities with the production of the book "The Biogeochemistry of Iron in Seawater" (John Wiley and Sons: New York 2001, IUPAC Series on Analytical and Physical Chemistry of Environmental Systems, Vol. 7). Another outcome of this working group is the drive toward producing a certified standard of ultralow dissolved iron in seawater. After two SCOR-sponsored planning workshops (Amsterdam in November 1998 and San Antonio in February 2000), the first international exercise was started during the IRONAGES-1 cruise in the Eastern Atlantic in October 2000 on-board RV Polarstern, which was funded by the European Union. In the oligotrophic ocean toward the southern section of this cruise, the four parallel shipboard iron analysis teams found subnanomolar dissolved iron in the surface waters (Bowie et al., 2003). This seawater was collected and filtered into a large tank and fixed at ~pH 2 by using ultrapure hydrochloric acid. This sample water was subsequently distributed into several hundred bottles, which were sent out to over 25 laboratories worldwide for analysis. The results were collated by an independent data manager and discussed in a workshop in San Francisco in December 2002, leading to a joint article (Bowie et al., Marine Chemistry, in preparation). Andrew Bowie of the University of Tasmania in Australia, who is currently synthesizing the data, comments: "The results are fascinating. Although progress still needs to be made, this study represents a significant improvement over earlier intercalibration exercises for trace elements where iron was measured. We are now aiming to harmonize sampling and analytical methods used for the routine determination of iron in seawater."


Deployment of Niskin-X samplers specially modified for trace metal clean research on-board R/V Weatherbird II in the North Atlantic. Photograph: Andrew Bowie, University of Tasmania, Antarctic Climate and Ecosystems CRC

The final cruise of the IRONAGES program took place in October of 2002. Hein de Baar of the Royal NIOZ in The Netherlands adds: "We will soon have new standard equipment for sampling iron. We have successfully tested the new system during the October 2002 IRONAGES-3 cruise near Madeira. We now have a special winch, which allows us to implement the new method routinely. We are talking about a 16-mm Kevlar cable, the core of which contains the signal wires for the CTD frame, so with 7 kilometers of wire on it the winch is quite large. We will now need only 4 to 5 hours of sampling in order to complete the 4 to 5 km deep water column, as compared to one day of ship time when using individual Go-Flo bottles. Thus we can now run real sections of a suite of deep stations for trace elements at feasible economics of low overall ship time. This helps us to accomplish substantial savings, as ship time usually is the largest expense of an ocean research project. All this was tested successfully in the October 2002 cruise. At that time, we still had a prototype ultraclean sampling/CTD frame, but we are now looking into building a superclean titanium frame."

There will be a second iron certification exercise in 2004. "The NSF recently awarded funds for the SAFE (Sampling and Analysis of Fe) project to our colleagues Boyle, Bruland, Coale, Johnson, Measures and Moffett in the U.S." explains Eric Achterberg of the University of Plymouth, another researcher with a strong interest in iron and whose group participated in IRONAGES and the SOIREE project, the first iron enrichment experiment in the Southern Ocean. The core of SAFE will be a cruise on RV Thompson (July 2-20, 2004; Hawaii to Astoria, Oregon), focused primarily on the low-iron region of the North Pacific." This area has been sampled three times (VERTEX and SOLAS programs 1984, 1986 and 2001) with similar results each time." says Eric. "Dissolved iron concentrations in surface waters were 0.05 to 0.1 nM and ~0.8 nM at 1000 m depth." RV Thompson will occupy a station at 30ºN, 140ºW for 10 days to conduct intercomparison measurements (collection, filtration and analysis of iron) among an international group of expert analysts from the U.S., Europe, Japan and other countries. Moreover, a large number of surface and 1000 m depth samples for analysis ashore will be collected as well as a subset for analysis at sea. RV Thompson will also occupy a coastal station with higher iron concentrations for 5 days. In addition, the cruise will contain a series of experiments at both stations to compare dissolved iron measurements by various techniques that are used in the field, such as flow injection-chemiluminescence, flow injection-colorimetry and cathodic stripping voltammetry with various ligands (SA, DHN, TAC). The range of sampling and filtration methods that are in general use to collect uncontaminated samples will be examined. The samples will be filtered through a 0.2 mm cartridge, acidified to ~pH 1.8, and sent out for land-based analyses (including graphite furnace atomic absorption spectroscopy and inductively coupled plasma-mass spectrometry with isotope dilution). A much smaller set of samples will be frozen without acidification for iron speciation measurements.


Deployment of trace metal clean samplers from RRS Discovery. Photograph: Eric Achterberg, University of Plymouth, School of Earth, Ocean and Environmental Sciences.


Deployment of trace metal clean samplers from RRS Discovery.

These are only a few examples of what is happening in marine iron research, but they make abundantly clear that anyone working on the marine biogeochemistry of iron will certainly welcome a new framework like Geotraces. And as iron is only one of those intriguing trace elements and isotopes (TEIs) out there about which we still have many questions, the need for a program like Geotraces is evident.

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For more information, see:

Andrew R. Bowie, Eric P. Achterberg, Stéphane Blain, Marie Boye, Peter L. Croot, Hein J.W. de Baar, Patrick Laan, Géraldine Sarthou, Paul J. Worsfold (2003). Shipboard analytical intercomparison of dissolved iron in surface waters along a north–south transect of the Atlantic Ocean, Marine Chemistry, in press.

Andrew R. Bowie et al. A community-wide intercalibration exercise for the determination of iron in seawater, Marine Chemistry, in preparation.

Organic biogeochemists pay tribute to John I. Hedges

Organic biogeochemists from all over the world helped the Friday Harbor Laboratory celebrate its 100-year anniversary by attending the Symposium on New Approaches in Marine Organic Biogeochemistry, a tribute to the life and science of John I. Hedges, a Fellow of the Geochemical Society. The meeting was held August 28-30, 2003, at the exquisite setting of the University of Washington's marine lab on San Juan Island. A primary goal of the conference was to bring together investigators studying various aspects of organic biogeochemistry to discuss approaches and progress in addressing analytical, methodological and conceptual questions pivotal to the field. This symposium assembled 82 participants, including graduate students and veteran researchers. The Geochemical Society provided a $2000 grant to support graduate student participation. NSF Chemical Oceanography supported speakers' participation, and the Friday Harbor Laboratory also contributed to the conference.

