

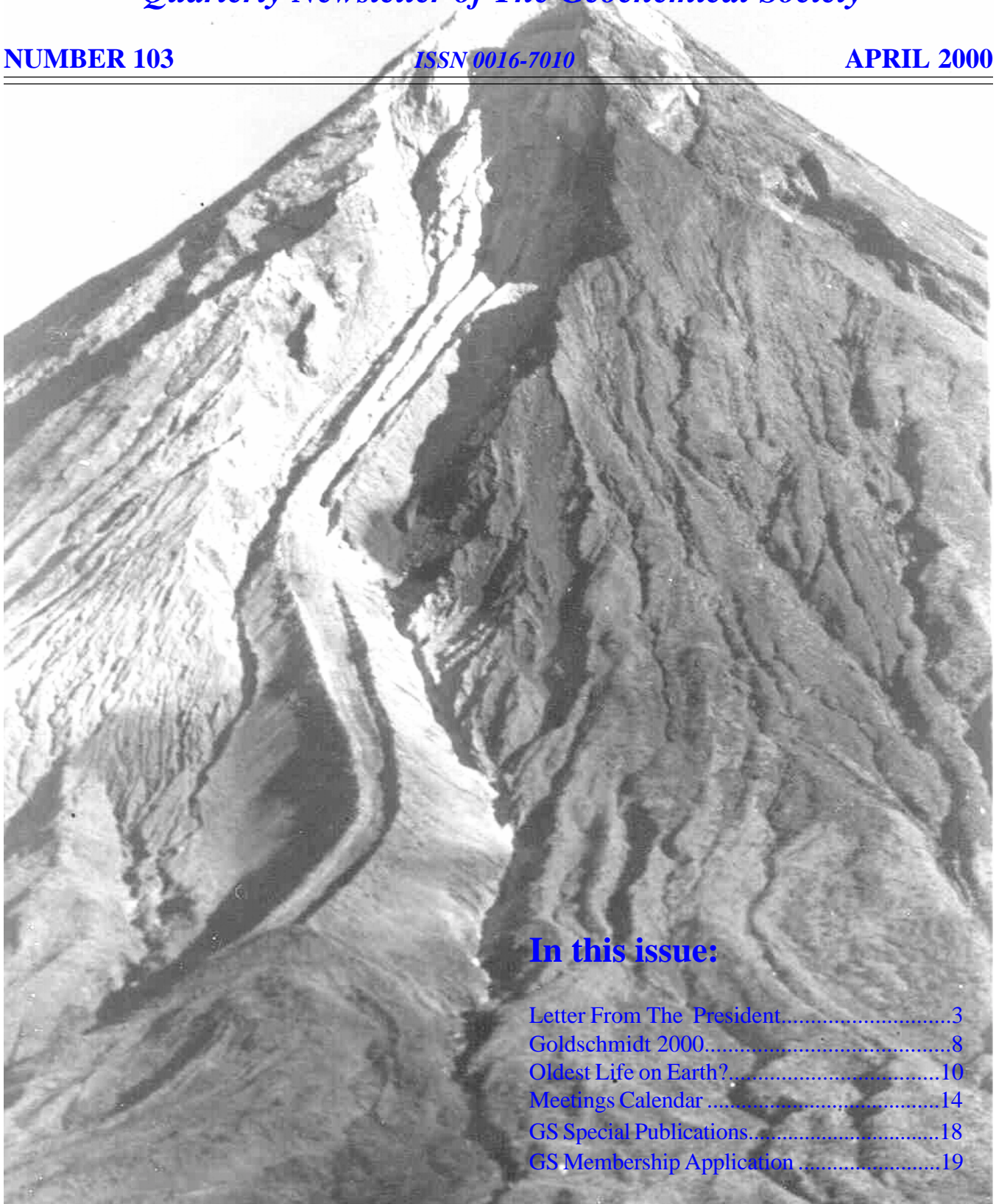
The Geochemical News

Quarterly Newsletter of The Geochemical Society

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APRIL 2000



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THE GEOCHEMICAL SOCIETY

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

Editor's Corner

Cover: Bonga gully, Mt. Mayon, Legazpi, Albay, Philippines.
 (Photograph taken Feb. 29, 2000 by Remy Rivera).

Neil C. Sturchio, Editor Phone: 630-252-3986
The Geochemical News Fax: 630-252-7415
 Argonne National Laboratory Email: Sturchio@ANL.gov
 9700 South Cass Ave., ER-203
 Argonne, IL 60439-4843 U.S.A.

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From the President

It's that time of year . . .

As the winter turns to spring (at least for those of us in the northern hemisphere), it often reminds me of the traffic jam of abstract deadlines coming up for summer and fall conferences that will occur in the months just ahead. The deadline this year that I hope you already have on your calendar is May 15, the abstract deadline for Goldschmidt 2000 which takes place from September 3rd to the 8th in Oxford, U.K. Goldschmidt meetings have a habit of getting better with each passing year (this will be the tenth annual meeting), and the Oxford meeting should be no exception. Both the science and setting will be something to remember. So whether you wish to contribute to one of the many theme sessions on everything from mantle dynamics and melting to the microbiology of pollution, or just want to submit an abstract in some field of geochemistry with no theme session at all in mind, we want to hear from you. Your contribution will help make this the most successful Goldschmidt ever. All the information that you need can be found at the following website: <http://www.campublic.co.uk/science/conference/Gold2000/>



Unsung heroes . . .

This is a particularly busy time of year for the Nomination and Awards committees. Behind the scenes, committee chairs and members comb through any number of files and e-mail ballots to come up with viable nominations to present to the GS Board of Directors. This year I believe that these committees have been exceptional in the fulfillment of their all-important commitments. My sincere thanks go to committee chairs Dean Presnall (Nominations Committee), Dick Holland (Goldschmidt Award), Malcolm McCulloch (Patterson Award), Marilyn Fogel (Treibs Award), Don Dingwell (Clarke Award), and Alex Navrotsky (Geochemistry Fellows), and of course the committee members that serve under these chairs.

Speaking of unsung heroes, perhaps the hardest working committee year-round is the Program Committee. This committee is responsible for the hundreds of geochemistry abstracts that are received each year for GSA and spring-AGU meetings, as well as reviewing symposia proposals. Susan Stipp, Pat Brady, and Dave Cole have been exceptionally conscientious and skilled at these time-consuming tasks. We owe them a huge debt of gratitude.

Have you considered publishing here? . . .

The Geochemical News (GN) occasionally contains short scientific articles of general interest. Why would you want to publish in the *GN*? It's a great way to reach the Society membership all at once, and the articles stand out as the only non-newsy portion of an issue. It would be a good idea to check with *GN*

Editor Neil Sturchio before submitting an article. He can tell you what the publication time would be if accepted, how long the article can be, and review procedure. Articles in the *GN* are citable and easily obtained due to their archiving within the GS website.

Think small . . .

A likely new funding opportunity is coming from NSF!

President Clinton's FY 2001 budget request includes a \$225 million (83%) increase in the federal government's investment in nanotechnology research and development. The Administration is making this major new initiative, called the National Nanotechnology Initiative (NNI), a top science and technology priority. NSF will gain a large piece of the pie if the budget is approved by Congress. The new NSF initiative is called Nanoscale Science and Engineering (NSE) which focuses on six research areas. The theme of most interest to GS members is entitled "Nanoscale Processes in the Environment and Solid Earth". Research in this area will focus on probing nanostructures of relevance in the environment from the Earth's core to the upper atmosphere, nanoscale processes at interfaces between biological materials and mineral surfaces, and reactions at the interface between solids, liquids, and gases. Themes will include development of environmental biotechnology, study of transport of ultrafine colloidal particles and aerosols, and study of interplanetary dust particles, among many others. Applications include better understanding of molecular processes in the environment that reduce pollution, and applications such as water purification, artificial photosynthesis for clean energy, and environmentally benign manufacturing processes. There will be three modes of support: interdisciplinary research teams, nanoscale science and engineering centers, and exploratory research. The current deadline date for proposal submission is Oct. 10, 2000, with pre-proposals required for planned centers. Detailed information and application instructions can be obtained at the NSF/NSE website at <http://www.nsf.gov/nano>. Keep in mind that this program still requires congressional budgetary approval. Check the website for updates.

