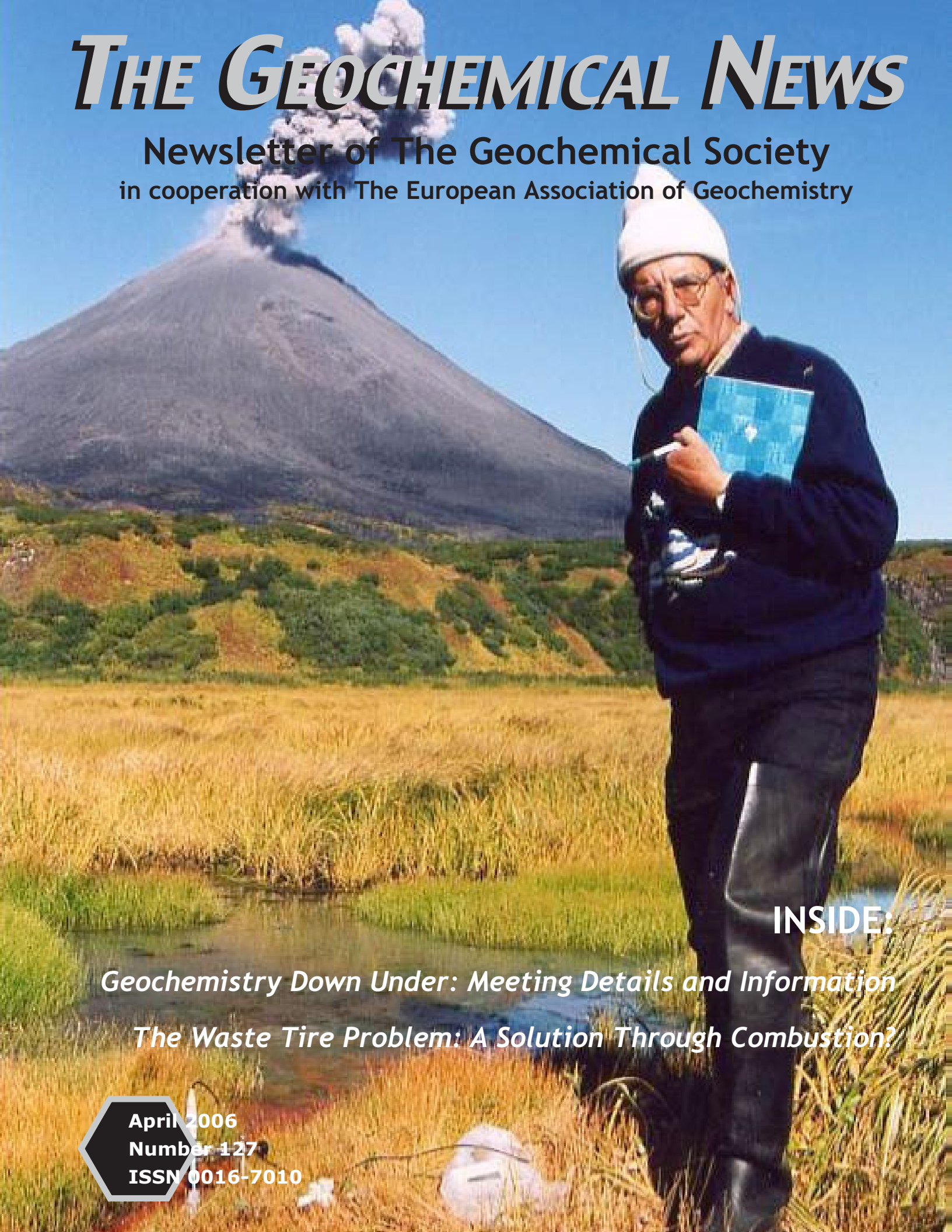
The Geochemical News

Newsletter of The Geochemical Society

in cooperation with The European Association of Geochemistry



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The Geochemical Society

The **Geochemical Society** is a nonprofit scientific society founded to encourage the application of chemistry to the solution of geological and cosmological problems. Membership is international and diverse in background, encompassing such fields as organic geochemistry, high- and low-temperature geochemistry, petrology, meteoritics, fluid-rock interaction, and isotope geochemistry. The Society produces a ***Special Publications Series***, ***The Geochemical News*** (this quarterly newsletter), the ***Reviews in Mineralogy and Geochemistry Series*** (jointly with the Mineralogical Society of America), the journal ***Geochimica et Cosmochimica Acta*** (jointly with the Meteoritical Society), and co-publishes the electronic journal ***G³*** (jointly with the American Geophysical Union: AGU); grants the ***V.M. Goldschmidt***, ***F.W. Clarke*** and ***Clair C. Patterson Awards***, and, jointly with the European Association of Geochemistry (EAG), the Geochemistry Fellows title; sponsors the V.M. Goldschmidt Conference, held in North America in odd years and elsewhere in even years, jointly with the EAG; and co-sponsors the Geological Society of America annual meeting and the AGU spring meeting. The Society honors our first President, F. Earl Ingerson, and our first Goldschmidt Medalist, Paul W. Gast, with the ***Ingerson*** and ***Gast Lectures***, held annually at the GSA Meeting and the V.M. Goldschmidt Conference, respectively. The Geochemical Society is affiliated with the American Association for the Advancement of Science and the International Union of Geological Sciences.

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

The Geochemical News
April 2006

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Cover: 2006 GS/EAG Fellow Jaques Schott demonstrates an important field safety tip.

From the GS President,

As I write this letter we are all on the verge of submitting abstracts to the 16th Annual Goldschmidt Conference in Melbourne Australia. It is a privilege to experience both local geology and local culture in a new venue every year. Each conference coordinating committee deserves tremendous gratitude for their work to provide a venue that promotes both science and international understanding.

The Geochemical Society governance body, the Board of Directors, meets annually during the conference. We welcome input to this meeting, and we encourage you to place items on the agenda by writing to the GS Secretary, Jeremy Fein (fein@nd.edu). This year we will be talking about a number of new developments including issues related to geochemical data storage and publication, the relationship of the European Association of Geochemistry (EAG) and the GS, outreach, and the exciting developments led by Patricia Dove to update our logo and our website. I will briefly update you about these below.

First, geochemical data: with the huge changes in computational infrastructure we are all experiencing, many feel that geochemical data should be available to everyone online. What could the GS do to facilitate such open data sharing and access? Second, the EAG: the GS and the EAG maintain a close relationship working together. How can we promote this relationship and further our joint activities? Third, outreach activities: the GS is learning how to be more active in educating policy makers about geochemical issues. Which such activities would be appropriate for an international society such as the GS? Fourth, logo and website: many thanks to all of you who submitted entries to our GS logo contest to update the symbol that dates back to the birth of our society in 1955. More than 144 entries –including from students – were received.

Check out the entries (http://www.geochemsoc.org/aboutgs/logo.html) and, while perusing the GS website, get ready for major changes at that url as well. Which of the logos will be the winning entry?... stay tuned.

Every year, GS committee members volunteer their time to complete GS business. At this time, I want to thank a few of these committees. In particular, we thank the Program Committee Chair, Daniele Cherniak (Rensselaer Polytechnic Institute) and her committee for facilitating geochemical sessions at the Spring AGU meeting and the Annual GSA meeting. We also thank the V.M. Goldschmidt Award Committee Chair, Sam Mukasa (University of Michigan) and his committee for selecting the 2006 recipient, Susan Solomon. The F.W. Clarke Award Committee Chair, Laurie Reisberg (CRPG), is saluted for her work with her committee in selecting the 2006 recipient, Alexis Templeton. We also are grateful for the work of the C.C. Patterson Award Committee chaired by Bob Aller (Stony Brook University) for selecting the 2006 recipient, Fred Mackenzie. Finally, the GS/EAG Geochemistry Fellows Selection Committee chaired by Cindy Lee (Stony Brook University) did a fine job selecting the 2006 fellows: William Casey, Jacques Schott, Borming Jahn, and Brian Popp. I think it is fair to say that Seth Davis (GS Business Manager) and Jeremy Fein deserve a lot of credit for keeping all of these volunteers – and myself – organized and on time in completing GS business.


Susan Brantley

Finally, I also want to salute the hard work of our outgoing President, Tim Drever. Believe me, Tim worked hard for this society. Marty Goldhaber, who is now the GS Vice-President, and I will try to keep up the good work.

What ideas do you have for the society? This society is your society, run almost entirely by volunteers from around the world. It is extraordinary that such cooperation and creativity can flourish worldwide… we seek your creative ideas as well as those of your colleagues. See you in Melbourne.

Susan L. Brantley, GS President

From the EAG President,

This issue of Geochemical News is the first opportunity to announce our EAG medallists for 2006. The Houtermans medal for an outstanding young scientist goes to James Badro of the Département de Minéralogie at the Institut de Physique du Globe in Paris, while our senior medal, the Urey medal, will this year be awarded to Herbert Palme of the Institut für Geologie und Mineralogie at the University of Köln. Both medals will be presented at the Goldschmidt conference in Melbourne, where there will be an opportunity to hear both medallists talk about their work. The EAG is delighted to be able to honour these outstanding scientists and their contributions.

EAG Council meets soon, in early May, where we will be discussing future directions for the EAG. At present the EAG, which has no office or staff, works closely with the Geochemical Society who, for example, look after the production of Geochemical News and help us in many other practical ways. We need to look at what potential there is for further support for the geochemical community in Europe to see whether the EAG will be able to meet those needs effectively or whether we should seek a closer relationship with the Geochemical Society to be able to better represent the needs and views of European geochemistry. Watch this space for any developments, but in the meantime, please get in touch if you are a geochemist based in Europe and have ideas about what the EAG should be doing.

Bruce Yardley, EAG President

Editors' Corner

What happens to old tires? Most are just thrown away, but what if they could be used as fuel? How clean do tires burn, compared with coal? In this issue Reto Gieré examines these timely questions in environmental geochemistry with a fascinating article on combustion as a possible solution to the buildup of old tires in landfills.

If you haven't done so already, make sure and visit the GS logo contest website, at:

www.geochemsoc.org/aboutgs/logo.html

where you can peruse a wide variety of potential logos. Our members have contributed some amazing artwork, and it's ultimately up to you - the members - to help pick a new symbol to represent the GS. Please send an email to Patricia Dove at **dove@vt.edu**, and tell her which are your favorite logo designs.