Subthemes of the symposium were: organic matter preservation, water column transformations, black carbon, organic biomarkers, terrigenous organic matter, and microbial and photochemical transformations. In addition, discussion round tables were held on marine gels and chemical reference standards. Speakers focussed on state-of-the-art methods that are so important to advancing in new directions. For example, applications using a veritable alphabet of techniques, e.g., DTMS, MAS solid-state ^{15}N and ^{13}C NMR, XANES, 2-D and 3-D NMR, ESI FT-ICR MS, were presented.

Organic biogeochemistry has evolved rapidly during the past decade, and the symposium provided an exciting forum for discussion and exchange of ideas within this increasingly interdisciplinary field. The symposium brought together some of the leading contributors in the scientific community with a healthy mix of graduate students, postdoctoral fellows, and junior faculty for the purpose of discussing and disseminating new concepts in scientific research.

The organization of the symposium followed that of the Gordon Research Conferences, although speakers will submit papers to a special issue of the journal Marine Chemistry based on their presentations. Sub themes were chosen to represent areas of research where Hedges made major advances during his lifetime.

The CHN's of organic geochemistry: characterization of molecularly-uncharacterized non-living organic matter, Session Chair: Patrick Hatcher, Ohio State University

Elizabeth Minor, Old Dominion University , "What is the "dead" POM? A preliminary study using fluorescent stains, flow cytometry, and mass spectrometry"

Norbert Hertkorn, GSF Research Center, Munich, Germany , "Molecular level structural characterization of organic matter by NMR spectroscopy"

Elizabeth Kujawinski, Barnard College, "Probing Molecular-Level Transformations of Dissolved Organic Matter: Insights from ESI FT-ICR MS"

Jeff Baldock, CSIRO Land & Water, "Chemical changes associated with the decomposition of natural organic materials found in soils and sediments"

Round Table: The role of marine gel-phase on carbon cycling in the ocean, Discussion Leader: Pedro Verdugo, University of Washington, Round Table Members: Alice Alldredge, University of California, Santa Barbara; Farooq Azam, Scripps Institution of Oceanography; Uta Passow, Alfred Wegener Institute; Peter Santschi, Texas A & M; and David Kirchman, University of Delaware

Transformations in the "twilight zone" and beyond, Session Chair: Cindy Lee, Stony Brook University

Anitra Ingalls, Harvard University, "Biogenic Mineral-Bound Organic Matter: From Carbon Preservation to Paleoceanography"

Jay Brandes, University of Texas at Austin, "Through the looking glass: A nanoscale view of early diagenesis"

Matt McCarthy, University of California at Santa Cruz, "Transformations on the molecular scale: Probing for altered amino acid structure in dissolved proteinacous material preserved in the deep"

Organic matter preservation, Session Chair: Larry Mayer, University of Maine

Neal Blair, North Carolina State University, "Watershed and shelf dynamics as determinants of the nature of organic carbon buried on continental margins"

Rick Keil, University of Washington, "Mechanisms of organic matter survival in sediments - Knights versus sketes"

Heike Knicker, Technische Universitat Munchen, "Stabilization of N-compounds in soil and sediments - What is the difference?"

Klaus Kaiser, Martin Luther University Halle-Wittenberg, "Organic matter preservation under saturated vs. unsaturated conditions: Sediment-soil comparisons"

Round Table: Chemical Reference Standards, Discussion Leader: Cindy Lee, Stony Brook University

Black carbon in the environment, Session Chair: Ellen Druffel, University of California at Irvine

Carrie Masiello, UC Santa Barbara and Cal. Inst. of Technology, "New Directions in Black Carbon Research"

Angela Dickens, University of Washington, "Reburial of fossil graphitic carbon in marine sediments"

Patrick Hatcher, Ohio State University, "Evidence for the presence of black carbon in riverine DOM from ultrahigh resolution mass spectrometry"

Reading the molecular Rosetta stone: molecular clues about the origin and diagenesis of organic matter, Session Chair: Stuart Wakeham, Skidaway Institute of Oceanography, Richard Pancost, University of Bristol, "Terrestrial biomarkers in marine environments: Developing high-resolution palaeo-records of continental environments and ecosystems"

Carol Arnosti, University of North Carolina, Chapel Hill, "Speed Bumps in the Carbon Cycle: Substrate Structural Effects on Carbon Cycling"

Josef Werne, University of Minnesota, "Understanding the sedimentary archive: Molecular isotopic clues to (paleo)environmental controls on organic matter sources and alterations"

Ann Pearson, Harvard University, "A new approach to the "biomarker": Separation of selected nucleic acids for isotopic analysis"

What happens to terrestrial organic matter in the ocean? , Session Chair: Ron Benner, University of South Carolina

Rainer Amon, Texas A&M University at Galveston, "A river runs through it - DOM in the Arctic Ocean"

Elizabeth Gordon, University of South Carolina, "Controls on the distribution and accumulation of terrigenous organic matter in a river-dominated margin"

Peter Raymond, Yale School of Forestry, "Evaluating system-specific variability in riverine organic carbon and ^{14}C: implications for determining terrestrial contributions to oceanic DOC"

EMPLOYMENT OPPORTUNITIES

Chair, Department of Geosciences
Western Michigan University

Western Michigan University invites applications for Chair of the Department of Geosciences, with a targeted start date of Fall 2004. Candidates must possess a Ph.D. in the geosciences and should currently hold a position at the Professor level or its equivalent. Candidates must have demonstrated teaching and research excellence, including an internationally-recognized publication record and experience in obtaining and managing significant externally-funded reseach.

The Department currently has 11 full-time faculty, with established B.Sc., M.Sc. and Ph.D. progrmas in geology, geochemistry, earth sciences, geophysics and hydrogeology. The successful candidate is expected to oversee and promote the growth of these programs and should also maintain working relationships with closely related Departments, including Chemistry, Geography, Biological Sciences and Environmental Studies. Candidates should have a research program that will be complementary to our current expertise in hydrogeology, near-surface geophysics, bluff stability, petroleum geology, and tectonics. Additional information is available at www.wmich.edu/geology.

Western Michigan University is a dynamic, growing, student-centered research institution that has recently been classified as a Carnegie Doctoral Research Extensive Institution. Extensive, modern research facilities are available in four buildings on the WMU campus. Kalamazoo, Portage and adjacent communities constitute a population center of about 150,000, located midway between Chicago and Detroit, and 50 miles from Lake Michigan. Submit a letter of application, a concise statement of research interests and vision for the future of the Department, complete vita, and names and addresses of at least three references. The search committee anticipates interviews to be initiated in January 2004; however, application will be accepted until the position is filled. Please send applications to: Chair Search Committee, Department of Geosciences, Western Michigan University, Kalamazoo, MI 49008.