Mike Hochella
President of The Geochemical Society

Geochemical Society Business

Please address all inquiries and correspondence concerning memberships, subscriptions, address changes, and charitable contributions to:

Business Manager, The Geochemical Society
Washington University
Earth and Planetary Sciences
One Brookings Drive, Box 1169
St. Louis, MO 63130, USA
Tel. 314-935-4131; Fax. 314-935-4121
e-mail: office@gs.wustl.edu

Plans Under Way for Goldschmidt 2001

Planning for Goldschmidt 2001 is already well under way. The meeting will be held in the spectacular Blue Ridge Mountains of Virginia, USA, in the scenic city of Roanoke, from May 20th to the 24th, 2001. Here are some meeting highlights:

- For the first time, sponsorship of the meeting will include the Mineralogical Society of America. MSA promises to bring an exciting new dimension to the meeting that is already established as the world's premier geochemistry conference.
- An Executive Planning Committee is currently assembling cutting-edge, interdisciplinary symposia and theme sessions. There will also be ample space for general contributions in all fields of geochemistry.
- The major venue for the meeting will be the Hotel Roanoke and Conference Center. The Hotel Roanoke, built in 1882, has hosted US Presidents and dignitaries from around the world. Constructed in the late 19th-century grand American tradition, it is on the United States National Registry of Historical Places. It was recently completely restored to recapture its original charm and elegance.
- The adjoining conference center is new and state-of-the-art, yet classic in interior design and appointment. It will provide the best meeting facilities ever utilized by a Goldschmidt Conference. Check out both the Hotel Roanoke and the Conference Center at <http://www.doubletreehotels.com/DoubleT/Hotel100/100/100Main.htm>



Hotel Roanoke and Conference Center, Roanoke, Virginia

Visit and bookmark the new GS web site
<http://gs.wustl.edu>

Letters



Dear Neil:

I received this question from a member: "*Congrats on the story on Hal, but tell me: Is that picture of a man on a sailboat on the cover that of Hal???* I have trouble believing it, and can find no statement in any of the 24 pages to identify the cover photo." If you could help me out, that would be appreciated.

Regards,
 Seth Davis
 GS Business Manager

Dear Seth:

Yes, that cover photo (*GN #102, January 2000*) of the man in the sailboat is, in fact, a photo of Hal Helgeson.

Regards,
 Neil

Geochemical Society-sponsored symposia

at the

Spring AGU Meeting

Washington, D. C., May 30 - June 3, 2000

For further information see www.agu.org

B16 Evolutionary Implications of a "Snowball Earth"

GS01 Accessory Minerals: The Current State of Knowledge from Isotopes, Experiments, and Trace Element Studies

GS02 Astrobiology Biosignatures

H02 Fate of Agricultural Nitrate in Drainage Basins

M01 Mineral Physics and Chemistry: Symposium in Honor of William A. Bassett

M02 Mineral Surface Chemistry and the Origin of Life

M03 Advances in Mineral Structure Analysis

V01 Volatiles in Magmas: The Current Perspective

V02 Towards an Understanding of the Kerguelen Plateau-Broken Ridge and Ontong Java Plateau

V04 Recent Advances in Re-Os Geochemistry

U05 Global Carbon Cycle

Special Offer: Stumm Issue of GCA Available

The collection is 600 + pages and contains 53 articles as well as the citation for the Goldschmidt Medal and Werner Stumm's acceptance speech. Cost is \$40. Orders should be made directly to Peter Henn at Elsevier with the form copied below.

Geochimica et Cosmochimica Acta
Volume 63 Nos 19/20

GEOCHEMISTRY IN AQUEOUS SYSTEMS
(A Special Issue in Honor of Werner Stumm)

Guest Editors: Susan Stipp, Patrick Brady, K. Vala
Ragnarsdottir and Laurent Charlet

* Please send me copy/copies of *GCA* Vol. 63, Nos 19/20

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Register Now!

Goldschmidt 2000
September 3-8, 2000
Oxford, U. K.

Abstract deadline: May 15, 2000

www.campublic.co.uk/science/conference/Gold2000/

*Call for papers***GEOCHEMICAL TRANSACTIONS**

Geochemical Transactions, a new, all-electronic journal is now accepting manuscripts for review. The journal is published by the Royal Society of Chemistry, in collaboration with the Division of Geochemistry of the American Chemical Society, and is devoted to all areas of geochemical research. *Geochemical Transactions* coverage includes the following:

- .. Organic and inorganic geochemistry, biogeochemistry
- .. Aquatic and marine chemistry
- .. Chemical and elemental cycles
- .. Numeric and computational models of geochemical processes
- .. Instrumental and analytical techniques

The launch date of the journal is January 2000. All manuscripts should be submitted to the Royal Society of Chemistry and will be reviewed by at least two expert referees. For information on how to submit a manuscript, visit the RSC website:

www.rsc.org/geochem

The editorial board includes:

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Advantages of publishing in *Geochemical Transactions* are:

- .. Rapid publication
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- .. Interactive images
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The Geochemical Society 2001 Awards Nominations

V.M. Goldschmidt Award

The V.M. Goldschmidt Award shall be made for major achievements in geochemistry or cosmochemistry, consisting of either a single outstanding contribution, or a series of publications that have had great influence on the field. The award will normally be given annually at the V.M. Goldschmidt Conference. Current members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination. Nominations should specify the name, address, and chief fields of specialization of the nominee, and be accompanied by a curriculum vitae and bibliography of the nominee, limited to two pages each, and up to three supporting letters. Nominations should also be accompanied by a letter from the nominator giving name, address, phone number, signature, and a brief summary of why the candidate is suitable for the award. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society.

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

Nominations for the 2001 V.M. Goldschmidt Award should be submitted before October 15, 2000, to:

Dr. Bernard J. Wood	Tel: 44-272-287792
Dept. Geology	Fax: 44-272-253385
Queen's Rd., Wills Memorial Bldg.	Email: b.j.wood
Bristol, BS8 1RJ	@bristol.ac.uk
UK	

F. W. Clarke Award

The F.W. Clarke Award shall normally be made annually at the V.M. Goldschmidt Conference to an early-career scientist for a single outstanding contribution to geochemistry or cosmo-chemistry, published either as a single paper or a series of papers on a single topic. Eligibility for this award is met if either of the following criteria is satisfied on the first day of the year in which the award is given: (a) the candidate must have received a recognized doctorate or its equivalent within the last six (6) years; or (b) must not have celebrated their thirty fifth (35th) birthday. Current members of the Board of Directors and past recipients of the award are ineligible for nomination. The Clarke and Patterson medals cannot be awarded for the same accomplishment. Nominations should specify the name, address, and chief fields of specialization of the nominee, and be accompanied by a copy of the paper(s) for which the nominee is being considered for the award, and up to three supporting letters. Nominations should also be accompanied by a letter from the nominator giving name, address, phone number, and signature, together with a brief statement explaining the significance of the nominee's work. This letter should also specify the nominee's date of birth and final degree received, the degree advisor's name, the year granted, and the name of the granting institution. Awards are based solely on scientific merit, without regard to citizenship or membership in the Society.

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

Nominations for the 2001 F.W. Clarke Award should be submitted before October 15, 2000, to:

Dr. Lisa M. Pratt	Tel: 1-812-855-9203
Indiana University	Fax: 1-812-855-7916
1005 E. 10 th Street	Email: prattl
Bloomington, IN 47405	@indiana.edu
USA	

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. Members of the Geochemical Society Board of Directors and past recipients of the award are ineligible for nomination. Nominations should include the name, address, and chief fields of specialization of the nominee, and be accompanied by a curriculum vita of not more than two pages, a list of no more than 10 peer-reviewed publications relevant to the 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

Past Recipients: M.L. Bender (1998), R.L. Edwards (1999), E.A. Boyle (2000)

Nominations for the 2001 Clair C. Patterson Award should be submitted before October 15, 2000, to:

Dr. Lynn M. Walter	Tel: 1-313-763-4590
University of Michigan	Fax: 1-313-763-4690
2534 C.C. Little Bldg.	Email: lmwalter
Ann Arbor, MI 48109	@umich.edu
USA	

Alfred E. Treibs Award

The Organic Geochemistry Division (OGD) of the Society bestows this award, for major achievements in organic geochemistry. A separate nominations call will be announced, and inquiries may be made to OGD Secretary Peggy H. Ostrom, Dept. Geological Sciences, Michigan State University, 206 Natural Science Building, East Lansing, Michigan, 48824, USA. Phone: 1-517-353-9768; Fax: 1-517-353-8787; Email: ostrom@msu.edu

THE GEOCHEMICAL SOCIETY

The Geochemical Society has a 16-member Board of Directors, currently composed of 10 Officer-Directors and 6 Non-officer Directors. Officers serving through at least 2001 include President Michael F. Hochella, Jr., Vice President Judith McKenzie, Secretary David J. Wesolowski, Treasurer Rebecca A. Lange, Special Publications Editor Scott A. Wood, Past President Michael J. Drake, Organic Geochemistry Division (OGD) Chair Michael H. Engel, OGD Secretary Peggy H. Ostrom and *Geochimica* Executive Editor Frank Podosek. Non-officer Directors serving through at least 2001 are Everett L. Shock, K. Vala Ragnarsdottir, Thure E. Cerling and Albrecht W. Hofmann. Those whose terms expire at the end of 2000 include International Secretary S. Ross Taylor, and Directors R. Keith O'Nions and Alexandra Navrotsky.