In this issue we also showcase the upcoming 2006 Goldschmidt Conference in Melbourne, Australia, by including ten pages of meeting information. You may have already received these pages as a flier, but if not please take a few minutes to look over the meeting details. This is going to be a very exciting conference, so make sure and register early!

Finally, if you're a graduate student and you want to go to Melbourne to give a talk or poster, look further down on this page for an announcement about a Goldschmidt Conference travel grant program, sponsored by the US National Science Foundation and the Geochemical Society. This program is open to all graduate students, including US students but now also including grad students abroad, thanks to additional support from the GS.

Until next issue,

*Johnson R. Haas (**johnson.haas@wmich.edu**),*
*Carla Koretsky (**carla.koretsky@wmich.edu**),*

Editors

2006 V. M. Goldschmidt Conference Travel Grant Program for Graduate Students

Sponsored by the US National Science Foundation and the Geochemical Society

The Geochemical Society announces an NSF- and GS-sponsored grant program that will provide awards of up to $1,000 to support graduate students giving talks or posters based on their own research at the 2006 Goldschmidt meeting in Melbourne, Australia.

Applicants who wish to be considered should submit a CV, a copy of their submitted Goldschmidt abstract (with abstract number), a one page summary describing the broader impacts and significance of their research, and a budget justification (including a statement of need, detailing alternative sources of funding). Applications are encouraged from women and minority candidates.

Applications will be accepted until 30 April 2006. Approximately forty awards will be made. Please direct all enquiries to Dr. Johnson Haas, Department of Geosciences, Western Michigan University, Kalamazoo, MI 49008, USA. Tel 269-387-2878, Fax 269-387-5513, Email johnson.haas@wmich.edu.

For further details see **http://www.geochemsoc.org/announce/2006goldtravel.html.**

GS News and Notes

Goldschmidt 2006 – Melbourne Australia
27 August - 1 September 2006
http://www.goldschmidt2006.org/.
The Melbourne Goldschmidt Conference is fast approaching! The early registration deadline is **June 30, 2006**. Remember that GS and EAG members qualify for a substantial registration discount. If you are not already a member of GS or EAG, then please join before you register to take advantage of this member benefit. With support from the National Science Foundation, the Geochemical Society will be awarding $40,000 (US) in student travel grants to the Melbourne Goldschmidt Conference. Recipients shall appear in the August issue of Elements.

Goldschmidt 2007 – Cologne, Germany (19-24 August 2007): Preparations for next year's Goldschmidt Conference are already underway. Dr. Herbert Palme (herbert.palme@uni-koeln.de) is the conference organizer.

Goldschmidt 2010?
The GS Board of Directors will be examining North American bids for the 2010 Goldschmidt Conference during the 2006 annual board meeting on August 26, in Melbourne, Australia. If you, your university, or your city are interested in submitting a bid, please contact the GS Business Office at gsoffice@geochemsoc.org.

2006 Geochemical Society Award Recipients Announced!
V.M. Goldschmidt Medal: Susan Solomon (US National Oceanic & Atmospheric Administration - Boulder)
F.W. Clarke Medal: Alexis Templeton (University of California – San Diego)
C.C. Patterson Medal: Fred Mackenzie (University of Hawaii – Manoa)

GS/EAG Fellows
William H. Casey (University of California – Davis), Bor-ming Jahn (Institute of Earth Sciences – Taipei), Brian N. Popp (University of Hawaii – Manoa), Jacques Schott (Laboratoire des Mecanismes et Transferts en Geologie – Toulouse)

GS Logo Contest
Thank you to everyone who participated in the GS Logo Contest. We received nearly 140 entries. As of this writing, the selection committee has been narrowing down the field.

GS at GSA Meeting & Exposition
The GS Program Committee will be organizing a number of sessions at the 2006 GSA Meeting and Exposition held in Philadelphia, PA from 22-25 October 2006. GS Members qualify for discounted registration. GS will also have a booth in the exhibition.

Elsevier Publication Discount
Through an agreement with Elsevier, Geochemical Society members can take advantage of a 25% discount to their full line of books, including the paperbacks editions of the Treatise on Geochemistry.
Order forms can be found either in Geochemical News, or on-line at: http://gs.wustl.edu/join/elsevierbooks.pdf

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Seth Davis

GS Sponsored Sessions at GSA

The Geochemical Society will be sponsoring several sessions at the 2006 GSA Annual Meeting and Exposition (http://www.geosociety.org/meetings/2006/index.htm) held from October 22-25 , 2006, in Philadelphia, PA, USA. These sponsored sessions are organized with the assistance of the 2006 Geochemical Society Program Committee:

Daniel Cherniak, Chair (Rensselaer Polytechnic Institute)
Tracy Rushmer (University of Vermont)
Albert Galy (University of Cambridge)
Andreas Luttge (Rice University)
Eric Oelkers (LMTG - Toulouse)
Marilyn Fogel (Carnegie Institute of Washington)

Many thanks to the program committee as well as each session chair.
We appreciate your efforts to promote geochemistry.

Geochemical Society Sponsored Sessions:

T1. **High Resolution Quaternary Records from Cave Environments**
GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Sedimentary Geology Division; Society for Vertebrate Paleontology; Paleontological Society; Geochemical Society; Karst Waters Institute
Organizers: Bonnie A.B. Blackwell, Donald McFarlane
Caves are geological time-capsules. When dated, they reveal detailed patterns of climatic, sedimentological, and hydrological changes, and botanical, faunal, and archaeological turnover.Contributions from all disciplines working in caves, rock shelters, or karst fissures welcomed. Oral and Posters.

T20. **The Occurrence, Bioavailability and Toxicity of Arsenic and Fluoride from Drinking Water—A Widespread Issue**
GSA Geology and Health Division; GSA Geology and Society Division; Geochemical Society
Organizers: Michalann Harthill, Achim Herrmann
Toxicity from arsenic or fluoride in drinking water especially from ground water sources is affecting human populations on a global scale. Knowledge of the mechanisms of bioavailability may help in design of mitigation measures. Oral.

T26. **Experimental Investigations into Hydrothermal Systems: Implications for Mass Transfer in the Earth's Crust**
Geochemical Society; Society of Economic Geologists; Mineralogical Society of America
Organizers: Brian Rusk, John Kaszuba
Hydrothermal and geothermal systems redistribute enormous amounts of mass and energy in the crust. This session provides experimental insight into fluid-magma-rock interactions in a wide range of geologic environments in continental and oceanic crust. Oral.

T27. **Better Living Through Geochemistry: Fostering an Understanding of Terrestrial Paleoenvironments and Paleoclimates**
GSA Sedimentology Division; Society for Sedimentary Geology; Geochemical Society
Organizers: Aisha H. Al-Suwaidi, Franciszek Hasiuk, Julie B. Retrum
This session will focus on applications of isotope and elemental geochemical techniques to explore the sedimentary and paleontological record of ancient terrestrial climates and environments. Oral and Posters.

T28. **An Appetite for Apatite: Conodont-Based Geological Investigations in the 21st Century**
Paleontological Society; Pander Society; Geochemical Society
Organizers: Jared R. Morrow, D. Jeffrey Over, Maya Elrick
Session highlights recent, increasingly innovative uses of conodont microfossils as a tool in a wide variety of geological applications, including geochemical, geochronologic, paleoceanographic, paleoclimatic, event stratigraphic, and paleotectonic studies. Oral and Posters.

T75. **Chemical and Hydrological Interactions in the Evolution and Control of Coal and Metal Mine Drainage**
GSA Hydrogeology Division; Geochemical Society: GSA Coal Geology Divisio
Organizers: Charles A. Cravotta, Joseph J. Donovan, Keith B.C. Brady
This session emphasizes the chemistry and hydrology of coal or metal mine drainage. Papers are solicited on aqueous chemical processes in mine settings; prediction and evolution of mine-water chemistry; innovative treatment; and long-term environmental effects. Oral and Posters.

2006 F. W. Clarke Medalist

Dr. Alexis Templeton, assistant professor at the University of Colorado, has been selected as the recipient of the **2006 F.W. Clarke medal**. Dr. Templeton received her Ph.D. from Stanford University in 2002, and then spent three years as a post-doctoral researcher at Scripps, before joining the University of Colorado in 2005. The Clarke award recognizes her outstanding contribution to understanding how microbial biofilm coatings on mineral surfaces affect the interaction of trace elements with these surfaces. A major part of her work required the development of new applications of advanced synchrotron radiation techniques. Dr. Templeton's research has greatly advanced our knowledge of the biogeochemical cycles of certain elements, such as Pb and Se, and provides a mechanistic understanding of the role bacteria play in the sorption of metals and metalloids on minerals. More recently, her research interests have expanded to include studies of novel chemolithoautotrophs in the deep ocean, biocorrosion of volcanic glasses, and bacterial oxidation and reduction processes in geologic materials.

Laurie Reisberg
Chair, F.W. Clarke Award Committee

Alexis Templeton

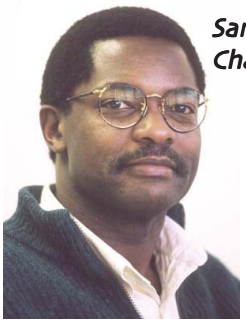
2006 Goldschmidt Award Medalist

Dr. Susan Solomon, senior scientist at the Aeronomy Laboratory, National Oceanic and Atmospheric Administration in Boulder, Colorado, is the recipient of the **2006 Goldschmidt Award**, following a unanimous vote on the first ballot by the five-member selection committee. Dr. Solomon received her MSc and PhD from the University of California, Berkeley, and immediately began her research career at NOAA. She was the leading scientist in identifying the mechanism that created the Antarctic ozone hole, putting forth a theory involving heterogeneous chemical reactions of chlorine on the surfaces of the particles found in very cold clouds in the Antarctic stratosphere. She then conducted observations in Antarctica over two expeditions in 1986 and 1987, and succeeded in providing key evidence for her theory. This research played a leading role in identifying the process by which the surfaces of clouds produced by the extremely low temperatures of Antarctica couple with increased atmospheric chlorine due to human use of chlorofluorocarbons (CFCs) to deplete ozone at unprecedented rates. Prior to this understanding of the ozone hole, the Montreal Protocol on "Substances that Deplete the Ozone Layer" required a freeze on production and consumption of ozone-destroying chemicals. Dr. Solomon's findings pro-

Susan Solomon

vided one of the scientific cornerstones for the amendments of the Montreal Protocol leading instead to the complete ban of CFCs beginning in 1990, and thus contributed significantly to the protection of the ozone layer.