WMU is an equal opportunity/affirmative action employer and encourages applications from qualified women and minorities.

Earth Science Education Position
Western Michigan University

Western Michigan University's College of Arts and Sciences seeks applications for a tenure-track position in Earth Science Education at the assistant professor level for fall 2004, pending budgetary approval. WMU has one of the largest teacher education programs in the USA. Science education is an important component of the education of all prospective elementary teachers and secondary science education students at WMU. The faculty member hired will be appointed in the Department of Geosciences and will have a joint appointment in The Mallinson Institute for Science Education, which offers Masters and Ph.D. programs in science education. Candidates must have a doctoral degree in Science Education with the equivalent of Masters in the Earth Sciences; or a doctoral degree in Geosciences with demonstrated experience and research in science education. Experience in the K-12 education is highly desirable. Appointees will be expected to develop a research program in science education, supervise graduate students, and develop and teach graduate and undergraduate content courses in the earth sciences for teachers. Western Michigan University is a student-centered research university and an Equal Employment Opportunity/Affirmative Action employer.

Send a cover letter, curriculum vitae, graduate transcripts, statement of research interests, and the names of three professional referees: Dr. Dave Barnes, Department of Geosciences, College of Arts and Sciences, Western Michigan University, Kalamazoo, MI 49008-5241. Review of the applications will begin November through Dec. 1, 2003 and continue until the position is filled.

Faculty Position in Mineralogy
University of Wisconsin - Madison

The Department of Geology and Geophysics solicits applications for a faculty position in Mineralogy at the Assistant Professor level. Applicants should have demonstrated research interests in any broadly defined area of Mineral Physics, Mineral Chemistry, or Biomineralization. Opportunities exist for collaborative research with a wide variety of areas in the department, including geochemistry, petrology, geophysics, sedimentary geology, and hydrogeology. An additional new position in geomicrobiology, as well as a new ion microprobe facility, provide further opportunities for collaborative research.

Screening of applicants will begin November 1, 2003, and the position will remain open until filled. Interested applicants should send a full vitae, including a statement of research and teaching interests, several reprints/preprints, and contact information for 3-5 letters of reference to Prof. John W. Valley, Mineralogy Search Committee Chair, Department of Geology and Geophysics, 1215 W. Dayton Street, University of Wisconsin, Madison, WI 53706, U.S.A.

Further information about the search and the department may be found at www.geology.wisc.edu or by contacting Prof. Valley at valley@geology.wisc.edu. UW-Madison is an equal opportunity/affirmative action employer and encourages applications from women and minorities. Unless confidentiality is requested in writing, information regarding applicants must be released upon request. Finalists cannot be guaranteed confidentiality.

Faculty Position in Geomicrobiology
University of Wisconsin - Madison

The Department of Geology and Geophysics solicits applications for a faculty position in Geomicrobiology. We seek applications from scientists across a broad range of disciplines who are interested in microbial interactions with fluids and minerals in modern and/or ancient environments. The position will include major new facilities dedicated to geomicrobiological research. Opportunities exist for collaborative research with members in the Department who are interested in paleobiology, low-temperature geochemistry (including mineral-fluid interface chemistry), hydrogeology, and isotope geochemistry. An additional new position in mineralogy, as well as a new ion microprobe facility, provide further opportunities for collaborative research. Beyond the Department, outstanding resources in microbiology, genomics, molecular biology, materials science, soil science, environmental engineering, and chemistry are available on the Madison campus.

Appointment level will be contingent upon qualifications. Screening of applicants will begin November 1, 2003, and the position will remain open until filled. Interested applicants should send a full vitae, including a statement of research and teaching interests, several reprints/preprints, and contact information for 3-5 letters of reference to Prof. Clark M. Johnson, Geomicrobiology Search Committee Chair, Department of Geology and Geophysics, 1215 W. Dayton Street, University of Wisconsin, Madison, WI 53706, U.S.A.

Further information about the search and the department may be found at www.geology.wisc.edu or by contacting Prof. Johnson at clarkj@geology.wisc.edu. UW-Madison is an equal opportunity/affirmative action employer and encourages applications from women and minorities. Unless confidentiality is requested in writing, information regarding applicants must be released upon request. Finalists cannot be guaranteed confidentiality.

Position Announcement:
Astrobiology Postdoctoral Fellows - University of Hawaii

The Institute for Astronomy (IfA) invites applications for postdoctoral fellows with a strong interest in astrobiology to collaborate with the University of Hawaii's NASA Astrobiology Institute lead team members. The UH lead team will maintain an innovative multi-disciplinary research environment linking biological, microbiological, chemical, geological and astronomical sciences to investigate the origin, history, distribution and role of water as it relates to life in the universe. The core of this program will center around interactions with an interdisciplinary group of postdoctoral fellows. Areas of primary research collaboration will be (1) formation and measurement of astrobiologically important molecules such as sugars, aminoacids, carboxylic acids, carbon homologoues, hopanes, steranes, and head to head isoprenoids, as well as interpretation of the redox environment as it pertains to life in water-rich extraterrestrial ice analog samples, (2) star formation (IR spectroscopy of sources in and behind dark clouds; sub-mm interferometry of disks), (3) studies of small solar system primitive bodies (including both IR spectra, and isotopic studies), (4) modeling the incorporation of water into pre-planetary grains; (5) mineralogy, petrology and isotope (D/H) chemistry of aqueously-altered carbonaceous chondrites;

(6) incorporation of water into planetary bodies, its cycling between surface and interior and its subsequent loss to space; (7) aqueous alteration on Mars; (8) evolution and diversity of microorganisms, especially those living in extreme and unusual Earth environments; (9) experimental and field investigation of indigenous microbiota and energetics of potential metabolic pathways in ocean crust and mantle rocks as analogs for early Earth habitats; (10) the ecology and bigeochemistry of extreme aqueous environments on the Earth, including subglacial lakes, high-altitude lakes and fumaroles as analogs to habitats elsewhere in the solar system; (10) the development of astrobiological instruments; and (11) models of theoretical ocean-bearing extrasolar planets and their remote characterization (12) the development of collaborative multidisciplinary computing techniques.