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

Additional nominations may be made by at least ten (10) members of the Society and the nominees must agree to serve if nominated. **If you are satisfied with the proposed slate of Officers and Directors for 2001, do nothing. Additional nominations must be submitted by August 1, 2000,** to the Secretary of the Geochemical Society (David J. Wesolowski, Chemical and Analytical Sciences Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee, 37831-6110, USA (Tel: 1-865-574-6903; Fax: 1-865-574-4961; Email: dqw@ornl.gov).

Proposed Slate of new Officers and Directors of the Geochemical Society

International Secretary

Eiichi Takahashi
Dept. Earth and Planetary Sciences
Tokyo Institute of Technology
Tokyo, Japan

Directors

Roberta Rudnick
Dept. Earth and Planetary Sciences
Harvard University
Cambridge, MA, USA

Edward R. Sholkovitz
Marine Chemistry and Geochemistry
Woods Hole Oceanographic Institute
Woods Hole, MA, USA



Goldschmidt 2000: The foremost geochemical conference in 2000

Goldschmidt 2000 is sponsored by both the European Association of Geochemistry, the Geochemical Society and the University of Oxford. The conference will cover all the most important topics in geochemistry, and a list of symposia already planned is given below. The conference will begin with the Ice Breaker Party at 3:00 pm on Sunday September 3rd and will finish at 3:0 pm on Friday September 8th, 2000 in Oxford, UK. The afternoon of Wednesday September 6th will be free for delegates to explore the charms of Oxford or to participate in the excursions that are planned (as detailed below). Further information on this conference will be available at the Goldschmidt 2000 website at

<http://www.campublic.co.uk/science/conference/Gold2000/>

Oxford is Britain's oldest University and is the beautiful and historic heart of a diverse and ancient city. From the founding of the first Colleges in the thirteenth century, Oxford established itself as a centre of academic excellence. The conference will be based around the Oxford University Museum and delegates to Goldschmidt 2000 will be accommodated in Christchurch, Keble, St Anne's and St. Hugh's Colleges. Oxford is less than an hour from London's Heathrow Airport, and is extremely well served by motorways and rail. It is set in the beautiful Cotswold countryside, and is within easy reach of the Shakespearian theatres of Stratford-upon-Avon.

Important Dates:

May 1	Deadline for registration at special rates
May 15	Abstract deadline
July 1	Final announcement
September 3-8	Goldschmidt 2000

Registration:

More than 800 potential delegates have already registered their interest in this conference, and we therefore expect that there will be a large number of delegates registering for the meeting. Submitted abstracts will be reviewed by the organising committee, and the acceptance of abstracts and registration will be confirmed in June. The registration form is now available from <http://www.campublic.co.uk/science/conference/Gold2000/front.html>

Registration Fees:

Every effort has been made to keep registration fees to a minimum, especially those for graduate students. The registration fee for delegates will 150 pounds, that for graduate students only 60 pounds; the abstract fee is 35 pounds. This reduced price registration has been extended right up to the registration deadline of May 15th, as this second circular is being distributed later than it was originally hoped. Payment can be made in pounds sterling, dollars, Euros, French Francs and German Marks. Registration will take place once the payment has been received by Cambridge Publications.

Accommodation:

Forms for requesting accommodation are available from on the Goldschmidt 2000 web site. Delegates will be accommodated in Oxford Colleges or at Oxford Brookes University. Oxford University is unmatched in the UK both for the age of its foundation (twelfth century) and the elegance of its College architecture. The Colleges are all within walking distance of the lecture theatres. The accommodation available in Oxford is limited to about 1000 places, so we recommend that those wishing to attend the meeting complete their registration and accommodation booking and payment as early as they can. Accommodation may be booked in Oxford's Colleges and breakfast will be provided at no additional cost. These delegates may also book evening meals. More economical accommodation is available at Oxford Brookes University, which is linked by a frequent bus service to the city centre. Payment can be made in pounds sterling, dollars, Euros, French Francs and German Marks. The request for accommodation will not be processed until the payment has been received.

The Awards Banquet:

The Awards Banquet will be held in Keble College (<http://www.keble.ox.ac.uk/conference/catering.khtml>) which boasts one of the finest feasting halls in Oxford. A banquet in Keble College Oxford has been described as a 'once in a lifetime experience', and the organising committee hope that as many delegates as possible will be able to enjoy this occasion. Places for this are limited to 400, and early booking is recommended.

Eating in Oxford:

The limited number of restaurants and pubs in central Oxford may struggle to cope with the influx of 1000 geochemists, and use of College facilities for lunch and evening meals is recommended. Sandwiches will be available at one of the conference locations at lunchtime each day, but a proper cooked luncheon is available at Keble College. Most delegates should plan to use one of these options, as few delegates will be able to find lunch in the city during the time available. Delegates who choose not to book evening meals each night, or those wishing to sample the hospitality at a different College may also book a place at a College Dinner in a different College.

Excursions:

A range of excursions is planned for Goldschmidt 2000. If there is sufficient interest among delegates these will include a visit to Stratford-upon-Avon to see a Shakespeare play (with dinner), a tour of the famous Cotswold villages (with tea) and special guided tours of the geological and mineralogical displays of the Natural History Museum in London.

Transport:

The centre of Oxford was designed for horses and the occasional carriage and is not well suited to cars as parking space is extremely limited. We strongly recommend that delegates plan to come to Oxford by train or by coach as these services are both rapid and frequent. Oxford is less than an hour from London by train, and this service operates every 30 minutes during the day. There are also direct coach services between Oxford and the London Airports.

Special Sessions at Goldschmidt 2000
September 3-8, 2000
Oxford, U. K.

Terrestrial Planets and Meteorites

Alex Halliday & Ed Young

Chemistry and Dynamics of the Earth

Bernie Wood & George Helffrich

Subduction Zone Processes

Chris Hawkesworth, Jon Blundy & Dave Rubie

Rapid Climate Change (Continents/Oceans)

Edouard Bard & Frank McDermott

Biological Geochemistry

Derek Lovely, Rob Raiswell & Matthew Collins

Ocean Circulation: Past and Present

Bill Jenkins & Gideon Henderson

Flow and Reaction of Fluids in Crust

Marion Holness & Terry Seward

Weathering and Erosion: Mechanisms and Rate

Mike Bickle, Niels Hovius & Mike Summerfield

Mineral Surfaces and Reactions

Vala Ragnarsdottir & Andrew Putnis

Mantle Dynamics and Melting

Eric Hauri & Tim Elliott

Life in Extreme Environments

Mike Russell & Everett Shock

Computational Geochemistry

Keith Refson & John Brodholt

Chemistry and Microbiology of Pollution

Adrian Bath & Barbara Sherwood-Lollar

Open Sessions

Surface Chemical Processes in Natural Environments

October 1-6, 2000

MONTE VERITÀ, ASCONA, SWITZERLAND

The goal of the Monte Verità workshop is to bring together leading scientists studying surface reactions in natural environments from different perspectives. Special emphasis will be on modelling and further developments and applications of spectroscopic and microscopic techniques, in particular synchrotron-based methods such as XAFS, XRF, micro-spectroscopies, and AFM. Further topics are macroscopic sorption equilibria and kinetics, and theoretical approaches to understanding surface reactions. For information on the workshop and submission of abstracts see:

<http://www.ito.umnw.ethz.ch/SoilChem/mverita/index.html>



Confirmed Invited Speakers:

Alain Manceau, Université Joseph Fourier, France; *Paul Bertsch*, University of Georgia, USA; *Satish Myneni*, Princeton University, USA; *William Bleam*, University of Wisconsin, USA; *Donald Sparks*, University of Delaware, USA; *Susan Stipp*, University of Copenhagen, Denmark; *Willem van Riemsdijk*, Agric. Univ. Wageningen, Netherlands; *Dimitri Sverjensky*, John Hopkins University, USA; *Michael Bradbury*, Paul Scherrer Institute, Switzerland; *Gerhard Brümmer*, University Bonn, Germany; *Kim Hayes*, University of Michigan, USA; *Stephan Hug*, EAWAG, Switzerland; *Martin Kaupenjohann*, University Hohenheim, Germany; *David Kinniburgh*, British Geological Survey, England; *Jacques Buffle*, University of Geneva, Switzerland; *Dimitri Kulik*, National Academy of Science, Ukraine; *Stephan Kraemer*, ETH Zurich, Switzerland; *Kathryn Nagy*, University of Colorado, Boulder, USA; *Tobias Reich*, Research Center Rossendorf, Germany; *James Rustad*, Pacific Northwest National Lab, USA; *Andreas Scheinost*, ETH Zurich, Switzerland.

Time constraints on when life began: The oldest record of life on Earth ?