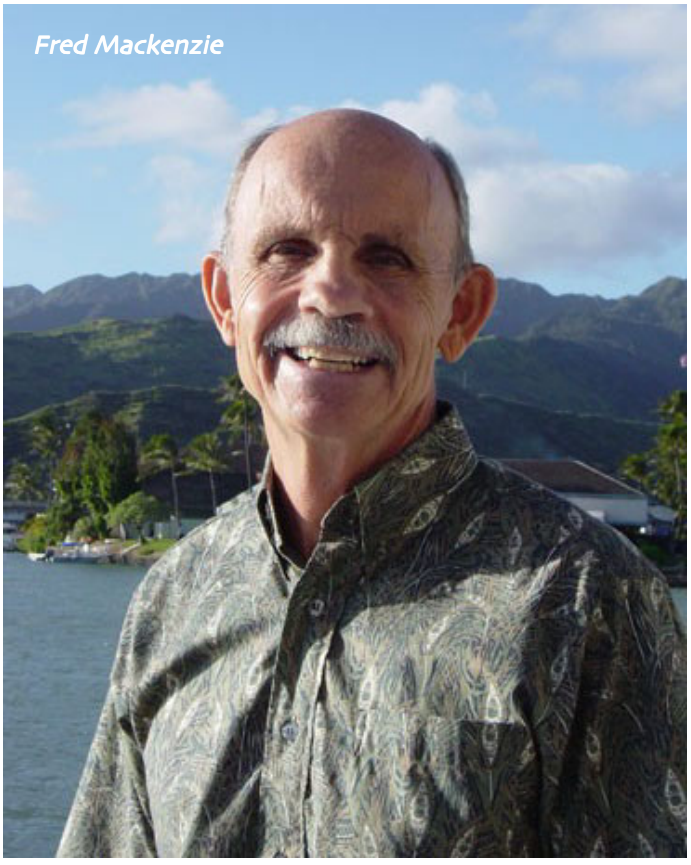
Dr. Solomon has authored two books and has written or co-written over 150 papers. She is the recipient of many honors and awards, including the J. B. MacElwane award of the American Geophysical Union, the Department of Commerce Gold Medal for Exceptional Service, the Henry G. Houghton and Carl-Gustaf Rossby awards of the American Meteorological Society for excellence in research, the ozone award from the United Nations Environment Program, and the National Medal of Science – the United States' highest scientific honor. She was named the third most highly cited geoscientist in the world during the decade of the 1990s by Science Watch in December, 2001. Dr. Solomon was elected member of the U.S. National Academy of Sciences in 1992, and was subsequently elected a Foreign Associate of both the French Academy of Sciences (1995) and the European Academy of Sciences (2000). In 2004, Dr. Solomon was recognized with The Blue Planet Prize of the Asahi Glass Foundation, an international award quickly developing the stature of the Nobel Prize, which recognizes individuals who have made major contributions to solving global environmental problems.



Samuel B. Mukasa
Chair, V. M. Goldschmidt Award Committee

2006 C. C. Patterson Award Medalist

Fred T. Mackenzie, of the University of Hawaii, is the winner of the **2006 Clair C. Patterson Medal** for Environmental Chemistry. The award recognizes Mackenzie's innovative contributions to the understanding of coupled biogeochemical cycles of C, N, P, and S at the Earth's surface, and particularly his models of the recent effect of anthropogenic activity on global elemental cycles and oceanic acid – base balances in the context of those operating over geologic time. His extraordinary record of life-long research activities also include significant contributions to knowledge of the thermodynamics and kinetics of carbonate and phosphate mineral formation and dissolution, the geochemistry of shallow marine carbonate sediments, and of the biogeochemical cycles leading to changes in the chemical composition of the ocean, atmosphere and sedimentary rocks over the past 500 million years. In addition, Prof. Mackenzie has made both recent and sustained major contributions to the education and conceptual guidance of a broad spectrum of both advanced and nonspecialist students of environmental geochemistry and Earth surface processes including the establishment in 1998 of a Bachelor of Science Program in Global Environmental Sciences at UH. Mackenzie received his B.S. degree in geology and physics at Upsala College and his Ph.D. degree in geology and geochemistry from Lehigh. He is the author or co-author of 7 books and 8 edited volumes in ocean, earth science and biogeochemistry, and over 200 scholarly publications. He has been Professor of Oceanography at UH since 1981.



Fred Mackenzie

2006 Geochemical Society/EAG Fellows

William H. Casey (center)

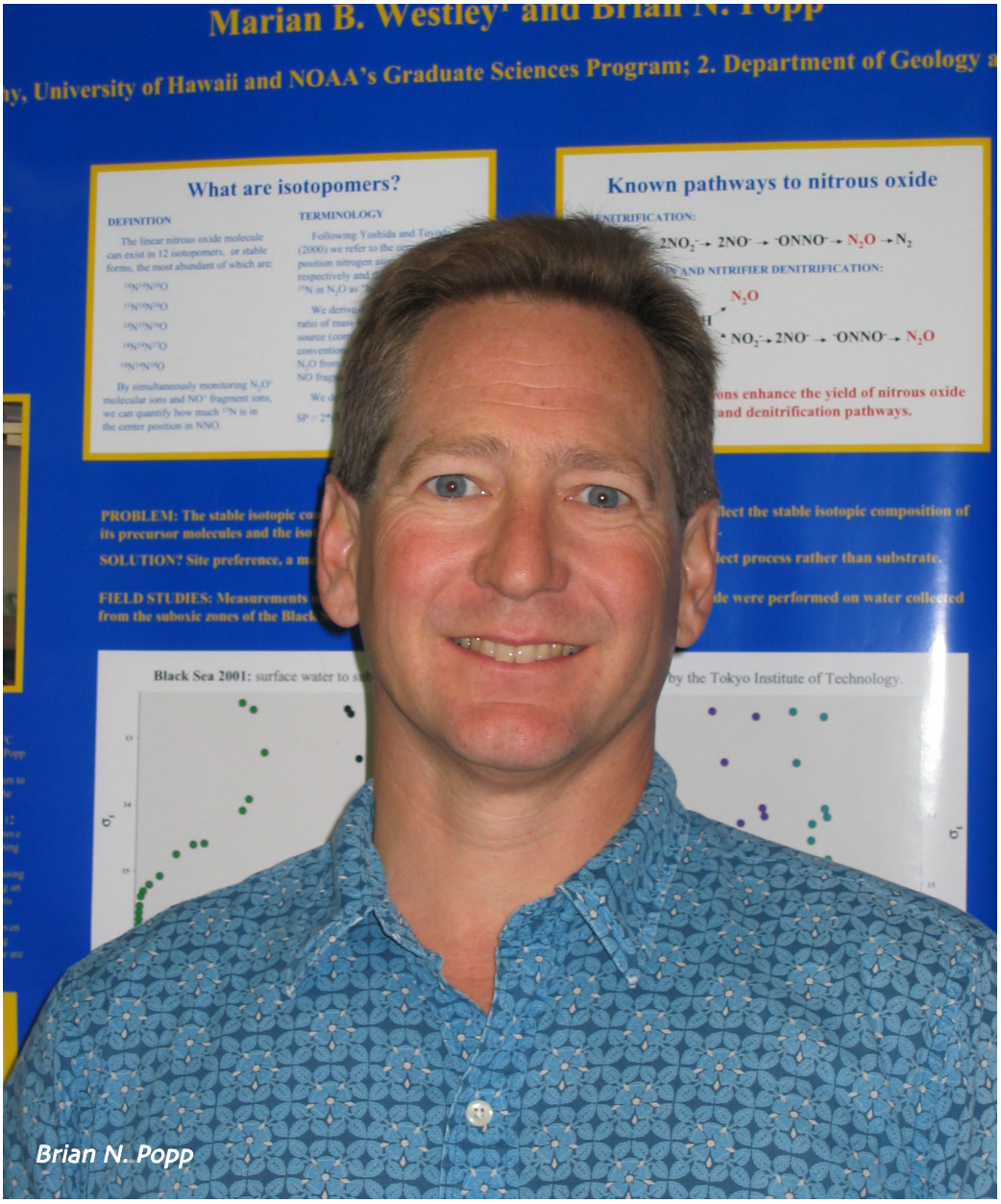
2006 Geochemical Society and European Association of Geochemistry Fellows:

ABOVE: Middle seated (white shirt), William H. Casey of the University of California, Davis, USA, along with his team of trained experts.

RIGHT: Bor-ming Jahn, of the Institute of Earth Sciences in Taipei, Taiwan.

Bor-ming Jahn

2006 Geochemical Society/EAG Fellows



Brian N. Popp

2006 Geochemical Society and European Association of Geochemistry Fellows, continued:

LEFT: Brian N. Popp, of the University of Hawaii, Manoa, USA.

COVER: Jacques Schott, of the Laboratoire des Mecanismes et Transferts en Geologie – Toulouse, France.

From the Chair of the Organic Geochemistry Division (OGD) of the Geochemical Society

I have heard it argued that Organic Geochemistry is such a broad subject that the commonality that links its component disciplines does not yield a particularly meaningful subdivision of natural science: in other words, the differences among the constituent disciplines are so much larger than what unites them, that the commonality is not that important. As you might suspect, I heartily disagree.

Organic geochemistry encompasses research as diverse as biogeochemistry, aspects of climate change studies, petroleum geochemistry, aspects of archaeology, and studies of extraterrestrial organic matter. Certainly, a potential liability pursuant to such diversity can be a lack of appreciation for and interaction among the constituent disciplines. Yet, on the other side of that same coin lays an incredible, albeit always "potential", asset: the potential for large, more-than-incremental, advances which the diversity of organic geochemical approaches can collectively yield when applied to complex natural systems.

The bylaws of the OGD state that "The purpose of the Division shall be to encourage and foster studies on the origin, nature, geochemical significance, and behavior during diagenesis and catagenesis of naturally occurring organic substances in the Earth, and also studies of extraterrestrial organic matter."