Minimum qualifications include a Ph.D. and and the expertise appropriate for the specific research focus selected by the applicant. This could include (but is not limited to):

Expertise in infrared astronomical spectroscopy and research experience in star formation, circumstellar disks, or small solar system bodies, experience with astronomical sub-millimeter spectroscopy & interferometry, background in experimental physical chemistry (reaction dynamics, photochemistry, charged and neutral particle sources and high vacuum technology), experience with solar nebula models, familiarity with basic analyses of seawater based fluids, microbial molecular genetic techniques, and thermodynamic modeling of fluid-rock solution systems, strong research programming skills (Java/C++/other) with an interest in collaborative computing and/or artificial intelligence, experience with scanning and transmission electron microscopy, electron and ion microprobes; experience in geo/cosmochemistry or physicochemistry, experience in marine microbial ecology and biogeochemistry, molecular Biology and microbiology techniques, modeling of upper atmospheric chemistry and physics, analysis of remote sensing of terrestrial surface and atmosphere, or experience in the design and construction of instrumentation. Additional desirable qualifications: Education and public outreach is an integral part of the Astrobiology program and experience with or interest in E/PO will be considered positively in an application.

The successful candidates will have access to unequaled astronomical observing facilities at the Mauna Kea and Haleakala observatories, an Ultra-High Vacuum Surface scattering machine, a 5 spectrometer electron microprobe and scanning electron microscope, a prototype Cryobot, fully-equipped molecular biology and microbiology laboratories, the R/V Kilo Moana oceanographic research ship, and the University of Hawaii Undersea Research Laboratory. In addition, successful candidates will be in close proximity to a variety of unique aquatic habitats (open ocean, high-altitude lakes, fumaroles). Appointments will be up to 3 years assuming satisfactory progress. Fellows will receive a stipend of $4,333 per mo, a relocation allowance and small research budget. Fellows may apply for an subsequent 2 year position as senior fellows.

Applicants are expected to propose a program of research in consultation with the lead team members. Please address application materials including a complete application form (http://www.ifa.hawaii.edu/UHNAI/application.html), which includes a CV, publication list, a research proposal describing connections to at least 2 lead team members (see http://www.ifa.hawaii.edu/UHNAI) and a list of at least three professional references to Dr. Rolf Kudritzki, Director, Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822. Request that the letters of recommendation are sent directly to this same address. Further details may be obtained from Dr. Rolf Kudritzki at 808-956-8566 or email kud@ifa.hawaii.edu. Questions about the UH Astrobiology lead team's program may be directed to Dr. K. J. Meech. Applications will be reviewed beginning Dec. 15, 2003, but the positions will remain open until filled. The University of Hawaii is an EEO/AA employer and encourages applications from women and minorities.

Dr. James P. Cowen
Department of Oceanography
University of Hawaii
1000 Pope Rd
Honolulu, Hawaii 96822
jcowen@soest.hawaii.edu
phone: 808-956-7124 / fax: 808-956-9225

PhD Opportunity at University of Geneva, Switzerland

A PhD project is available at the Department of Mineralogy, University of Geneva, entitled "Magmatic and tectonic evolution of the Pataz Batholith, Northern Peru". The aim of this project is assess the relative contributions of subduction versus rift-related magmatism in this area of northern Peru, and hence better understand the geodynamic evolution of this segment of the Andes during the Paleozoic and Mesozoic.

The project includes (a) fieldwork in northern Peru in the area around the Pataz Batholith (ca. 300 km inland of Trujillo, Valle Marañon) to establish the emplacement sequence of the magmatic rocks, to study the regional structures within and around the batholith, and take samples for geochemical and geochronological studies of granitoid rocks from within the batholith and from volcanic rocks of the hosting Paleozoic to Mesozoic strata; and (b) laboratory work in Geneva (the major part of the project), including whole-rock chemistry and Pb-Nd-Hf isotope chemistry as well as U-Pb-dating and determination of Hf isotopic compositions of zircon.

The position is funded by the Swiss Fonds National de Recherche Scientifique, with a starting salary (before deduction of social security and taxes) of SFR. 2'650,00/month. The successful applicant should start the project in Geneva between January 1st and March 1st, 2004, a first field season is envisaged to start in April/May 2004. The project benefits from a close collaboration (including logistical as well as geological support from different mining companies and from Ingemmet, Peruvian Geological Survey organisation). The student will be carefully introduced to regional geology and be accompanied throughout the project by a mapping team of Ingemmet geologists.

Requirements: We seek a candidate who is capable of doing fieldwork in high altitude and in a physically challenging and remote terrain. The project clearly demands a strong affinity for laboratory work, including micro-chemistry in a clean-air laboratory, low-level isotopic analyses and mass spectrometry. Languages: English, French and Spanish; willingness to learn conversational Spanish is essential.

Candidates are kindly asked to supply a CV, three academic references, as well as a personal statement why they are interested in this project and about their motivation to continue their studies with a PhD. For further information please contact Urs Schaltegger, +41 22 379 66 38, urs.schaltegger@terre.unige.ch, or David Chew, +41 22 379 66 24, david.chew@terre.unige.ch. Closing date for applications is Nov. 30, 2003.

Applications are kindly requested to be sent to the following address: Prof. U. Schaltegger, Université de Genève, Département de Minéralogie, rue des Maraîchers 13, 1205 Genève, Switzerland.

Postdoctoral Position in Estuarine/Coastal Ocean Organic Matter Cycling Old Dominion University

The Virginia Institute of Marine Science and the Old Dominion University Department of Chemistry seek applicants for a 1-2 year postdoctoral fellowship starting Spring 2004 or sooner. The research involves the effects of microbial and photochemical transformations on DOM structure and isotopic signatures in river, estuarine, and coastal ocean systems. The work will be directed jointly by Drs. Jim Bauer and Ken Mopper. The candidate should have a strong background in aquatic isotope or organic geochemistry. Experience in natural abundance isotopic techniques (^{14}C, ^{13}C, ^{15}N, ^{18}O), organic matter characterization (e.g., GC-MS, NMR, IR, UV), microbial ecological methods, and/or photochemical techniques is strongly desirable. Applicants for the position should send their full CV, a one-page statement of research interests and experience, and full contact information to Dr. Jim Bauer, School of Marine Science, VIMS, College of William and Mary, 1208 Greate Road, Gloucester Point, VA 23062-1346, or bauer@vims.edu. Position open until filled.

Goldschmidt Geochemistry
Copenhagen 2004

Processes in Geochemistry: Forces, Fluxes and Structure

5 - 11 June 2004

Conference Themes:

- The Dynamic Solid
- Fluids of the Earth
- The Deep Earth
- The Dynamic Interface
- The Earth's Surface
- Early Earth, Moon, Planets

Goldschmidt 2004 will be held at the University of Copenhagen Geocenter and Ørsted Institute

The Geocenter Copenhagen was established as a centre for geoscientific research, education, consultancy and communication at the highest international level. Geocenter Copenhagen represents five independent institutions which have committed themselves to this cooperative venture: The Geological Survey of Denmark and Greenland (GEUS), the Danish Lithosphere Centre (DLC) and the three geoscience institutes of the University of Copenhagen (Geological Institute, Geographical Institute, Geological Museum).