Martin Whitehouse
Swedish Museum of Natural History
Box 50007, SE-104 05 Stockholm, Sweden

Introduction

When did life begin on Earth? The fossil record takes us back only to ca. 3.5 Ga by which time complex organisms, cyanobacteria, had already evolved (Schopf, 1993). The evolutionary processes that led to these organisms started much earlier than this, but the combined effects of poor preservation of such ancient crust and an increasing likelihood of that crust being reworked conspire to limit our access to this crucial time period. Many rock complexes of appropriate age are dominated by grantoid gneisses; they represent some of the first vestiges of continental crust but are not suitable targets for a search for early life which must be sought in the ancient sedimentary record. An additional constraint on the time of the development of life on Earth is the effect of intense bolide bombardment which ceased on the Moon (and so presumably on Earth) at ca. 3.8 Ga. This bombardment is generally expected to have severely frustrated the development of life (Chyba, 1993) and may reasonably be assumed to provide an upper age limit beyond which claims for life must be treated with extreme caution.

This article reviews, briefly, the evidence for life on Earth prior to 3.5 Ga and, in more detail, its geochronological foundation. The two examples that are discussed both come from the early Archaean gneiss complex of southern West Greenland. As will be shown, there remains considerable controversy over the interpretation of geochronological data pertaining to the earliest life, and the degree of controversy increases with increasing age.

The early Archaean gneisses of West Greenland

Approximately 3000 km² of early Archaean rocks are preserved in the Gothåbsfjord Region of southern West Greenland (Fig. 1). This consists predominantly of tonalite-trondhjemite-granodiorite suite (TTG) gneisses with subordinate amounts of mafic and ultramafic intrusive rocks and supracrustal rocks. Collectively, these have been incorporated into the so-called Itsaq Gneiss Complex (Nutman et al., 1996) which includes TTG gneisses of possibly different ages, commonly called Amîtsoq gneisses, enclaves within these known as the Akilia association, and the Isua Greenstone Belt (IGB). The IGB is the largest enclave in the TTG gneisses and preserves a remarkable sequence of little-deformed metavolcanic and metasedimentary



Figure 1. Index map of Greenland showing the Archean (undifferentiated). Early Archean is exposed for ca. 3000 km² around Nuuk.

rocks >3.7 Ga. Putative evidence for early life has been presented recently from localities in the IGB, ca. 150 km NE of Nuuk, by Rosing (1999) and a locality on Akilia island, ca. 25 km south of Nuuk by Mojzsis et al. (1996; Figure 1).

Isua Greenstone Belt

Evidence for possible biogenic activity in the Isua Greenstone Belt was presented recently by Rosing (1999) who also reviewed earlier work in the region. His evidence came from light carbon isotope signatures ($\delta^{13}\text{C} \sim -19\%$) for immature volcanoclastic sediments from the western part of the belt which contain microscopic graphite globules. Ion microprobe carbon isotopic measurements have also yielded light carbon ($\delta^{13}\text{C} < -30\%$; Mojzsis et al., 1996) from a banded iron formation at Isua which may represent a biogenic end-member that has been diluted in Rosing's bulk rock measurements.

Ion microprobe U-Pb zircon dates presented by Nutman et al. (1997a) bracket the depositional age of the Isua supracrustals to a ca. 3.7-3.8 Ga interval, possibly with two separate tectonic units of ca. 3.7 Ga and 3.8 Ga. Rosing (1999) includes his sedimentary samples on a 3779 ± 81 Ma Sm-Nd regression line, together with enclosing basalts. This age is similar to 3772 ± 33 Ma Sm-Nd regression reported by Moorbath and Whitehouse (1996) from felsic (volcanoclastic) and pelitic rocks. While there remains discussion about the precise timing of events at Isua, if the carbon-isotope data truly represented biogenic activity, then life had likely commenced on Earth during this 3.7-3.8 Ga time interval.

This age is compatible with sustained life on Earth arising shortly after the cessation of intense bolide impacts. Whether there is evidence for older life than this depends upon the resolution of an intense geochronological debate centered around a few tens of square metres of outcrop on Akilia island as discussed below.

Akilia Island

The island of Akilia, located in the Gothåbsfjord region, ca. 25 km south of the Greenland capital of Nuuk, is host to potentially the oldest but, perhaps, most controversial claim for early life on Earth. Akilia is the type locality for the Akilia association series of metasupracrustal rocks and in one of these enclaves in the TTG gneisses, a quartzitic rock, interpreted as a banded iron formation (BIF), contains apatite with graphitic inclusions. Mojzsis et al. (1996) reported extremely light $\delta^{13}\text{C}$ values (average -37%) for graphite inclusions in apatite, measured using an ion-microprobe, which they interpret as evidence for ancient biological processes. Attribution of this biological activity to the earliest life on Earth was based on U-Pb zircon ion-microprobe data presented from an adjacent, apparently cross-cutting, tonalitic sheet dated by Nutman et al. (1997b). This sample was interpreted to indicate a ca. 3.85 Ga protolith age and, therefore, a ≈ 3.85 Ga age for this particular Akilia metasupracrustal enclave. Unlike the Isua example described above, the suggested age for this putative early life on Akilia extends into the period of intense bolide impacts in the Earth-Moon system (Wilhelms, 1987) and has therefore attracted a great deal more critical scrutiny. Chal-

lenges to the carbon isotopic evidence itself are beyond the scope of this article which is restricted to discussion of the proposed >3.85 Ga age of Nutman et al. (1997b). However, it should be pointed out that the very same apatite crystals that host the graphitic intrusions have yielded a U-Pb age of only ca. 1.5 Ga (Sano et al., 1999), leading to an exchange of views with Mojzsis et al. (1999) on the possibility of an abiogenic origin for the graphite inclusions.

Much of the geochronological controversy about the age of early life on Earth is related to the fundamental interpretation of geochronological data from different methods and has been intimately, but not, as will be shown below, necessarily inextricably, linked to discussion of the age of the Amîtsoq TTG gneisses. As pointed out earlier, the evidence for a >3.85 Ga age for the Akilia BIF is based upon an interpreted igneous protolith age from a TTG gneiss sheet which reportedly cuts the enclave (Fig. 2).

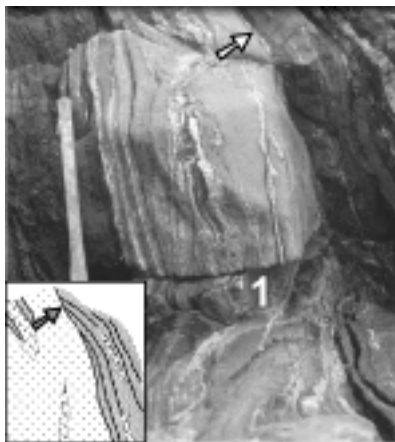


Figure 2. Photograph of field relationships between an Amîtsoq gneiss sheet and reputed early-life bearing Akilia association amphibolites on Akilia island (taken by the author, July 1998). (1) Locality of sample claimed by Nutman et al. (1997) as >3.85 Ga and by Whitehouse et al. (1999) as ca. 3.65 Ga, both on the basis of SIMS U-Pb. Arrow in photograph and inset (part of Nutman et al., 1997, Figure 2) shows location of claimed discordance between the gneiss sheet and amphibolite. Hammer handle is ca. 0.8 m.

Ion-microprobe U-Pb zircon data presented by Nutman et al. (1997b) from a sample from this sheet show a range in ages from ca. 3.6 Ga to >3.85 Ga, which these authors interpreted as the result of “ancient radiogenic Pb-loss” from >3.85 Ga zircons, together with some metamorphic growth and/or recrystallisation at ca. 3.65 Ga. The latter are represented by low Th/U zircons. For the Akilia TTG samples, and other Amîtsoq gneisses from the Gothåbsfjord region, it has become common practice to interpret broad age-ranging spectra such as those shown in Fig. 3 in a similar way (Nutman et al., 1996; 1997b; Kinny, 1986). This has led to the postulation of a long and complex magmatic evolution from 3.9–3.6 Ga, in which scenario, gneisses separated by only a few tens or hundreds of metres may have completely different protolith ages. These age interpretations have also been used to attempt to constrain the early Nd (Bennett et al.,

1993) and Hf (Vervoort et al., 1996) isotope evolution of the Earth on the assumption that these isotopic systems have remained closed on a whole-rock scale since the age recorded by the oldest zircon. Criticism of this approach has been made by Moorbath et al. (1997) and is again beyond the scope of a discussion about the age of early life, but it is mentioned here to highlight the more wide-reaching implications of the interpretation of geochronological data from these rocks.