To fulfill this purpose, the OGD engages in several activities, including:

- Annual selection of the Alfred Treibs Medal winner: This medal is awarded for major achievements, over a period of years, in organic geochemistry. The bylaws describe such achievements as "pioneering and innovative investigations, which have made highly significant contributions to the understanding of the origin and fate of organic materials in the geosphere and/or in extraterrestrial environments."

- Selection of the Best Paper of the Year Award, which is presented to the author(s) of the paper judged by the Best Paper Award Committee to be the most outstanding contribution published in the open literature in the previous twelve months.

- Organization of organic-geochemistry-themed research symposia which are held annually as part of any of several earth science meetings, such as the Goldschmidt, GSA, ACS, or AAPG.

Unstated in the OGD bylaws, but implicit throughout, is the notion that the OGD should strive to facilitate excellence in its component disciplines, and interaction among those disciplines is a key to achieving that excellence. Consider the list of past recipients of the Alfred Treibs Medal:

Jaap Sinninghe Damste (2005), Erik Galimov (2004), Roger E. Summons (2003), Archie Douglas (2002), John Smith (2001), John I. Hedges (2000), John M. Hayes (1997), Patrick Parker (1996), Keith A. Kvenvolden (1995), Isaac R. Kaplan (1993), Jan W. deLeeuw (1991), James R. Maxwell (1989), T. C. Hoering (1987), P. Albrecht (1985), W. K. Seifert (1984), D. H. Welte (1983), J. M. Hunt (1982), G. Eglinton (1981), B. Tissot (1980), G. T. Philippi (1979).

The rich, interdisciplinary, fecund careers of these scientists provide remarkable examples of what Organic Geochemistry, at its interdisciplinary best, can achieve. As 2006-2007 Chair of the OGD, I hope to help the OGD further this unstated mission of stimulating substantive, even seminal interaction among its various branches – interaction that makes the most of our wonderful diversity.

Mark A. McCaffrey

P.S. All members of The Geochemical Society with an interest in any of the diverse aspects of organic geochemistry may join its Organic Geochemical Division (OGD) without additional charge by checking the appropriate entry on the yearly GS dues statement. For information about the OGD contact Mark McCaffrey, Chair, OGD <mccaffrey@oiltracers@com>.

The Waste Tire Problem: Solution Through Combustion?

Reto Gieré

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Introduction

Automotive tires are an important part of the solid waste stream in today's society. Accumulating globally at a rate of several hundred million per year, discarded tires pose a considerable environmental problem. They have traditionally been placed in landfills or stockpiles, but innovative alternatives to disposal have been developed over the past decades. Because of their high heat content and their low levels of moisture and nitrogen compared to coal, tires are ideally suited for energy recovery through combustion. Combustion now represents one of the most important options for treating waste tires. This process, however, generates gaseous and particulate emissions as well as solid materials, which must be characterized in order to assess the overall environmental impact of tire combustion (for a recent review and relevant literature, see ref. 1). This contribution summarizes the life-cycle of discarded tires, describes some general aspects of tire combustion in coal-fired power plants, and discusses benefits and disadvantages of combustion.

The Life-Cycle of Discarded Tires

In 2003, Americans disposed of 290 million car, truck, bus, and airplane tires (2). This number also includes exported used tires, landfilled tires, as well as 30 million tires whose fate is unknown. The number of tires is equivalent to approximately one discarded tire per person per year, a value that is typical for most industrialized nations. Figure 1 displays the life-cycle of discarded tires and gives the most recent figures available for the U.S. (2). Four main paths can be distinguished:

1) Resale: After removal from initial service, many tires are still usable on vehicles and thus, are resold either in the U.S. (21 million) or exported to other countries (9 million).

2) Retreading: This method uses less energy and requires up to 70% less oil than the fabrication of a new tire, and thus offers the best strategy for value recovery from tires (3). Consequently, the price for retreaded tires may be considerably lower than that of new tires. Retreading is therefore an attractive option (16 million in 2003), particularly for relatively expensive tires, such as those from trucks and airplanes.

3) Disposal: Disposal in landfills has been the preferred path in the life-cycle of waste tires. Tires, however, do not decompose nor can they easily be compacted, and thus occupy large volumes of landfills. Moreover, buried tires are buoyant relative to their surroundings, because the abundant empty space, resulting from their shape, is often filled with air. Therefore, tires tend to rise to the surface, where they will disrupt the protective final cover of closed landfills, allowing precipitation to enter the landfill and gases (e.g., methane) to escape. For these reasons, many landfill operators do not accept tires or charge high tipping fees, and the regulatory trend is to ban whole tires from landfills. Disposal of shredded tires in monofills, however, has become a prominent alternative.

In 2003, about 27 million tires were landfilled in the U.S. The most significant problem of tire stockpiles is that they are prone to fires. Tire fires are extremely difficult to extinguish and typically burn for several weeks. Moreover, quenching such fires with water increases the production of pyrolytic oil, which can escape into the environment. Uncontrolled tire burning also releases significant amounts of hazardous gases and unburned hydrocarbons, which create thick black smoke plumes. Another problem of tire stockpiles is that rainwater collects in the open space of the impermeable tires, and, together with trapped windblown pollen and dust, creates an ideal environment for the development of mosquito larvae. The number of stockpiled tires in the U.S. has been reduced from 800 million in 1994 to approximately 265 million at the end of 2003 (2). This reduction results from stockpile abatement programs, which take advantage of various alternative methods to tire disposal.

4) Alternative Options: Several approaches have been made to reduce the number of landfilled, stockpiled or illegally dumped tires (for review, see ref. 1). Today, markets exist for about 90% of all waste tires (Fig. 1). Whole waste tires can be utilized for many practical purposes, such as, crash barriers, breakwaters, playground equipment, erosion-control constructions, and artificial reefs. Processing of tires by shredding, cutting, stamping, or grinding is becoming increasingly important. It reduces the tire volume by up to 75%, thus

significantly reducing transportation costs. Shredded tires are used extensively in various civil engineering applications (e.g., road base, highway embankments, drainage systems). Moreover, pyrolysis is an attractive option, as it converts waste tires into secondary products of significant value (e.g., oils, residual char). Pyrolysis, however, is an expensive method, and the resulting oils may contain high concentrations of polycyclic aromatic hydrocarbons (PAH), some of which are carcinogenic and/or mutagenic. Ground rubber, or crumb rubber, is produced either by mechanical grinding with an abrasive at ambient temperature or by cryogenic fracturing. The resulting material is used mainly as an asphalt modifier in highway construction (rubberized asphalt). By far the most important alternative to disposal of waste tires is combustion, consuming 130 million tires in the U.S. Combustion is the preferred method of tire elimination in many other countries as well.

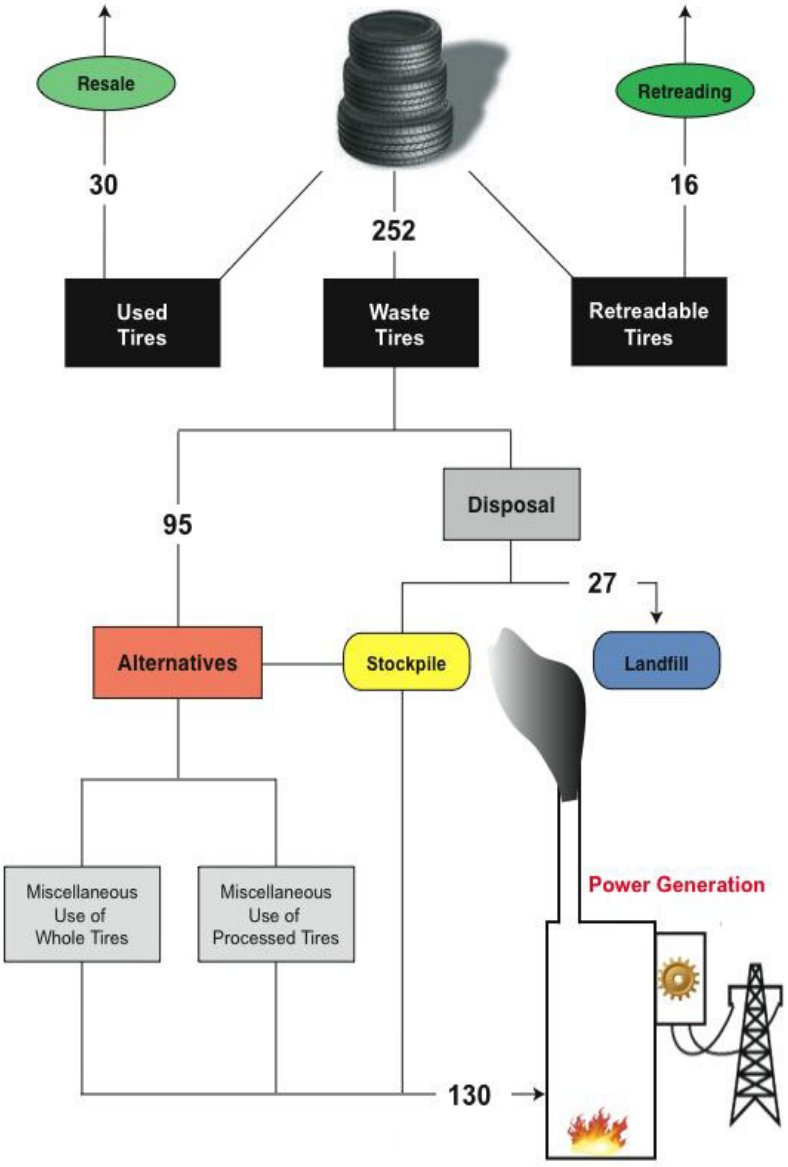

Figure 1. Schematic diagram showing the life-cycle of discarded tires. Numbers (in million tires) are valid for 2003 in the U.S. (2).

Tires as Energy Source

As an energy source, tires represent an attractive alternative to other fuels because they contain low concentrations of nitrogen (<0.6 wt%) and high amounts of heat (27-39 MJ/kg). The heat content is relatively high when compared to that of bituminous coal (26-30 MJ/kg), and is more than twice the heating value of municipal solid waste or chipped wood waste. Another important advantage of tire fuel is that it typically contains <2 wt% moisture. This moisture content is considerably lower than that of coal (3-10 wt%) and negligible compared to that of wood waste (10-60 wt%). Although tires can be used as an alternate fuel, they are most often utilized as a supplemental fuel (see discussion in ref. 1). Tire fuel exists either as whole tires or in shredded form. The latter is known as tire-derived fuel (TDF) and consists of tire chips, which are typically smaller than 2.5 x 2.5 cm, and in many cases de-wired. Both shredding and wire removal increase the costs of energy recovery.