Hosted by the Nordic Countries
Denmark, Norway, Iceland, Sweden and Finland

For more information, please contact:
Goldschmidt 2004, Geological Institute, University of Copenhagen
ØsterVoldgade 10, DK-1350 Copenhagen K, Denmark.
fax: +45 33 14 83 22
E-mail: goldschmidt@geol.ku.dk

MEETINGS ANOUNCEMENTS

Call for Abstracts
Frontiers in Analytical Geochemistry: Session G-04.01
2004 International Geological Congress

The frontiers of research are rapidly moving forward as a result of revolutionary advances in technology. We write to call you attention to the 2004 International Geological Congress, which will take place from 20-28 August 2004 in Florence, Italy and to invite your participation in the general session on *Frontiers in Analytical Geochemistry.* Complete information about the Congress is available from the web site: http://www.32igc.org. The session on *Frontiers in Analytical Geochemistry*, sponsored by the International Association of Geochemistry and Cosmochemistry, will focus on the applications of recent advances in technology for in-situ, spatially-resolved analysis across a broad spectrum of both organic and inorganic geochemistry.

Abstract Submission & Review

Abstracts for oral or poster presentations may be submitted until **January 10, 2004,** indicating two sessions in priority order. Each abstract must be submitted by the person who is going to make the oral or poster presentation. Each presenter can submit only one abstract for volunteered oral presentations. A person who is not the presenter may be co-author of more that one abstract. There are no limitations on the number of posters submitted. All abstracts should be submitted electronically. Instructions for submitting an abstract are provided on the second page of this announcement.

Each Congress sessions will be overseen by 2-3 conveners, who will co-chair the sessions. The conveners of each session will select the abstracts submitted for oral and poster presentations. A special time slot has been reserved for poster presentations on the afternoon of each day after the end of the oral sessions, with the express purpose of focusing attention on this important form of communication. The abstract review processes will take place from 11 January to 29 February 2004. Following the completion of the review, the electronic system will inform each presenter of acceptance, session allocation, and mode of presentation of his/her abstracts.

Presenters of accepted abstracts must meet the payment deadline for Congress registration fees of **31 March 2004**. In the case of non-payment, abstracts will be canceled from the Scientific Program and Abstract Volume. To counteract the effects of “no-shows”, conveners will alert two or three poster presenters so that they will be ready to present their poster orally.

Presentation Modes

Oral presentation. Within Topical and General Symposia, 15 minutes (12 minutes plus three for discussion) will be allocated for standard oral presentations. The duration of oral presentations in Special Symposia will vary according to session format.
Poster presentation. A special time slot has been scheduled on the afternoon of each day with the express purpose of focusing attention on this important form of presentation. Posters should be set up for display on the day when the related oral session is scheduled. The presenters must stand by the poster booth during the poster session, which will be held from 5.00 to 6.30 p.m., and are also encouraged to be present during lunch time (12.45 – 02.15 p.m.).

Proceedings

We anticipate a publication comprised of selected contributions to the oral and poster presentations of the *Frontiers in Analytical Geochemistry* session as a special volume of the journal *Applied Geochemistry.*

Session Conveners: Russell Harmon, Jochen Hoefs, & Riccardo Vannucci

Instructions For Submission Of Abstracts

1. Open the sitehttp://www.32igc.orgClick on “**REGISTRATION FORMS**” and log in with your Username and Password. If you do not possess a Username and Password, click on “**REGISTRATION**” and enter the required details. Click on “**SUBMIT**” and check if your data are correct. After clicking on “**CONFIRM**”, the system will automatically issue your Username and Password, which are necessary to activate the submission process. You will also receive confirmation of your Username and Password by e-mail.**2. Select presentation mode***Invited oral presentation*: this mode applies only to authors invited for sessions of Special and Topical Symposia.*Volunteered oral presentation*: this mode applies to authors wishing to submit abstracts to sessions of Topical and General Symposia for oral presentation.*Poster presentation*: this mode applies to authors wishing to submit abstracts to sessions of Topical and General Symposia for poster presentation.*No preference*: this mode applies to authors wishing to submit abstracts with no preference for oral or poster presentation to sessions of Topical and General Symposia.After selecting the presentation mode, click on “**ABSTRACT REGISTRATION**”, then check and confirm your data. Click on “**START SUBMISSION**” to initiate the abstract submission process.**3. Start submission process***EDIT*: select the “**EDIT**” option on the side column and fill in all the required fields by clicking on the listed items.*Title*: write title in capital letters. Click on “**SAVE**” at any time to update your working progress. You can log out after saving and log in again to resume your work.*Authors*: up to 10 authors (including the presenter) can be listed. If the number of authors exceeds 10, check the appropriate box “**et al**.”. The presenter, whose name will be automatically underlined by the system, is not necessarily the first author.*Key words*: enter no less than 3 and no more than 5 key words.*Abstract*: enter the text. The text must not exceed 2,500 characters, including spaces. Figures and tables are not permitted. To include formulas click on “Instruction to include formulas”.*Choice of session*: click on “**1st OPTION**”, then on “**INSERT**”, and use the pull-down menu to indicate the symposium in which your preferred session is included. Click on “**SELECT**” to obtain the complete list of sessions, and choose your preferred session. Click on “**ENTER**” to go to the “**2nd OPTION**”, and proceed as above. Abstracts can be updated and modified at any time until final submission by clicking on “**EDIT**”. Up to this time it is possible to check your data input by clicking on “**DATA CHECK**” in the side column. When you have completed editing click on “**FINALSAVE**” and then to send your abstract click on “**SEND ABSTRACT**”, after which abstracts will be visible by clicking on “**VIEW**” but no longer modifiable.**The deadline for abstract submission is January 10, 2004.**

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MEETINGS CALENDAR

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

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

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

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

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

Oct 23-24, 2003: 10th Sampling, On-Site Analysis; Sample Prep Conference, Pittsburgh, PA, U.S.A. Contact: Henry Nowicki, PACS Testing and Consulting Services; Phone.: +1 724-457-6576 or 800-367-2587; Fax: +1 724-457-1214; E-mail: HNpacs@aol.com; Web site: http://www.pacslabs.com