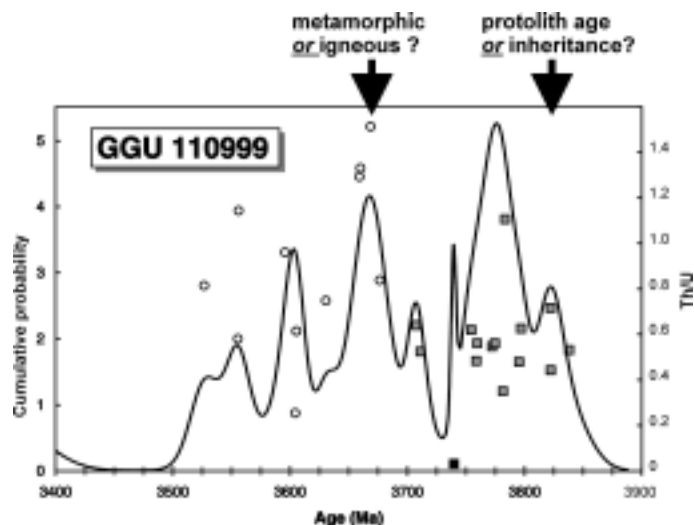


Figure 3. Typical complex age spectrum from an Amîtsoq gneiss (data from Whitehouse et al., 1999) showing how different interpretations (arrowed) might be reached concerning major age peaks.

The wide range of interpreted protolith ages is in strong conflict with age determinations based upon whole-rock regressions which have yielded concordant Pb/Pb (3654 ± 73 Ma; Kamber and Moorbath, 1998), Sm-Nd (3640 ± 120 Ma; Moorbath et al., 1997) and Rb-Sr (3660 ± 67 Ma; Kamber and Moorbath, 1998), the weighted mean of which yields 3655 ± 45 Ma which Kamber and Moorbath (1998) regarded as a reliable estimate of the age of emplacement of magmatic precursors to the Amîtsoq gneisses. An argument commonly levelled at the whole rock regression method is that it potentially generates only average age values for the emplacement of a range of non-cogenetic gneisses (Nutman et al., 1996; 1997b), although arguments about cogenicity are themselves based upon an assumption that interpretation of the single mineral zircon U-Pb ages is correct. It is certainly worth noting that the weighted average age of the whole rock regressions is towards the low end of the age range proposed from ion-microprobe zircon geochronology, and the concordance of these ages is at least persuasive evidence for a significant crustal event at ca. 3.65 Ga.

Kamber and Moorbath (1998) presented new, and re-interpreted existing, whole-rock and feldspar Pb-isotope data from Amîtsoq gneisses in an attempt to further evaluate the significance of the results of ion-microprobe zircon U-Pb and conventional isotopic dating methods in this terrane. This study is of

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particular importance because, like the U-Pb zircon method, feldspar Pb-isotope data may be interpreted in the context of a single rock, not a suite, and so no assumption of cogenicity is required. Figure 4 shows the feldspar and whole rock Pb-isotope data presented by Kamber and Moorbath (1998) relative to the most recent terrestrial growth curve estimate of Kramers and Tolstikhin (1997). What is immediately clear from this diagram is that many of the Amîtsoq gneisses have extremely unradiogenic Pb isotopes which plot close to the primary growth curve at ca. 3.65 Ga. Kamber and Moorbath (1998) point out that the present-day Pb-isotopes can be compatible with a protolith age much greater than ca. 3.65 Ga provided that (1) the whole rocks evolved from >3.8 Ga to ca. 3.65 Ga with a m value ($^{238}\text{U}/^{204}\text{Pb}$) similar to depleted mantle (i.e., between 6 and 10), (2) any event at ca. 3.65 Ga is capable of extracting on average 80% (and up to 95% for individual samples) of the U from the system, and (3) every sample so far analysed for Pb isotopes from the region had its U-Pb systematics completely reset at 3.65 Ga. Kamber and Moorbath (1998) present a series of arguments to suggest that these scenarios are not only individually implausible (for example, the low U content of >3.8 Ga zircons suggest that they crystallised from a U-poor melt, not a much higher U melt required prior to any postulated 3.65 Ga depletion event), but taken together, they render exceedingly unlikely the suggestion by Nutman et al. (1996) that the Pb-isotope systematics of the Amîtsoq gneisses simply reflect “post-igneous isotopic disturbance”.

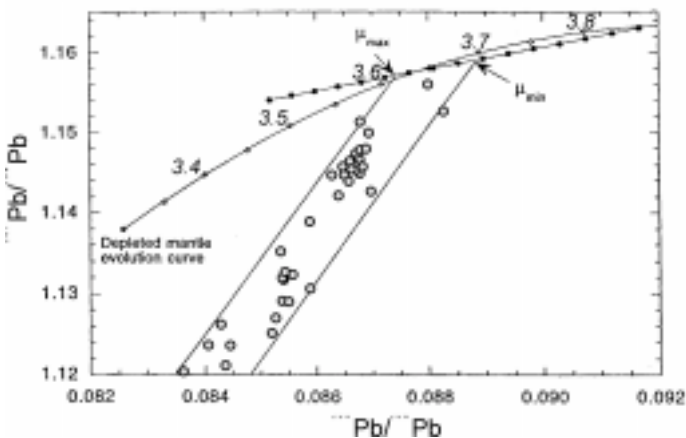


Figure 4. Pb-isotope systematics of Amîtsoq gneisses (after Kamber and Moorbath, 1998). A model 3.85 – 3.65 Ga paleoisochron is shown; intersections of 3.65 Ga isochrons through individual analysed Amîtsoq gneisses with this line yield model primary m values between 6 and 10.

The results and conclusions of the Pb isotope study of Kamber and Moorbath (1998), together with the assignment of 3.65 Ga isotopic disturbance (both whole rock and in zircon crystals) to a somewhat vague “metamorphism” (Kinny, 1986; Nutman et al., 1997b) prompted a detailed reinvestigation of the zircon U-Th-Pb geochronology by Whitehouse et al. (1999). Unlike most previous studies of zircon grains from the early Archean

gneisses of West Greenland, this investigation utilised cathodoluminescence (CL) imaging of zircons to guide the high spatial resolution ion-microprobe analyses. Such CL imaging (or the alternative and complimentary technique, back-scattered electron imaging) has become a routine part of high-spatial resolution studies in recent years and can reveal considerable complexity which, if ignored and/or unsuspected could lead to mixed age analyses and erroneous interpretations (for example, without imaging, it might be impossible to distinguish between high-temperature Pb-loss and mixing).

Figure 5 shows a typical early Archean zircon grain from the tonalitic gneiss sheet on Akilia island shown in Fig. 2 in transmitted plane-polarised light and in CL, clearly illustrating that the statement by Nutman et al. (1996) that such zircons are “mostly optically homogeneous”, while in fact quite accurate, in no way presents a full picture of the complex, polyphase zircon growth history. For three samples from Akilia island and nearby Angiorsuaq island, Whitehouse et al. (1999) documented >3.8 Ga oscillatory (igneous origin) banded cores which were overgrown by ca. 3.65 Ga rims, occasionally with an intervening phase of zircon erosion and reworking of poorly constrained age. In addition, most grains exhibit late Archean (ca. 2.7 Ga) overgrowths on their tips. The growth banding and relatively high Th/U (similar to the cores) were used to suggest that the 3.65 Ga rims represent growth of zircon from a melt phase rather than simple metamorphic recrystallisation or new growth. These observations, considered together with the Pb-isotope data of Kamber and Moorbath (1998), were interpreted by Whitehouse et al. (1999) in favour of a ca. 3.65 Ga magmatic origin for the analysed Amîtsoq gneisses, with the older zircon cores representing inherited grains from an ancient, but presently unexposed source.

Controversy continues about the age of the Amîtsoq gneisses. Nutman et al. (in press) now claim that the ca. 3.65 Ga rims recognised in the CL guided study of Whitehouse et al. (and, retrospectively, in their own previously analysed grains) represent magmatic crystallisation but from an *in situ* partial melt. If this were the case, however, the similar U and Th contents of the overgrowth and core zircon phases would require a very high degree of partial melting. In such a scenario, not only is it difficult to see how such a melt could facilitate the extreme lowering of U/Pb ratios required by the Pb isotopes, but it seems likely that a rock containing such a high proportion of partial melt could readily be mobilised, in which case its intrusive field relationships might, potentially, relate to the partial melting event, not to a much older protolith crystallisation.