In the U.S., tires are combusted together with traditional fuels, predominantly coal, in cement kilns (53 million), pulp and paper mills (26 million), and electric utility or industrial boilers (41 million). In addition, whole tires are used as the sole fuel source in dedicated tire-to-energy facilities, which, however, only combusted approximately 8% of all tire fuel in the U.S. The situation is entirely different in other countries where, in many cases, tires are combusted exclusively in cement kilns equipped with sophisticated air pollution control systems.

Tire Combustion in Coal-Fired Power Plants

The use of tires in electric utility and industrial boilers comprises approximately 31% of the market for tire fuel in the U.S. (2). These facilities combust TDF mixed with coal in a variety of proportions, ranging from 2 to 40 wt% TDF. Both coal and tire combustion

generate large amounts of gaseous (e.g., SO_2, CO_2, NO_x, metal vapors) and particulate atmospheric pollutants in addition to solid waste materials, including various types of ash, which represent the non-combustible matter in the fuels.

Figure 2 displays a schematic diagram of a coal-fired power plant, and shows where the different combustion products are collected. Bottom ash accumulates directly underneath the grate of the boiler and contains the coarsest ash particles (Fig. 3c). The hot flue gases produced in the boiler contain suspended ash particles (fly ash) and must pass through various air pollution control devices (e.g., electrostatic precipitators) before they can be emitted into the atmosphere. These devices are designed to remove the particulate matter (PM) from the flue gas and exhibit overall particle-capturing efficiencies in excess of 99%. The trapped fly ash has a mineralogical composition that depends strongly on the fuel. Combustion of typical bituminous coal, for example, yields a fly ash consisting of various forms of carbon, amorphous materials (usually aluminum-silicate spheres; Fig. 3f), as well as crystalline phases, including mullite ($Al_6Si_2O_{13}$), quartz, hematite, and magnetite (4). The trapped fly ash is either discarded or used for various purposes, depending on its physical and chemical properties. The most important consumer of fly ash is the concrete industry. In the U.S., only 33% of the ~60 Mt fly ash accumulated annually through coal combustion are used (5), but in other countries, nearly all fly ash is used (e.g., Germany, Netherlands). Boilers may further be equipped with scrubbers to reduce emissions of certain gases. When high-sulfur coal is burned, for example, the flue gases are forced to interact with lime or calcite slurries to reduce the SO_2 emissions. This procedure generates a valuable by-product (synthetic gypsum), which can be used by the wallboard industry.

In the example shown in Figure 2, the flue gas first passes through a cyclone-type mechanical collector and subsequently through an electrostatic precipitator, which collects a much finer fraction of ash particles (Fig. 3). Some power plants use fabric filters instead of electrostatic precipitators. Both devices, however, are least efficient in capturing the smallest particles in the fly ash, and thus lead to preferential emission into the atmosphere of the finest particles. At the same time, the finest particles are substantially enriched in a number of toxic elements relative to the larger size fraction. This commonly observed relationship is believed to result from condensation of volatilized compounds from the flue gas onto the surface of fly ash particles, whereby the effect is greatest for small particles because they have the largest surface area per unit mass (6). The emitted fly ash particles exhibit long atmospheric residence times and are typically in the respirable range, thus potentially ending up in the respiratory tract of animals and humans.

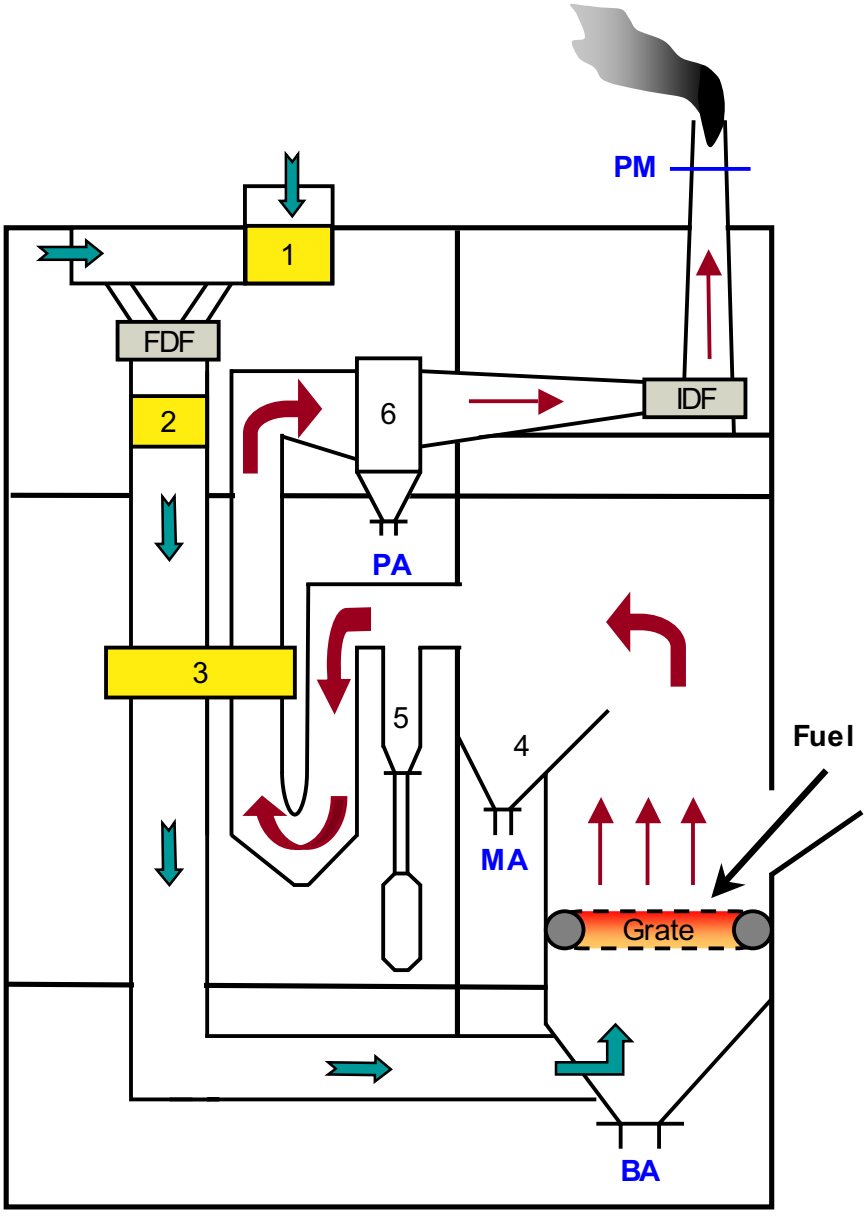

Figure 2. Schematic diagram of a stoker-boiler unit at Wade Utility Plant of Purdue University. Sampling points are shown in blue and include those for collection of particulate matter (PM) on filter paper inserted into the smoke stack (this material consists of PM); electrostatic precipitator ash (PA); mechanical separator ash (MA); and bottom ash (BA). Other symbols and numbers indicate the following: forced draft fan (FDF); induced draft fan (IDF); outside air heater (1); steam reheater (2); Ljungstrom rotary air heater (3); manual hoppers (4); mechanical cyclone separator hoppers (5); electrostatic precipitator hoppers (6). Green arrows show inlet air flow, red arrows show outlet air flow.

Impacts of Tire Combustion

The composition of tires has a considerable effect on the chemical and mineralogical composition of the solid waste products, but