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

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

Nov 17-19, 2003: Third ALAGO Workshop. Theme: Petroleum Biodegradation, Havana, Cuba. Latin-American Association of Organic Geochemistry. Abstract deadline: Sept 15, 2003. Contact: Dr. Jos Orlando Lopez Quintero, Centro de Investigaciones Del Petroleo, Washington 169, Cerro, CP 12000, Habana, Cuba; Phone: + 537 57-7301; Fax +537 66-6021; E-mail: jorlando@ceinpet.cupet.cu

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

Dec 6-7, 2003: Biomineralization Short Course, Silverado Resort, 1600 Atlas Peak Road, Napa Valley, California, 94558, U.S.A. Organizers: Patricia Dove, James J. DeYoreo and Steve Weiner. Sponsored by Mineralogical Society of America. Web site: http://www.minsocam.org/MSA/SC/BioSC_descrptn.html

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

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

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

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

Jan 5-7, 2004: Volcanic and Magmatic Studies Group - Annual Meeting (with the Mineralogical Society), Assembly Rooms, Bath, U.K. Main theme: geothermal processes. Abstract deadline 31 October 2003. Contact: Kathryn Goodenough; E-mail: kmgo@bgs.ac.uk; Web site: http://www.minersoc.org

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

Jan 18-22, 2004: Penrose Workshop, Neogene Continental Margin Volcanism; see above. **Jan 26-30, 2004: AGU Ocean Sciences Meeting**, Portland, Oregon. Web site: http://www.agu.org/meetings/meetings.html

Jan 21, 2004: Depleted Uranium: Facts Behind the Science, East Midlands Regional Group, British Geological Survey, Keyworth, U.K. Contact: Martin Culshaw; E-mail: mgc@bgs.ac.uk

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

Feb 8-13, 2004: 17th Australian Geological Convention - Past, Present and Future, Hobart, Tasmania. Contact: Conference Design, PO Box 342, Sandy Bay Tasmania 7005; Web site: http://www.17thagc.gsa.org.au

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

Feb 15-20, 2004: ASLO-TOS Ocean Research Conference, Honolulu, Hawaii, U.S.A. Co-sponsored by the American Society of Limnology and Oceanography and The Oceanography Society. Web site: http://www.aslo.org/honolulu2004/index.html

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

March 29-31, 2004: Euradwaste '04, Sixth European Commission Conference on the Management and Disposal of Radioactive Waste, European Commission, Jean Monnet building, Luxembourg - Kirchberg. Web site: http://www.cordis.lu/fp6-euratom/events.htm

April 5-6, 2004: Seventh Nederlands Aardwetenschappelijk Congres (NAC VII). No further information yet.

April 6-7, 2004: The 8th international conference of Jordanian Geologist Association, Faculty of Engineering, University of Jordan, Amman, Amman, Jordan. Contact: Dr. Ahmad Al-Malabeh, Jordanian Geologist Association; Phone: +962 6 5652310; Fax: +962 6 5652312; E-mail: jga@joinnet.com.jo; Web site: http://www.jo-geologists.com

April 12-16, 2004: MRS 2004 Scientific Basis for Radioactive Waste Management XXVIII, San Francisco, CA, U.S.A. Web site: http://www.mrs.org/meetings/spring2004/

April 14-19, 2004: 5th International Symposium on Eastern Mediterranean Geology, Thessaloniki, Greece. A conference covering all earth science topics related to the broader eastern Mediterranean region. Contact: Alexandros Chatzipetros; Phone: +30 (231) 0998512; Web site: http://www.geo.auth.gr/5thISEMG

April 22-23, 2004: Symposium on Silica: Sampling and Analysis, Salt Lake City, Utah, U.S.A.Contact: Dorothy A Fitzpatrick, Symposia Operations, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Consholhocken, PA 19428 2959, U.S.A.; E-mail: mharper@cdc.gov

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

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

May 17-21, 2004: joint meeting - 2004 AGU Spring meeting and the Canadian Geophysical Union annual meeting, Montreal, Canada. Contact: meetinginfo@agu.org; Web site: http://www.agu.org/meetings/

May 23-27, 2004: 104th General Meeting American Society for Microbiology, Ernest N. Morial Convention Center, New Orleans, LA. Web site: http://www.asm.org/Meetings/index.asp?bid=697

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

Summer 2004: The 2nd International Symposium on Volcanic Ash and Aviation Safety, Washington, DC. Contact: Mary Cairns or Donald Carver, Office of the Federal Coordinator for Meteorology, 8455 Colesville Road Silver Spring, MD 20910, U.S.A.; Phone: +1 301-427-2002; Fax: +1 301-427-2007; Web site: http://www.ofcm.gov/homepage/text/spc_proj/volcanic_ash/volash2.html

June 2-7, 2004: 20th Colloquium of African Geology - Geoscientific Infrastructure in Africa for Sustainable Development, Orl ans, France. Bureau de recherches g ologiques et mini res (BRGM). Contact: Secretariat of CAG 20, BRGM 3, Avenue Claude Guillemin, B.P. 6009 - 45060 Orl ans cedex 2, France; Phone: +33 2 38 64 38 11; Fax: +33 2 38 64 38 61 - +33 2 38 64 37 29; E-mail: cag20@brgm.fr; Web site: http://cag20.brgm.fr

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

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

June 5-9, 2005: 105th General Meeting American Society for Microbiology, Atlanta, GA, U.S.A. Web site: http://www.asm.org/Meetings/index.asp?bid=470

June 13-18, 2004: ASLO Summer Meeting, Savannah Convention Center, Savannah, Georgia, U.S.A. Contact: Amy Parker, University of Georgia; E-mail: aparker@smokey.forestry.uga.edu; Alan Decho, University of South Carolina; E-mail: Awdecho@gwm.sc.edu

June 19-24, 2004: 41st Clay Minerals Society annual meeting, Richland, WA, U.S.A., by the Clay Minerals Society and Pacific Northwest National Laboratory. Contact: Jim Amonette; Phone: +1 509-376-5565; Fax: +1 509-376-7972; E-mail: jim.amonette@pnl.gov; Web site: http://www.pnl.gov/cms/

June 20-24, 2004: The East African Rift System: Development, Evolution and Resources, Addis Ababa, Ethiopia. Web site: http://www.gl.rhul.ac.uk/ear_conference/EAR1_circular.pdf

June 27-July 2, 2004: XIth International Conference on the Coordination and Organometallic Chemistry of Germanium, Tin and Lead, Santa Fe, New Mexico. Contact: Prof. Keith Pannell, Department of Chemistry, University of Texas at El Paso, El Paso, TX 79968-0513, U.S.A.; Phone: +1 915-747-5796; Fax: +1 915-747-5748; E-mail: kpannell@utep.edu