We are probably still a long way from resolving the dispute over the magmatic emplacement age for many of the Amîtsoq gneiss TTG rocks. Regardless of the outcome of this debate, however, the precise relationship between the TTG rocks and the Akilia supracrustal enclave remains ambiguous at the outcrop scale. Given the potential importance of the claimed intrusive relationship at the locality shown in Fig. 2 for the age of early life on Earth, detailed documentation of this discordance is surprisingly poor. On a visit to this locality in 1998, the author was unable to reconcile the actual appearance of the outcrop with the published field sketch of Nutman et al. (1997b) which, apparently, was printed back-to-front, or to find any convincing discordances. Furthermore, detailed mapping of this outcrop during

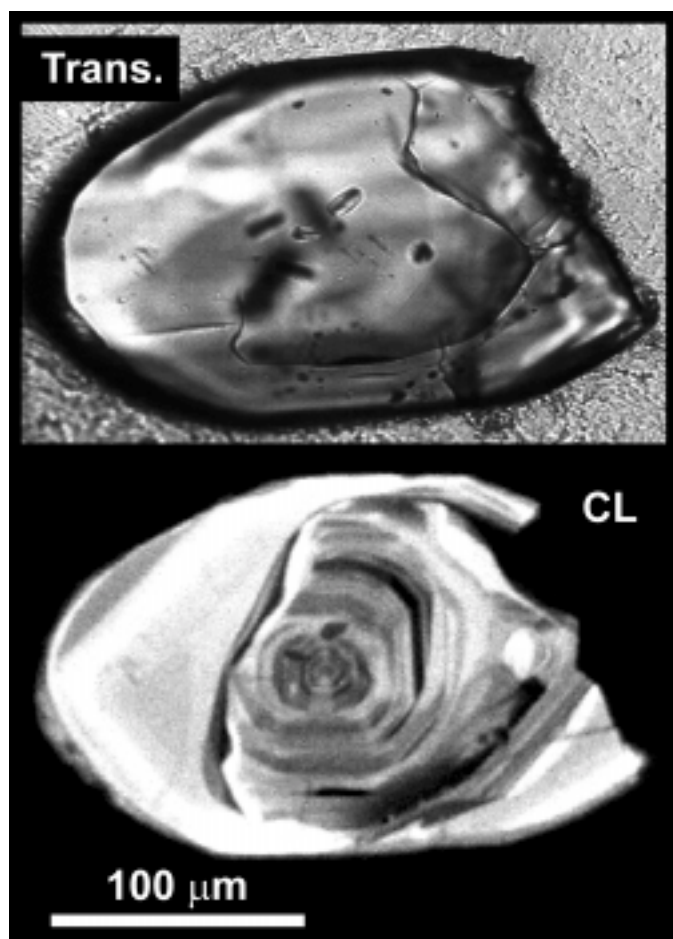


Figure 5. Comparative transmitted light and cathodoluminescence images of a polyphase zircon grain from Akilia island.

1999 by J.S. Myers and J.L. Crowley (manuscript submitted to *Precambrian Research*, November 1999) has also failed to find compelling evidence for a cross-cutting intrusive relationship.

In the absence of unambiguous evidence for an Amîtsoq gneiss of undisputed age cutting the Akilia supracrustals, attempts to constrain the age of the putative early life must rest with dating of the Akilia enclave itself. Direct dating of amphibolites such as these, particularly in a complex polyphase terrane, is not a simple task, but a number of studies suggest that the Akilia enclaves themselves might not be much older than ca. 3.65 Ga. These studies have tended to be forgotten in all the discussion about the age of the TTG gneisses, probably because of the importance accorded (perhaps falsely) to the proposed cross cutting relationship.

Schiøtte and Compston (1990) presented ion-microprobe U-Pb zircon data for a biotite schist of probable volcano-sedimentary origin from an Akilia enclave on nearby Innersuartaunut island. This study yielded two main groups of ages, the youngest and most abundant of which, 3685 ± 8 Ma, was interpreted as the maximum age for this particular sequence. This latter age overlaps with a 3677 ± 37 Ma Sm-Nd isochron (mswd < 1) for four samples of Akilia association gabbros and leucogabbros from Akilia and nearby Innersuartaunut islands (Moorbath and Kamber,

1998), and is also consistent with unradiogenic feldspar and whole-rock Pb-isotope data from Akilia series enclaves on Akilia and Innersuartaunut islands which “suggest an age of deposition between 3.70 and 3.65 Ga” (Kamber and Moorbath, 1998). Searches for ancient grains in the actual Akilia island enclave that contains the biogenic carbon signature have failed to find anything in excess of the ages reported above. Those that have been found have generally been interpreted as the result of late-Archean and ca. 3.65 Ga metamorphism (e.g., Mojzsis and Harrison, 1999). If the Akilia enclave is really >3.85 Ga and resided for >200 Ma in a part of the Earth’s crust that was subject to a long and complex thermal history, reputedly involving multiple phases of TTG magmatism, then, given the ability of zircon to grow in these rocks during metamorphism, it is somewhat surprising that older grains have never been found.

Conclusions

So what do we know about the age of earliest life on Earth? The supracrustal rocks of the Isua region provide a fairly confident estimate that life may have existed towards the upper end of the time interval 3.7 – 3.8 Ga. Thus, if so, life had established itself very shortly after the cessation of major bolide impacts on Earth. Claims for life on Earth before this time remain clouded in controversy, particularly, as we have seen, related to the geochronology of rocks in which it might be hosted. Much of this controversy relates to the precise interpretation of ion-microprobe U-Pb data. Considering the zircon data in isolation, without appreciation of other critical isotopic and geochemical data may produce erroneous age interpretations. Spectacular claims for early life warrant completely unambiguous evidence and, in the absence of such, must be treated with considerable caution.

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Meetings Calendar

May 7-11, 2000: Salt Symposium, The Netherlands Congress Centre, The Hague, The Netherlands. Contact: Secretariat Organizing Committee 8th World Salt Symposium, P.O. Box 25, NL-7550 GC Hengelo (Overijssel), The Netherlands; Phone: +31 74 244 3908; Fax: +31 74 244 272; E-mail: Salt.2000@inter.NL.net. Web Site: <http://www.salt2000.nl/>

May 8-11, 2000: 2nd International Conference on Applications of Stable Isotope Techniques to Ecological Studies, Braunschweig, Germany. Dr. Anette Giesemann, Institute of Agroecology, Federal Agricultural Research Centre, Bundesallee 50, D-38116 Braunschweig Tel.: +49 531/596-217; FAX: +49 531/596-366; e-mail: anette.giesemann@fal.de; <http://www.pe.shuttle.de/slater/anette>

May 15, 2000: Geology and ore deposits 2000: the great basin and beyond - A Geological Society of Nevada Symposium, Reno/Sparks, Nevada, USA. Co-sponsored by: Nevada Bureau of Mines and Geology, U.S. Geological Survey, Society of Economic Geologists and The Association of Exploration Geochemists. Deadline abstract drafts: October, 1999. Contact: GSN Symposium Editor, P.O. Box 12021, Reno, NV 89510-2021, USA. Tel: +1 775 323-3500; Fax: +1 775 323-3599; E-mail: gsnsymp@unr.edu; Web Site: <http://www.gsnv.org/symp2000.htm>

May 15-20, 2000: 2nd EMU School and Symposium on Environmental Mineralogy, Eötvös University, Budapest, Hungary. Contact: EMU Secretariat, Department of Mineralogy, Eötvös University Múzeum krt. 4/A, H-1088 Budapest, Hungary; Fax: +36 1 266 4992; E-mail: emu@ulixes.geobio.elte.hu. Web Site: <http://ulixes.geobio.elte.hu/emu.htm>

May 21-24, 2000: Biogenic Iron Minerals, Kastély and Park Hotels, Tihany, Lake Balaton (Hungary). Contact: Mihalý Pósfai, e-mail posfaim@almos.vein.hu; Web Site: <http://www.vein.hu/conference/bim/>

May 24-28, 2000: Meteorite Impacts in Precambrian Shields, Lappajarvi, Finland. Contact: Dr. Lauri J. Pesonen; Geological Survey of Finland; P.O. Box 96, FIN-02151 Espoo, Finland; Phone: +358-205 50 2269/+358-40-5015533; Fax: +358-205 50 12; Email: Lauri.Pesonen@gsf.fi; Web Site: <http://psri.open.ac.uk/esf>

May 27-June 1, 2000: Mineral Surface Reactivity, San Feliu de Guixols, Spain. Euroconference on The Interaction of Mineral Surfaces with Organic and Inorganic Species in Aqueous Solution: Experiment and Theory. Andrew Putnis and Martin Dove, Conveners. Web site --- <http://www.esf.org/euresco>.