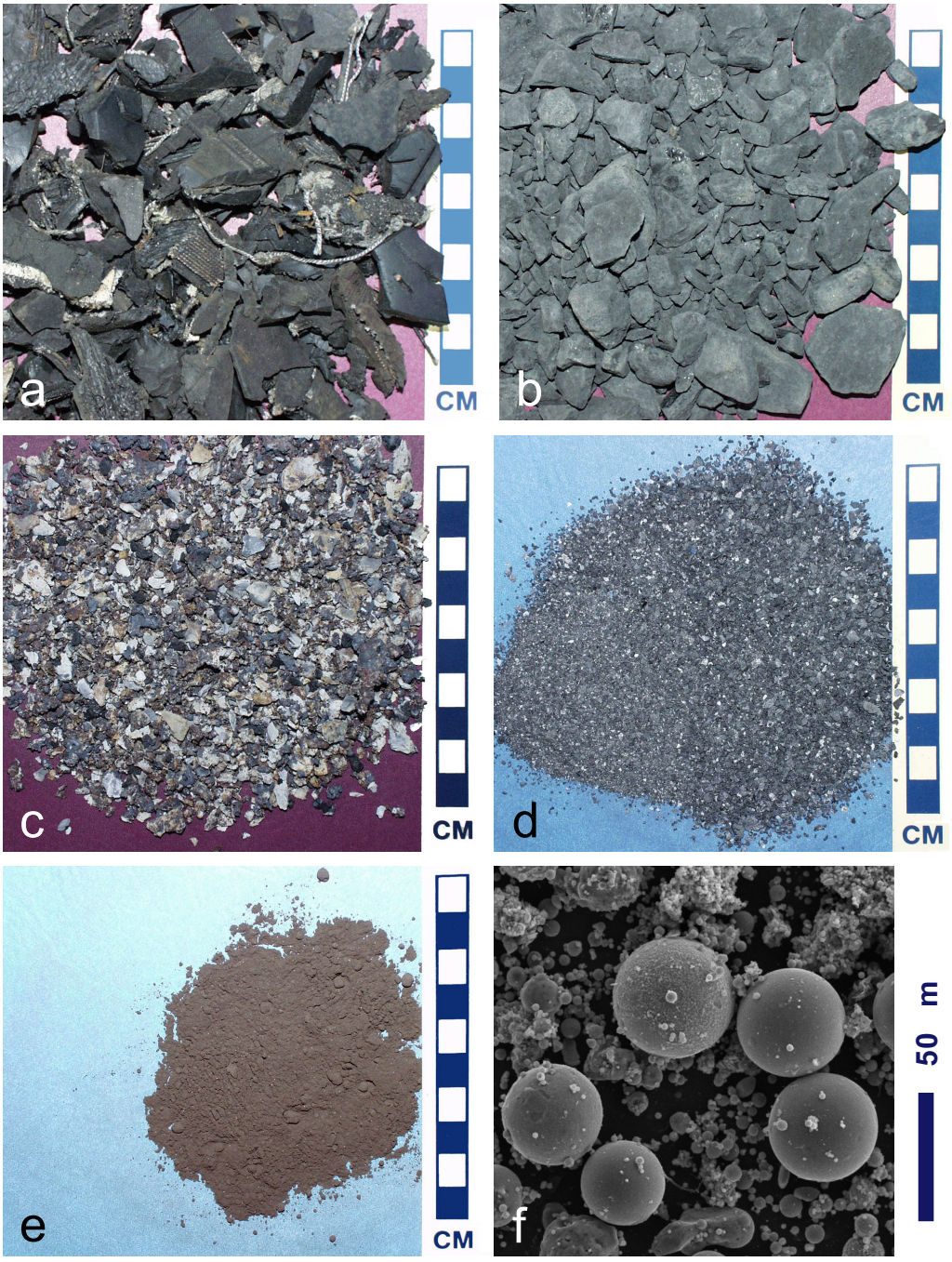

Figure 3. TDF, coal and combustion products from the Purdue University experiment. a) TDF; b) coal; c) bottom ash; d) mechanical collector ash; e) electrostatic precipitator ash (a-e all at same scale); f) scanning electron image of the electrostatic precipitator ash shown in e).

also on the gaseous and particulate emissions. Tires are chemically complex, as they contain of a multitude of markedly different components: natural and synthetic rubber, typically styrene-butadiene (known as SBR); reinforcing fillers (e.g., carbon black, silica, clay, calcium carbonate) and fibres/wires (e.g., nylon, polyester, rayon, steel); extenders or softeners (e.g., petroleum process oils); vulcanizing agents and accelerators (e.g., zinc oxide, stearic acid, organic sulfur compounds); and various antioxidants (7). The chemical composition differs greatly amongst various manufacturers, tire types, and even tire parts (e.g., tread *vs.* side wall).

A typical passenger car tire contains approximately 3-5 wt% textile fibres, 10-17 wt% steel wire, 1 wt% ZnO, and 21-31 wt% carbon black, with the remainder being primarily natural and synthetic rubber. As mentioned, tires contain significantly less N and moisture than typical bituminous coal, but they are distinctly richer in volatiles and Cl, whereas their S content is similar to that of medium-S coal. In addition to the high amounts of Zn and Fe (up to 16 wt% if steel-belted), tires may contain considerable quantities of trace elements (1), including the environmentally critical and volatile elements Hg and Pb.

To assess the environmental impact of adding TDF to coal, it is necessary to compare the composition of solid combustion products and of gaseous and particulate emissions. Due to the large compositional variability observed for tires and other fuels, however, it is difficult to compare various data sets. Direct comparison is further complicated by differences in combustion conditions and ash collection procedures at different facilities. However, test burns conducted at a single facility allow quantification of the effects on solid and gaseous combustion products. Unfortunately, only a few tests have been performed at power plants rather than in the laboratory (see review by ref. 1). One such test-burn was conducted at the Purdue University power plant, which combusted two different sets of fuel (stoker boiler, ~1500 ºC) in two successive weeks: pure coal during the first week, and a blend of 95 wt% coal plus 5 wt% TDF during the second week. The TDF consisted of shredded tires, whereas the feed coal was bituminous coal from southern Indiana (Fig. 3). To collect

escaped PM, filter papers were inserted into the top part of the smoke stack through sampling ports. The filters remained overnight in the smoke stack and trapped the fly ash fraction that would have escaped into the atmosphere.

The data revealed that the bulk fly ash from the coal+TDF mixture was distinctly richer in SO_3 and Zn than the fly ash from pure coal. This result is due to the higher average concentrations of these components in the coal+TDF blend. The concentrations of most other trace metals in the bulk fly ash decreased with the addition of TDF. For the bottom ash, many of the patterns observed for the fly ash are reversed. This result is expected, because the bottom ash accumulates directly from the boiler, which is much hotter than the collection points for the fly ash, and therefore, the relatively volatile elements are partitioned into the fly ash. Moreover, the smaller particles of the fly ash are more effective at capturing volatile elements than the larger ones in the bottom ash. The mineralogical examination of the fly ash is not completed yet, but it appears that, in addition to the phases typical of coal fly ash, the coal+TDF ash contains Zn-rich phases.

Several general trends in gaseous emissions have been reported from laboratory-scale studies at carefully controlled conditions: compared to coal combustion, burning of coal+TDF under the same conditions typically produces smaller amounts of NO_x emitted into the atmosphere, but higher emissions of CO and PAHs. Our industrial-scale test-burn, however, revealed that adding TDF to the coal did not affect the NO_x emissions and reduced CO emissions. On the other hand, a pronounced increase in HCl emissions was observed when TDF was added. This increase is due to the high Cl content of the TDF (nearly 3000 ppm), which is considerably higher than that of the pure coal (215 ppm). Our experiment further showed that combustion of the coal+TDF blend rather than pure coal leads to significantly enhanced average bulk emissions of various metals, including Be, Al, Cr, Ni, Cu, Zn, Cd, Sb, and Pb (8). Most dramatic was the increase observed for Zn, whose emissions averaged nearly 2.4 kg/h for the coal+TDF blend, compared to 15 g/h for the combustion of pure coal. The higher metal emission rates probably result from the higher Cl concentrations of the flue gas, which may facilitate formation of gaseous chloride species of some metals.

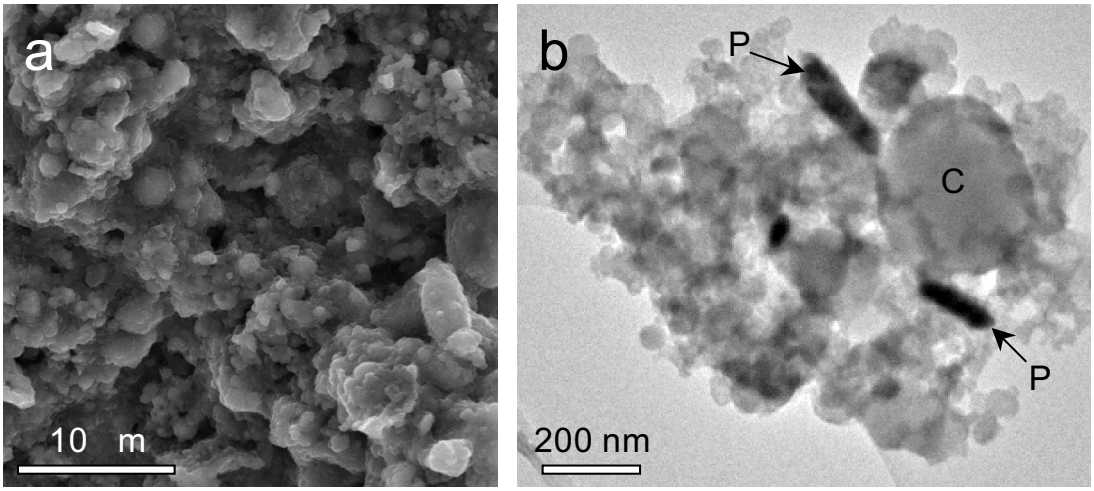

Figure 4. Images of particulate matter trapped by a filter paper inserted into the smoke stack above all air pollution control devices of a coal-fired power station. a) Scanning electron microscope image showing the layer of trapped particulate material; b) transmission electron microscope image of a typical particle agglomerate. Most particles shown are amorphous aluminum-silicate spheres. The large rounded particle (C) is amorphous carbon, and the dark elongated crystals (P) consist of Pb, S, and O.

To better characterize these metal emissions, the chemical and structural properties of the particulates trapped on the filter papers have been investigated. Micro- and nano-analytical examination of the thin layer of PM on the filter papers (Fig. 4a) revealed that the trapped material consists mainly of very fine particles (<1 μm across). In addition to carbon, the PM comprises various particle types, including aluminum-silicate glass and metal sulfates (9). Some of these sulfates are highly soluble and thus will be affected by atmospheric moisture and surface water. Because most of the emitted particles are in the respirable range (Fig. 4b), the particles may also interact with fluid or tissue in the respiratory tract of animals and humans. A recent study of the fly ash produced during our test-burn has shown that considerable amounts of Zn and Pb are bioaccessible when the fly ash is exposed to synthetic lung fluids at body temperature (10). Such studies provide important information in regard to possible health impacts resulting from the combustion of tires in coal-fired power plants.

Discussion

The most obvious advantage to using tires as a fuel source is a considerable alleviation of several problems associated with traditional tire disposal in stockpiles and landfills. Tire combustion further conserves the limited amount of fossil fuel supplies and, as a result of the

high heat content of tires, can be a financially better alternative to fossil fuel combustion. The economic benefits, however, may be reduced by several factors, including proximity of the tire source to the facility and costs associated with shredding and wire removal.

Studies have shown that atmospheric emissions can be greatly reduced if proper air pollution control systems are installed. Laboratory and field data provide evidence indicating that concentrations of some environmental pollutants, especially NO_x, may decrease due to tire combustion, whereas others increase compared to pure coal combustion. Zinc is an example of an element that increases in both solid combustion products and atmospheric emissions. The geochemical impact of higher Zn contents in fly ash on leaching processes in ash disposal sites remains to be tested. Combustion of tires as sole fuel in tire-to-energy facilities produces ash with particularly high Zn contents, which might represent a valuable secondary source of Zn. The Zn content of such ash may approach the contents in pure sphalerite, the most important Zn ore. But even if the Zn contents are lower, recovery of Zn from tire ash may be more economical than extraction from sphalerite ore because it does not involve mining. Moreover, the bulk ash is a fairly homogeneous and fine-grained material compared to sphalerite ore, and the use of tire ash as a source of Zn would take advantage of a waste material. Another important advantage of extracting Zn from ash produced in tire-to-energy facilities is that it would not create sulfide waste with its associated environmental problems.