June 27-July 1, 2004: International Basement Tectonics Association (IBTA) Conference on the Four-D Evolution of Continental Crust, Oakridge, TN, U.S.A. Sponsors: IBTA, AGU, Geological Society of America, others. Contact: R.D. Hatcher, Jr., Department of Geological Sciences, University of Tennessee, 305 Geological Sciences Building, Knoxville, TN 37996-1410 U.S.A.; E-mail: bobmap@utk.edu

June 27-July 2, 2004: 11th International Symposium on Water-Rock Interaction, Saratoga Springs, New York, U.S.A. Contact: Cheryl Corman, Phone: +1 814-863-1738; Susan Brantley, Secretary General, Dept. of Geosciences, The Pennsylvania State University, 239 Deike Building, University Park, PA 16802, U.S.A.; Phone: +1 814-863-1739; Fax: +1 814-863-8724; Web sites: http://www.outreach.psu.edu/C&I/WRI/ and http://wwwrcamnl.wr.usgs.gov/wri/future_meetings.htm

June 28-30, 2004: 4th BGA Geoenvironmental Engineering Conference, Stratford-upon-Avon, U.K. The main conference theme is "Integrated Management of Groundwater

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and Contaminated Land". Organized by the Geoenvironmental Research Centre (Cardiff School of Engineering, Cardiff University) and the National Groundwater & Contaminated Land Centre (Environment Agency) on behalf of the British Geotechnical Association. Web site: http://www.grc.cf.ac.uk/4bga/

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

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

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

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

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

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

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

Aug 16-20, 2004: Western Pacific Geophysics Meeting, Honolulu, Hawaii, U.S.A.Sponsor: AGU. Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 U.S.A.; Phone: +1-202-777-7333; Fax: +1-202-328-0566; E-mail: meetingsinfo@agu.org; Web site: www.agu.org/meetings

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

Aug 20-28, 2004: symposium G-04.04 Kinetics and geochemical reactions, part of the 32nd International Geological Congress (IGC), Florence, Italy (see above). Web site: http://www.32igc.org/default1.htm

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

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

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

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

Sept 6-10, 2004: ECORAD 2004, Aix en Provence, France. Web site: http://www.irsn-dpre.com/ecorad/

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

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

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

Oct 13-16, 2004: SOLAS Science 2004. Halifax, Nova Scotia, Canada.Web site: http://www.uea.ac.uk/env/solas/ss04.html

Nov 7-10, 2004: GSA 2004 Annual Meeting & Exposition, Denver, Colorado. Web site: http://www.geosociety.org/

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

Dec, 2004: ACE 2004 - 5th European meeting on environmental chemistry, Bari, Italy. Contact: Dr. Michele Aresta, METEA Research Center, University of Bari, via Celso Ulpiani 27, 70126 Bari, Italy; E-mail: resta@metea.uniba.it; Web site: http://www.science.plym.ac.uk/ace/Meetings.html

Dec 5-8, 2004: Salt-Sediment Interactions and Hydrocarbon Prospectivity: Concepts, Applications, and Case Studies for the 21st Century, Adam's Mark Hotel, Houston, TX U.S.A. GCSSEPM Foundation. Contact: Paul J. Post; Phone: +1 504-736-2954; Fax: +1 504-736-2905; E-mail: paul.post@mms.gov: Web site: http://www.geolsoc.org.uk/template.cfm?name=GCSSEPM1

Dec 6-7, 2004: Channel Flow, Ductile Extrusion and Exhumation of lower-mid crust in Continental Collision Zones, The Geological Society of London, Burlington House, London, U.K. Contact: Helen Wilson, Geological Society of London, Burlington House, Piccadilly, London W1J 0BG; Phone: +44 (0)20 7434 9944: Fax: +44 (0)20 7494 0579; E-mail: helen.wilson@geolsoc.org.uk; Web site: http://www.geolsoc.org.uk/template.cfm?name=channel_flow

Dec 13-17, 2004: AGU Fall Meeting, San Francisco, California, U.S.A. Contact: E. Terry, AGU Meetings Department, 2000 Florida Avenue NW, Washington, DC 20009 U.S.A.; Phone: +1-202-777-7335; Fax: +1-202-328-0566; E-mail: eterry@agu.org; meetinginfo@agu.org; Web site: www.agu.org/meetings

Apr 25-29, 2005: European Geosciences Union (EGU) XXX General Assembly, Nice, France. Sponsors: EGU, AGU. Contact: EGU Office, Max-Planck-Str. 13, 37191 Katlenburg-Lindau, Germany; Phone: +49-5556-1440; Fax: +49-5556-4709; E-mail: egu@copernicus.org; Web site: www.copernicus.org/EGU/EGU.html

May 23-27, 2005: AGU Joint Assembly, New Orleans, Louisiana, U.S.A. Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 U.S.A.; Phone: +1-202-777-7333; Fax: +1-202-328-0566; E-mail: meetinginfo@agu.org; Web site: www.agu.org

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

Sept 26-29, 2005: MRS 2005 Scientific Basis for Radioactive Waste Management XXIX, Gent, Belgium.

Oct 16-19, 2005: GSA 2005 Annual Meeting & Exposition, Salt Lake City, Utah. Web site: http://www.geosociety.org/

Dec, 2005 - 6th European Meeting on Environmental Chemistry, Belgrade, Yugoslavia. Contact: Dr. Branimir Jovancicevic, Department of Chemistry, University of Belgrade, Akademski trg 12-16, POB 158, 11001 Beograd, Yugoslavia; E-mail: bjovanci@chem.bg.ac.yu; Web site: http://www.science.plym.ac.uk/ace/Meetings.html

Dec 5-9, 2005: AGU Fall Meeting, San Francisco, California, U.S.A. Contact: E. Terry, AGU Meetings Department, 2000 Florida Avenue NW, Washington, DC 20009 U.S.A.; Phone: +1-202-777-7335; Fax: +1-202-328-0566; E-mail: eterry@agu.org; meetinginfo@agu.org; Web site: www.agu.org/meetings

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

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

Oct 22-25, 2006: GSA 2006 Annual Meeting & Exposition, Philadelphia, Pennsylvania. Web site: http://www.geosociety.org/

Dec, 2006 - 7th European Meeting on Environmental Chemistry, Brno, Czech Republic. Contact: Dr. Josef Caslavsky, Institute of Analytical Chemistry, Czech Academy of Science, Veveri 97, 61142 Brno, Czech Republic; E-mail: caslav@iach.cz: Web site: http://www.science.plym.ac.uk/ace/Meetings.html