May 29-June 2, 2000: GeoCanada 2000, Calgary, Alberta, Canada. <http://www.geocanada.com>

May 30-June 3, 2000: AGU Spring Meeting, Washington, D.C., U.S.A. Sponsor: AGU. Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 USA. Tel: +1-202-462-6900; Fax: +1-202-328-0566; E-mail: meetings@kosmos.agu.org; Web Site: <http://www.agu.org/meetings>

June 11-18, 2000: Modern approaches to ore and environmental geology, Espoo, Finland. Geological Survey of Finland and Helsinki University of Technology. Contact: Dr Kari K. Kojonen, Geological Survey of Finland, Betonimiehenkuja 4, FIN 02150 Espoo Finland. Tel: +358 205 50 2483; Fax + 358 205 5012; E-mail kari.kojonen@gsf.fi Web sites: <http://www.hut.fi/Units/Geophysics/Kojonen/ilmoitus.html> and <http://www.gsf.fi>

June 21-24, June 2000: GREEN3, 3rd International Symposium on Geotechnics Related to the European Environment, Federal Inst. for Materials Research and Testing (BAM), Berlin, Germany; Contact: Dr. Paul H. McMahon, Civil and Environmental Engineering Subject Group, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB; E-mail: pm4@bolton.ac.uk; Web Sites: <http://www.acs.bolton.ac.uk/~pm4> and <http://www.technology.bolton.ac.uk/civils/>

June 26-30, 2000: Mineralogical Museums in the 21st Century – International Symposium on the History of Mineralogy, Mineralogical Museums, gemology, Crystal Chemistry, and Classification of Minerals, St. Petersburg, Russia. Contact: Galina F. Anastasenko, Vladimir G. Krivovichev, Faculty of Geology, St. Petersburg University, Universitetskaya Emb. 7/9, St. Petersburg 199034, Russia. Tel: +7 812 328 9481; E-mail: dept@mineral.geol.pu.ru.

July 1-6, 2000: Isotope Workshop V, Krakow, Poland. European Society for Isotope Research. Contact: Dr. P. Wachniew, University of Mining and Metallurgy, Michiewiczza 30, 30-059 Krakow, Poland. Tel. +48-12-617-29-66; Fax. +48-12-634-00-10; E-mail: VIW@ftj.agh.edu.pl; Web site: <http://www.ftj.agh.edu.pl/~viw>

July 5-7, 2000: BOGS 2000, British Organic Geochemical Society, Bristol, U.K. Contact: Dr Ian D Bull, Organic and Biological Section, School of Chemistry, University of Bristol, Cantock's Close, Bristol BS8 1TS, U. K.; Tel. +44-(0)117-9289934; Fax. +44-(0)117-9293746; Email: Ian.D.Bull@bris.ac.uk; Web site: <http://www.chm.bris.ac.uk/bogs>

July 9-12, 2000: Catastrophic Events and Mass Extinctions: Impacts and Beyond, Institute of Geochemistry, University of Vienna, Austria. Web Site: <http://cass.jsc.nasa.gov/meetings/impact2000/>

July 10-14, 2000: Symposium on the Role of Erosion and Sediment Transport in Nutrient and Contaminant Transfer, University of Waterloo — Waterloo, Ontario, Canada. International Association of Hydrological Sciences. Web Site: <http://www.fes.uwaterloo.ca/Research/IAHS2000/>

July 11-12, 2000: 1st International Professional Geology Conference, Alicante, Spain. Web Site: <http://www.ua.es/sri/1IPGC.htm>

July 12-14, 2000: GEOFLUIDS III '2000. Third international conference on fluid evolution, migration and interaction in sedimentary basins and orogenic belts, Barcelona, Spain. Contact: Geofluids III, Institut de Ciències de la Terra, C/ Lluís Solé I Sabarís s/n, 08028, Barcelona, Spain. Tel: +34 93 409 5410; Fax: +34 93 411 0012; E-mail: geofluids@natura.geo.ub.es; Web Site: <http://www.ub.es/geoquimi/geofluids.htm>

July 12-14, 2000: ACCURACY 2000 - 4th International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences, Amsterdam, The Netherlands. Email: accuracy@frw.uva.nl; <http://www.gis.wau.nl/Accuracy2000>

July 12 - 18, 2000: First International Conference - Soils of Urban, Industrial, Traffic and Mining Areas, Essen, Germany. Contact: Prof. Dr. Wolfgang Burghardt, FB 9 - Angewandte Bodenkunde, Universität-GH Essen, Postfach 103 764, D-45117 Essen, Germany. Fax: +49-201-183-2390; E-mail: Wolfgang.Burghardt@uni-essen.de; Web sites: <http://www.uni-essen.de/bodenkunde/suitma2.htm>

July 16-22, 2000: ICAM 2000: 6th International Congress on Applied Mineralogy, Gottingen & Hannover, Germany. Contact: ICAM 2000 Office, P.O. Box 510153, D-30631 Hannover, GERMANY. Fax: +49-511-643-3685; E-mail: ICAM2000@bgr.de; Web Site: <http://www.bgr.de/ICAM2000>

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July 17-19, 2000: The Extreme of the Extremes - International Symposium on Extraordinary Floods, Grand Hótel Reykjavík, Iceland. Convened by The Hydrological Service - National Energy Authority in co-operation with The International Association of Hydrological Sciences (IAHS); Web Site: <http://www.os.is/vatnam/extremes2000/>

July 18-22, 2000: International Association of Volcanology and Chemistry of the Earth (IAVCEI) General Assembly 2000, Bandung, INDONESIA. Abstract Deadline: February 29, 2000. Sponsor: IAVCEI. Contact: Secretariat, Volcanological Survey of Indonesia, Jalan Diponegoro 57, Bandung 40122, INDONESIA. Tel: +1-62-22-772606; Fax: +1-62-22-702761; E-mail: iavcei@vsi.dpe.go.id; Web Site: <http://www.vsi.dpe.go.id/iavcei.html>

July 24-28, 2000: 10th International Meeting of the International Humic Substances Society, Toulouse, France. Information : PROGEP - Florence FOUCAUD, "IHSS 10", 18 chemin de la Loge, 31078 Toulouse Cedex 4 (France), Tel : 33 (0)5 62 25 23 80 - Fax : 33 (0)5 62 25 23 18, <Progep@ensigct.fr>. Eric Lichtfouse <Eric.Lichtfouse@ensaia.inpl-nancy.fr>

July 25-28, 2000: Joint Sixth International Symposium on Hydrothermal Reactions (ISHR) & Fourth International Conference on Solvo-Thermal Reactions (ICSTR), Kochi, Japan. Abstract deadline: Feb. 20, 2000. Contact: K. YANAGISAWA, Joint ISHR & ICSTR, Res. Lab. Hydrothermal Chem., Faculty of Science, Kochi University, Kochi 780-8520, Japan. FAX: +81-88-844-8362 TEL: +81-88-844-8352; e-mail: shr@cc.kochi-u.ac.jp

Aug. 6 - 12, 2000: 11th International Peat Congress - Sustaining Our Peatlands, International Peat Society, Québec, Canada. Web site: http://www.cqvb.qc.ca/wetland2000/english/frame_home_ips.html

Aug. 6-17, 2000: 31st International Geological Congress, Rio de Janeiro, BRAZIL. Sponsors: International Union of Geological Sciences (IUGS), Brazilian Geological Society, The Brazilian Ministry of Mines and Energy, others. Abstract Deadline: September 1, 1999. Contact: Secretariat Bureau, 31st International Geological Congress. Av. Pasteur, 404, Anexo 31 IGC, Urca, Rio de Janeiro, RJ, CEP 22.290-240, Brazil. Tel: +1 55 21 295 5847; Fax: +1 55 21 295 8094; E-mail: 31igc@31igc.org.br

August 13-16, 2000: 7th Canadian Continuous-Flow Isotope Ratio Mass Spectrometry Workshop, Montreal (Quebec), Canada. For information and registration: www.cf-irms.uottawa.ca

August 30-Sept. 3, 2000: GEOANALYSIS 2000, 4th International Conference on the Analysis of Geological and Environmental Materials. Pont à Mousson, Lorraine, France. <http://crpg.crgp.cnrs-nancy.fr/NEWS/Geoanalysis-2000/>

Sept. 2-8, 2000: GIS/EM4 - 4th International Conference on Integrating Geographic Information Systems (GIS) and Environmental Modeling, Banff, Alberta, Canada. Web site: <http://www.colorado.edu/Research/cires/banff/content.html>

Sept. 3-8, 2000: Goldschmidt 2000, Oxford, UK. Sponsors: Geochemical Society, European Association for Geochemistry, The University of Oxford. Contact: P. Beattie, Cambridge Publications, Publications House, PO Box 27, Cambridge UK CB1 4GL. Tel: +44 -1223 -333438; Fax: +44- 1223-333438; E-mail: Gold2000@camppublic.co.uk; Web Site: www.camppublic.co.uk/science/conference/Gold2000/

Sept. 11-15, 2000: 7th International Mine Water Association Congress - Mine Water And The Environment - Environmental impacts of mining and mines closure, Katowice - Ustron, Poland. Contact: Dr. Andrzej J. Witkowski, Dr Andrzej Kowalczyk, Secretariat of the 7th IMWA Congress, University of Silesia, Bedzinska Ul. 60, PL-41-200 Sosnowiec, Poland . Tel: +48 32 291-6888; Fax: +48 32 291-5865; E-mail: awitkows@us.edu.pl; kowalcz@ultra.cto.us.edu.pl. Web site: <http://www.geo.tu-freiberg.de/~cwoelke/IMWA/Cong2000.htm>

Sept. 17-22, 2000: 8th International Symposium on Biological and Environmental Reference Materials (BERM-8), Bethesda, Maryland, USA. Web site: <http://www.nist.gov/berm-8>.