From an environmental standpoint, tire-to-energy facilities with their specially designed air pollution control devices therefore represent a promising option for dealing with one of the greatest disposal challenges for solid waste. On the other hand, the common practice in the U.S. of combusting tires in coal-fired power plants has important drawbacks, because the air pollution control systems of these facilities have not been designed for this purpose. Micro- and nano-analytical studies of individual particles emitted from power plants are rare, even for those burning pure coal. Our large-scale experiment was aimed at providing these lacking details. Knowledge of the physical and chemical properties of individual particles in the emissions is essential for the evaluation of environmental and health effects of both coal and tire combustion. In summary, the use of tire fuel has environmental impacts that must be weighed carefully against the benefits of reducing the large volume of tires in the global waste stream.

References

(1) Gieré, R.; LaFree, S. T.; Carleton, L. E.; Tishmack, J. K. Environmental impact of energy recovery from waste tyres. In *Energy, Waste, and the Environment: a Geochemical Perspective*; Gieré, R., Stille, P., Eds.; The Geological Society, London, 2004; Vol. 236, pp 475-498.

(2) RMA; Rubber Manufacturers Association, Washington, D.C.: www.rma.org, 2004.

(3) Amari, T.; Themelis, N. J.; Wernick, I. K., Resource recovery from used rubber tires. *Resources Policy* 1999, *25*, 179-188.

(4) Hower, J. C.; Rathbone, R. F.; Robertson, J. D.; Peterson, G.; Trimble, A. S., Petrology, mineralogy, and chemistry of magnetically-separated sized fly ash. *Fuel* 1999, *78*, 197-203.

(5) Kalyoncu, R. S. Coal Combustion Products. In *Metals and Minerals*; U.S. Geological Survey: Rston, VA, 2001; Vol. Minerals Yearbook 2001, v.I, pp 19.11-19.15.

(6) Natusch, D. F. S.; Wallace, J. R.; Evans, C. A., Toxic trace elements: Preferential concentration in respirable particles. *Science* 1974, *183*, 202-204.

(7) JATMA, Tire industry of Japan. 2002, *www.jatma.or.jp*.

(8) Gieré, R.; Smith, K. L.; Blackford, M. G., Chemical composition of fuels and emissions from a coal+tire combustion experiment in a power station. *Fuel* in press.

(9) Gieré, R.; Li, H.; Smith, K. L.; Blackford, M. G. In *World of Coal Ash*; http://whocares.caer.uky.edu/wasp/AshSymposium/Authors05.asp: Lexington, KY, 2005.

(10) Twining, J.; McGlinn, P.; Loi, E.; Smith, K. L.; Gieré, R., Risk ranking of bioaccessible metals from fly ash dissolved in simulated lung and gut fluids. *Environmental Science and Technology* 2005, *39*, 7749-7756.

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Program at a Glance

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Sunday 27 August 2006	Monday 28 August 2006	Tuesday 29 August 2006	Wednesday 30 August 2006	Thursday 31 August 2006	Friday 1 September 2006
Registration 1100 - 1700	Opening Plenary Session 0830 - 1000	Theme Plenary and Concurrent 0830 - 1000	Theme Plenary and Concurrent 0830 - 1000	Theme Plenary and Concurrent 0830 - 1000	Theme Plenary and Concurrent 0830 - 1000
	Morning Tea 1000 - 1030	Morning Tea 1000 - 1030	Morning Tea 1000 - 1030	Morning Tea 1000 - 1030	Morning Tea 1000 - 1030
	Concurrent Sessions 1030 - 1230	Concurrent Sessions 1030 - 1230	Concurrent Sessions 1030 - 1230	Concurrent Sessions 1030 - 1230	Concurrent Sessions 1030 - 1230
	Lunch 1230 - 1330	Lunch 1230 - 1330	Lunch 1230 - 1330	Lunch 1230 - 1330	Lunch 1230 - 1330
	Plenary Session 1330 - 1430	Plenary Session 1330 - 1430	Plenary Session 1330 - 1430	Plenary Session 1330 - 1430	Plenary Session 1330 - 1430
	Afternoon Tea 1430 - 1500	Afternoon Tea 1430 - 1500	Afternoon Tea 1430 - 1500	Afternoon Tea 1430 - 1500	Afternoon Tea 1430 - 1500
	Concurrent Sessions 1500 - 1600	Concurrent Sessions 1500 - 1600	Concurrent Sessions 1500 - 1600	Concurrent Sessions 1500 - 1600	Concurrent Sessions 1500 - 1530
Ice Breaker Welcome Reception 1700 - 1830 (included in the registration fee)	Poster Sessions & Geo Café 1600 - 1800	Poster Sessions & Geo Café 1600 - 1800	Poster Sessions & Geo Café 1600 - 1800	Poster Sessions & Geo Café 1600 - 1800	Poster Sessions & Geo Café 1530 - 1800
				Gala Dinner Rivers Reception Centre 1830 - 2230 (optional)	

PROGRAM THEMES

THEME 1: ADVANCES IN TECHNIQUES IN GEOCHEMISTRY

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Trevor.Ireland@anu.edu.au

Co-Chair: Andrew Berry
a.berry@imperial.ac.uk

S1-01: Nuclear methods in geochemistry

S1-02: Reactions and processes at internal and external mineral interfaces

S1-03: Determining coordination and structure with synchrotron light

S1-04: Techniques for EARTHTIME and CRONUS

S1-05: Techniques for isotopic and abundance measurements of light elements

S1-06: Techniques for heavy stable isotope analysis

S1-07: Techniques for nanoscale geochemistry

S1-08: Noble gases in the 21st century

THEME 2: MINERAL DEPOSITS AND ORE GEOCHEMISTRY

Chair: Andy Barnicoat
andrew.barnicoat@ga.gov.au

Co-Chair: Chris Heinrich
heinrich@erdw.ethz.ch

S2-01: Quantitative hydrodynamic and thermodynamic modelling of hydrothermal processes

S2-02: Fluid-melt-mineral interactions in nature and experiments

S2-03: Element mobility in the regolith: ore body formation, dispersion and discovery

S2-04: Geochemical and isotopic techniques –applications to ore deposits and exploration

S2-05: Sources and mobility of metals across scales: from veins to the lithosphere

S2-06: Sulfide mineralogy and geochemistry; to mark the publication of Vol 60 in the Reviews in Mineralogy and Geochemistry series

THEME 3: SOLAR SYSTEM FORMATION

Chair: Herbert Palme
herbert.palme@uni-koeln.de

Co-Chair: Marc Norman
marc.norman@anu.edu.au

S3-01: Chronology of the early Solar System

S3-02: Stellar and Nebular Processes

S3-03: Planetary Formation and Differentiation

S3-04: Geochemistry of Planetary Surfaces

S3-05: Cosmochemistry of Habitable Planets

THEME 4: CONVECTING MANTLE

Chair: Bernie Wood
bwood@els.mq.edu.au

Co-Chair: Janne Blichert-Toft
jblicher@ens-lyon.fr

S4-01: Experimental constraints on upper mantle processes - a special symposium honouring Prof. David H Green

S4-02: Messages from the past - the signature of ancient subduction

S4-03: Early Mantle evolution

S4-04: Mantle-core interactions

S4-05: Perovskite and post-perovskite- stability, geochemical and geodynamical consequences

S4-06: Intergrated Studies of MORB Petrogenesis: Sources, Melting Processes, and Timescales

S4-07: Volatiles in the mantle

S4-08: Plumes and large igneous provinces

THEME 5: LITHOSPHERE EVOLUTION

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rudnick@geol.umd.edu

Co-Chair: Greg Yaxley
Greg.Yaxley@anu.edu.au

S5-01: The deepest lithosphere and beyond: Diamonds and related research - a session in honour of Jeff Harris

S5-02: Earth Evolution 4.5 to 3.5 Ga: Deciphering the Earliest Global Systems

S5-03: Geochemical and geophysical probing of continental dynamics

S5-04: Precambrian ophiolites and greenstone belts: insights into mantle dynamics and lithosphere evolution

S5-05: Processes of mantle refertilisation and modification

S5-06: Ross Taylor symposium - the origin of continents

S5-07: Shen-su Sun Symposium - Geochemical reservoirs and mantle convection (jointly with theme 4)

S5-08: Continental Crust Subduction and Recycling

S5-09: Granites and mantle-crust interaction

THEME 6: SUBDUCTION PROCESSES

Chair: Tim Elliott
tim.elliott@bris.ac.uk

Co-Chair: Richard Arculus
richard.arculus@anu.edu.au

S6-01: Fluid loss during early subduction

S6-02: "Deep" fluid release from the slab

S6-03: Mantle melting in subduction zones

S6-04: Unscrambling differentiation

S6-05: Mineralisation at subduction zones

S6-06: Subduction zone evolution in 4-D

PROGRAM THEMES

THEME 7: GEOCHEMICAL CONSTRAINTS ON TIMESCALES AND MECHANISMS OF TECTONIC PROCESSES

Chair: Derek Vance
d.vance@bristol.ac.uk

Co-Chair: Joerg Hermann
joerg.hermann@anu.edu.au

S7-01: Accessory phases and trace elements: links between geochronology and petrology

S7-02: Up and down: Geochemical constraints on paleotopography and tectonic geomorphology

S7-03: Fast and furious versus slow and steady: rates of geological processes

S7-04: Extreme metamorphism

S7-05: Light elements in the continental crust

S7-06: Fault systems: their geochronology and geochemistry

THEME 8: BIOGEOCHEMISTRY AND THE ORIGIN AND EVOLUTION OF LIFE

Chair: Malcolm Walter
malcolm.walter@mq.edu.au

Co-Chair: Mike Russell
michaelr@chem.gla.ac.uk

S8-01: Mediation across the abiotic-biotic transition at the dawn of life

S8-02: Quantum aspects of life

S8-03: Novel isotopic tracers of biogeochemical processes

S8-04: Compound specific isotope analysis and its contributions to palaeoreconstruction. A session to be held in recognition of John M Hayes

S8-05: Major episodes of extinction, radiation and biogeochemical change

S8-06: Microbe-mineral interactions

S8-07: Life's signatures and products up to 2.0 Ga

S8-08: Possible biogeochemistries of Mars

S8-09: Timescales of human evolution

THEME 9: AQUEOUS GEOCHEMISTRY AND FLUIDS IN THE CRUST

Chair: John Mavrogenes
john.mavrogenes@anu.edu.au

Co-Chair: Sue Brantley
brantley@essc.psu.edu

S9-01: Fluid immiscibility in High T systems

S9-02: Supercritical behaviour

S9-03: Water-rock interaction in aquifers: reactions, rates, controls

S9-04: Low-temperature geochemistry in surface environments

S9-05: Nanoscale size effects on geochemical processes: reactivity, kinetics, and pathways

THEME 10: SURFACE PROCESSES, LOW TEMPERATURE SYSTEMS AND LANDSCAPE EVOLUTION

Chair: Paulo Vasconcelos
paulo@earth.uq.edu.au

Co-Chair: Rod Brown
r.brown@earthsci.gla.ac.uk

S10-01: Geochemistry, chronology and global consequences of terrestrial weathering

S10-02: Low temperature thermochronometry: models, methods and applications

S10-03: Terrestrial cosmogenic nuclides: surface process rates and/or dates?