Dec 11-15, 2006: AGU Fall Meeting, San Francisco, California, U.S.A. Contact: E. Terry, AGU Meetings Department, 2000 Florida Avenue NW, Washington, DC 20009 U.S.A.; Phone: +1-202-777-7335; Fax: +1-202-328-0566; E-mail: eterry@agu.org; meetinginfo@agu.org; Web site: www.agu.org/meetings

Oct 28-31, 2007: GSA 2007 Annual Meeting & Exposition, Denver, Colorado. Web site: http://www.geosociety.org/

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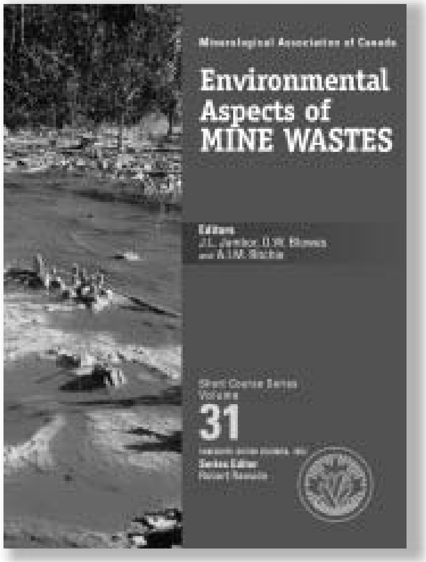

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ISBN 0-921294-31-X
SC31, 436 pages, 2003
US$50 (outside Canada) CDN$50 (in Canada)
(Member Price US$40/CAN$40)

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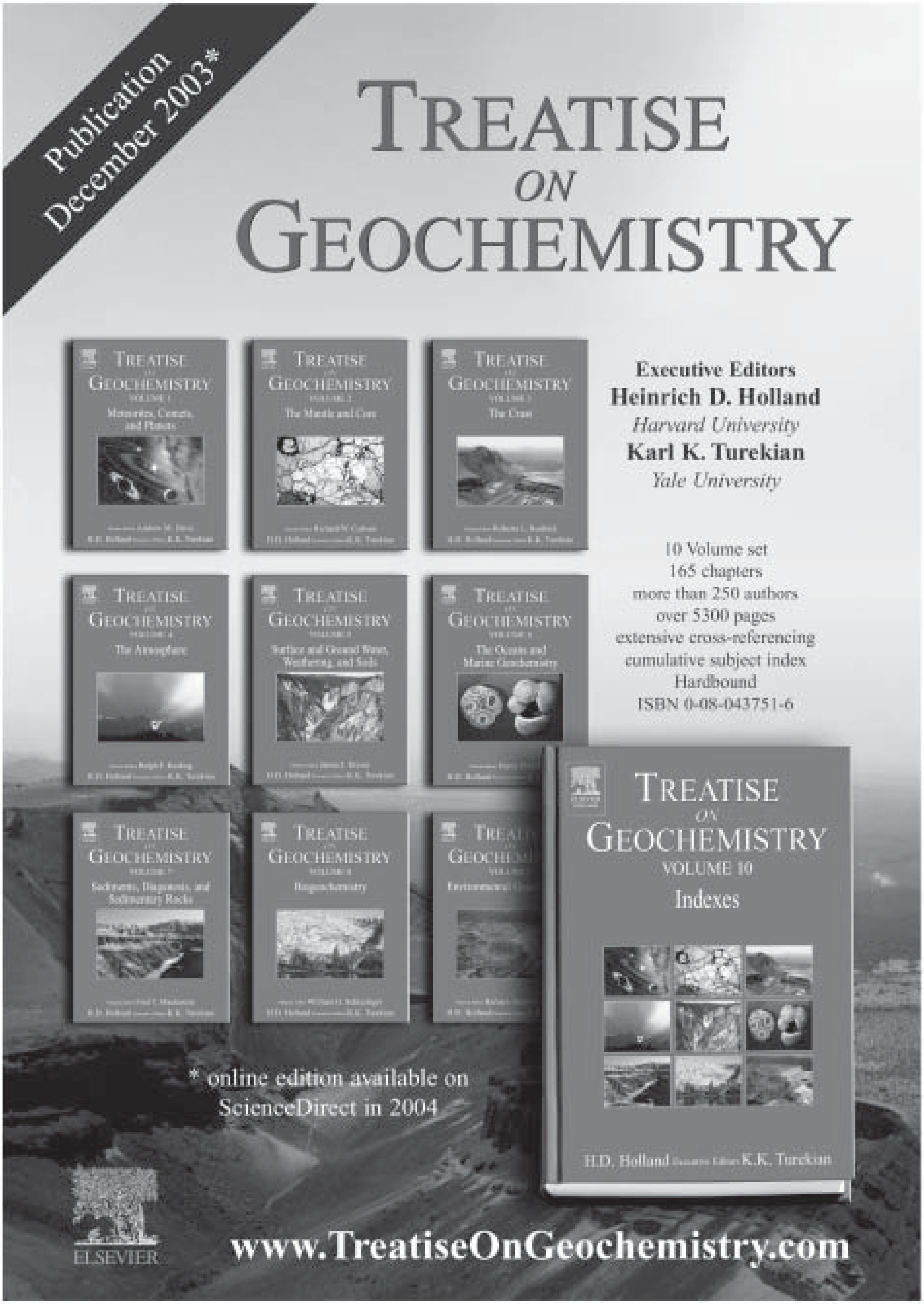

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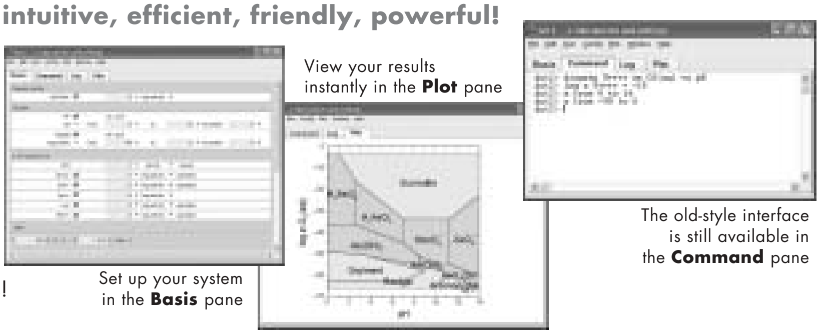

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Department of Chemistry / Geosciences
1903 W. Michigan Avenue
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