Sept. 17-26, 2000: KARST'2000 - International Symposium & Field Seminar on Present State and Future Trends of Karst Studies, Marmaris - Turkey. Contact: Secretariat of Karst'2000, International Research & Application Center for Karst Water Resources (UKAM), Hacettepe University, 06532 Beytepe, Ankara, Turkey. Tel: +90 312 235 2543 ;Fax: +90 312 299 2136; Email: karst@hun.edu.tr Web sites: <http://www.karst.hun.edu.tr/> and <http://www.karst.hacettepe.edu.tr/>

Sept. 18-21, 2000: European Workshop on Clay Mineralogy, Jena, Germany. Contact: Prof. Dr. Reinhard Gaupp, Institut für Geowissenschaften, Burgweg 11, D-07749 Jena. Tel: +49 3641 948 620; Fax: +49 3641 948 622; E-mail gaupp@geo.uni-jena.de; Web site: <http://www.unijena.de/chemie/geowiss/kurse/kurse.html#clay>

Oct. 6-9, 2000: International Symposium Mineral Diversity - Research and Preservation, Sofia, Bulgaria. Contact: Earth and Man National Museum, Bulgaria, Sofia 1421, bul. Cherni vruch 4; Tel: +359 2 65 66 39; Fax: (+359 2) 66 14 55; E mindiv@museum.web.bg Web Sites: <http://mineraldiversity.web.bg>; <http://museum.web.bg>; <http://web.bg/nmzh/mineraldiversity/symposia/Symposiumen.htm>

Oct. 18-20, 2000: EURO ENVIRONMENT 2000 on Industry and Environmental Performance, Aalborg, Denmark. Visions, strategies and actions towards sustainable industries. Contact: Aalborg Congress and Culture Centre, Europa Plads, PO Box 149, DK-9100 Aalborg, Denmark. E-mail: else_herfort@akkc.dk; Web site: <http://www.akkc.dk/uk/euro/envire/>

Nov. 2-4, 2000: Advances on Micas - Problems, Methods, Applications in Geodynamics, Rome, Italy. Accademia Nazionale dei Lincei and Università degli Studi Roma Tre. Abstract deadline: September 1, 2000. Contact: Daniela Volpato, Accademia Nazionale dei Lincei, Via della Lungara 10, I-00165 Roma RM; Tel: +39-06-6868223; Fax: +39-06-6893616; E-mail: segreteria@accademia.lincci.it Web Site: <http://www.unimo.it/micas2000/>

Nov. 11-12, 2000: MSA Short Course on Sulfate Minerals: Geochemistry, Crystallography, and Environmental Significance. Granlibakken Resort, Tahoe City, California. Co-conveners: Charlie Alpers (cnalpers@usgs.gov), John Jambor (jlj@wimsey.com), and D.Kirk Nordstrom (dkn@usgs.gov). Registration: MSA Business Office, 1015 Eighteenth St NW Ste 601, Washington, D.C. 20036-5274, USA. Tel: 202-775-4344; Fax: 202-775-0018; E-mail: business@minsocam.org; Web site: http://www.minsocam.org/MSA/SC_SO4.html

Nov. 13-16, 2000: GSA Annual Meeting, Reno, NV USA. Contact: GSA Meetings, Box 9140, Boulder, Colo. 80301-9140. Tel: +1-303-447-2020, ext. 164; Fax: +1-303-447-1133; Web Site: <http://www.geosociety.org/meetings/index.htm>

Dec. 15-19, 2000: AGU Fall Meeting, San Francisco, Calif., U.S.A. Sponsor: AGU. Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 USA. Tel: +1-202-462-6900; Fax: +1-202-328-0566; E-mail: meetins@kosmos.agu.org; Web Site: <http://www.agu.org/meetings>

April 19-23, 2001: Third IAEA Symposium on Isotope Techniques in the Study of Environmental Change, Vienna, Austria. Contact: Pradeep K. Aggarwal, Isotope Hydrology Section, International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A 1400, Vienna, Austria; Ph. +43-1-2600-21735; Fax +43-1-26007; e-mail: p.aggarwal@iaea.org

May 20-24, 2001: Goldschmidt 2001, Roanoke, VA, USA. Contacts: Mike Hochella (hochella@vt.edu) and Bob Bodnar (bubbles@vt.edu), Department of Geological Sciences, Virginia Tech, Blacksburg, VA 24061-0420.

June 10-15, 2001: 10th Water-Rock Interaction Symposium, Tanka Village Congress Centre, Villasimius, Sardinia, Italy. Organized by the University of Cagliari in cooperation with the Working Group on Water-Rock Interaction of the International Association of Geochemistry and Cosmochemistry. Contact: WRI-10 Scientific Committee Secretariat (Prof. L. Fanfani, secretary general), Department of Earth Sciences, University of Cagliari, Via Trentino 51, I-09127 Cagliari, Italy; Phone.: +39 070 6757724; Fax: +39 070 282236; E-mail: wri10@unica.it. Web Site: <http://www.unica.it/wri10/>

August 19-24, 2001: Gordon Conference on Inorganic Geochemistry, Proctor Academy, New Hampshire. The theme will be the formation, modification and preservation of ore deposits, with a focus on geochemical processes related to tectonic, climatic, and surficial factors. Attendance will be limited; subsidies for students are anticipated. Convened by Jean Cline, Jeff Hedenquist and John Thompson. Contact Jeff Hedenquist, gordongeochem@aol.com.

August 25-31, 2001: 20th European Crystallographic Meeting (ECM-20): Crystallography in Natural Sciences and Technology, Kraków, Poland. The Jagiellonian University. In collaboration with Stanislaw Staszic University of Mining and Metallurgy. Contact: ECM20, Conference Secretariat, Faculty of Chemistry, Jagiellonian University, Ul. Ingardena 3, 30-060 Kraków, Poland. E-mail: ECM2001@chemia.uj.edu.pl Web site: <http://www.ch.uj.edu.pl/ECM2001.htm>

Sept. 17 - 21, 2001: 7th International Conference on Paleoceanography (ICP7), Sapporo, Japan. Abstract Deadline: March 10, 2001 Co-Conveners: Hisatake Okada (Dept. of Earth and Planetary Sciences, Graduate School of Science, Hokkaido University, Sapporo, 060-0810, Japan. Phone: 81-11-706-3537. Fax: 81-11-746-0394. E-mail: oka@cosmos.sci.hokudai.ac.jp), Itaru Koizumi, and Tadamichi Oba

Nov. 5-8, 2001: GSA Annual Meeting, Boston, MA USA. Contact: GSA Meetings, Box 9140, Boulder, Colo. 80301-9140. Tel: +1-303-447-2020, ext. 164; Fax: +1-303-447-1133; WWW: <http://www.geosociety.org/meetings/index.htm>

Sept. 9-13, 2002: Mineralogy for the new millenium (IMA 2002), 18th General Meeting of the International Mineralogical Association, Edinburgh, United Kingdom. Contact: Mr K. Murphy, Executive Secretary, Mineralogical Society of Great Britain and Ireland, 41 Queen's Gate, London SW7 5HR, United Kingdom: Phone: +44 171 584 7516; E-mail: IMA@minersoc.demon.co.uk.

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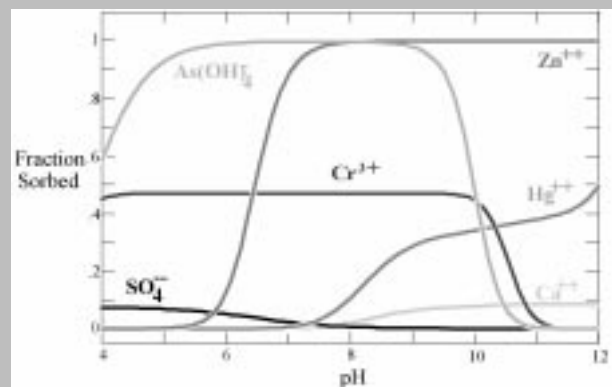
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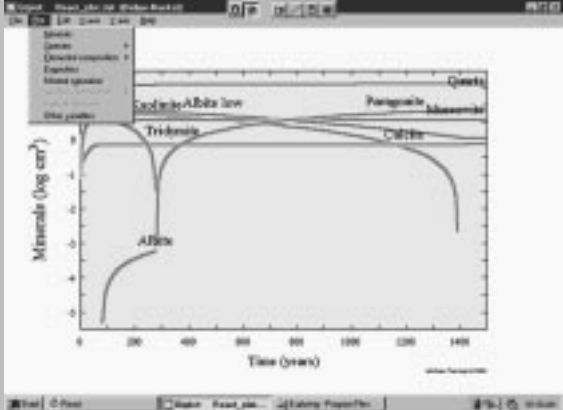
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