S10-04: Microbial cycling of metals in the weathering crust

S10-05: High-resolution Quaternary palaeoclimate proxies

S10-06: Synchrotron applications in environmental geochemistry

S10-07: Mobility, availability, toxicity and remediation of pollutants

S10-08: Contributions of Geochemistry to understanding the inorganic and organic chemistry of wine

Add S10-09: Chemical weathering and mineralogy of the Martian surface and Earth analogs

THEME 11: OCEAN CHEMISTRY AND CIRCULATION; CLIMATE AND ENVIRONMENT

Chair: Rachael James
R.H.James@open.ac.uk

Co-Chair: Malcolm McCulloch
Malcolm.McCulloch@anu.edu.au

S11-01: Deep-Sea Carbonate Systems

S11-02: Marine biogeochemical forcing of Earth's atmosphere on short and long timescales

S11-03: Evolution of ocean chemistry: past, present and future

S11-04: Multi-proxy investigations of the past marine environment

S11-05: Continental chemical fluxes to the oceans

S11-06: Absolute and relative chronologies of climate change

GENERAL SYMPOSIA

G-01: Analytical geochemistry
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G-03: Biogeochemistry
G-04: Computational geochemistry
G-05: Cosmochemistry
G-06: Crystallography
G-07: Environmental geochemistry/ mineralogy
G-08: Experimental geochemistry/ petrology
G-09: Geochronology
G-10: Hydrology/ Hydrogeochemistry
G-11: Hydrothermal geochemistry
G-12: Igneous geochemistry
G-13: Isotope geochemistry
G-14: Marine geochemistry
G-15: Metamorphic geochemistry
G-16: Mineral deposits

KEYNOTE SPEAKERS

Keynote speakers include:

John Ayers, *Vanderbilt University, USA*
Gray Bedout, *Lehigh University, USA*
Paul Bierman, *University of Vermont, USA*
Jean-Louis Birk, *Institut de Physique du Globe, France*
Ian Campbell, *Australian National University, Australia*
Rick Carlson, *DTM, Carnegie Institute, USA*
Thure Cerling, *University of Utah, USA*
Simon Clark, *Daresbury Laboratory, UK*
Yildirim Dilek, *Miami University, USA*
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Tim Eglinton, *Woods Hole Oceanographic Institution, USA*
Rob Embley, *National Oceanic and Atmospheric Administration, USA*
Ken Farley, *California Institute of Technology, USA*
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Andrew Jephcoat, *Oxford University, UK*
James Kasting, *Pennsylvania State University, USA*
David Kelsey, *University of Adelaide, Australia*
Alexander Krot, *University of Hawaii, USA*
Adrian Lenardic, *Rice University, USA*
Kevin McKeegan, *University of California, USA*
Scott McLennan, *State University of New York, USA*
Eiji Ohtani, *Tohoku University, Japan*
Stefano Piana, *Curtin University, Australia*
Greg Ravizza, *University of Hawaii, USA*
Richard Reeder, *State University of New York, USA*
Peter Reiners, *Yale University, USA*
Ros Rickaby, *University of Oxford, UK*
Andy Ridgewell, *University of British Columbia, Canada*
Kevin Rosse, *Pacific Northwest National Lab, USA*
Gary Sposito, *University of California, USA*
Claudine Stirling, *University of Otago, New Zealand*
Wolfgang Sturhahn, *Argonne National Laboratory, USA*
Weidong Sun, *Institute of Geochemistry, China*
Richard Walker, *University of Maryland, USA*
Michael Walter, *Bristol University, UK*
Hajime Yano, *Institute of Space and Astronautical Science, Japan*

For the most up to date list of keynote speakers please visit the conference website at:
www.goldschmidt2006.org

Introduction

The 16th Annual V.M. Goldschmidt Conference will take place 27 August – 1 September 2006 at the Melbourne Exhibition and Convention Centre. The conference will be held for the first time in the southern hemisphere, in Melbourne, Australia. Australia's unique, plate-scale natural laboratory has driven a rich tradition of geochemical, experimental, cosmochemical and isotope research, from the extraordinary archives of past climate of the Great Barrier Reef to the oldest known terrestrial materials of Mount Narryer and Jack Hills. The local organizing committee invites you to come downunder to share in discussions of the latest international developments in geochemistry, and to explore the geology, landscape and culture of Australia.



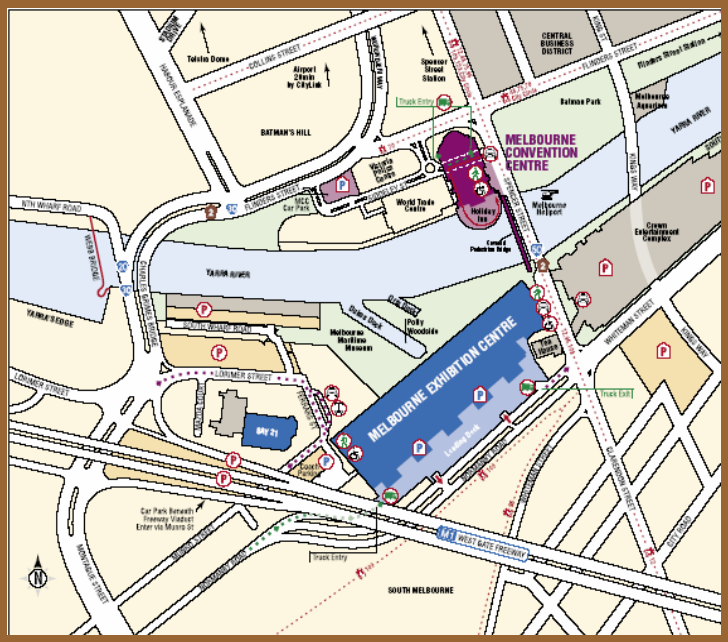
CALL FOR ABSTRACS

Important Dates
Abstract submission deadline: 13 April 2006
Speaker registration deadline: 30 June 2006

ABSTRACT SUBMISSION DEADLINE:

THURSDAY 13 APRIL 2006!

To ensure your paper is included in the Conference Program, your abstract MUST reach the Conference Managers by Thursday, 13 April 2006.



General policies and requirements for the submission of abstracts

- All abstracts must be original work.
- All abstracts must be prepared as per the guidelines provided.
- All abstracts will be peer reviewed by the Program Committee. The Program Committee reserves the right to accept or reject abstracts for inclusion in the program and to change your submission preference from oral to poster or visa versa.
- Abstracts in the program will be grouped by themes and symposia. Authors need to indicate the theme most suitable to their abstract. Please note this does not guarantee that an abstract will be grouped within this theme in the final program.
- A non-refundable abstract processing fee of A$130.00 is payable at the time of abstract submission. This fee is payable by the first author who makes the submission and is based on a per abstract submitted basis regardless of the number of contributing authors.
- Presenting authors will be also required to register for the Conference in order for their abstract to be accepted.
- Please note that first authors can submit one abstract only.
- Presenting authors will be notified of their acceptance by end of May 2006, together with instructions for presentation as a poster and/or oral communication.

Abstract Submission Instructions

- Abstracts must only be submitted via the Abstract Submission Form on the Conference website in Microsoft Word format.

Venue

A unique feature of Goldschmidt 2006 is that all meeting rooms are under one roof at the Melbourne Exhibition and Convention Centre (MECC).

A consistent winner of many prestigious 'Awards for Excellence', the MECC is renowned for providing national and international convention and exhibition organisers with the highest standards of personal service and event facilities.

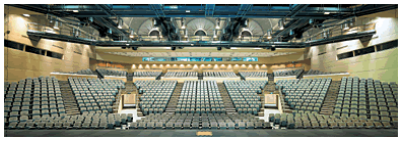
The Centre was the very first to earn the distinction of being named the World's 'Best Congress Centre' by the principal professional body for congress centre managers - the Association Internationale des Palais de Congres (AIPC). Domestically, the MECC has also been a recipient of the Meetings Industry of Australia's highest accolade many times over.

The MECC offers a level of Quality Controls and flexibility that has made it popular with exhibition organisers and meeting planners alike. Whether it is the ease of access and loading dock facilities or the state-of-the-art Theatres and meeting rooms, the Centre more than meets expectations - it exceeds them.

Few venues are better equipped to cater for the 16th Annual V.M. Goldschmidt Conference requirements than the MECC. Meeting rooms are all equipped with the highest level of sound, video and staging technology as well as the latest Telecommunications.

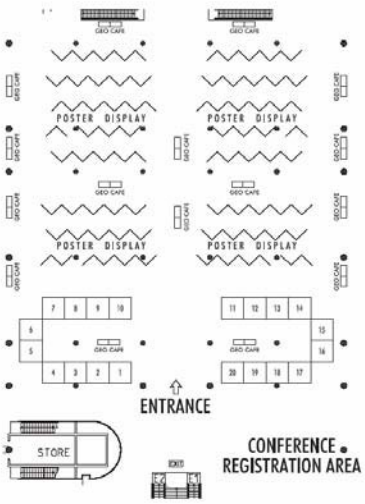
The MECC's commitment to excellence also extends to Food and Beverage, where the team of highly skilled chefs, led by Executive Chef Frank Burger prepare and serve meals that reflect the Centre's overall reputation for excellence.

The Goldschmidt plenary session will be held in the John Batman Theatre. Encompassing both Level 3 and 4 of the Melbourne Convention Centre, the John Batman Theatre is a world class venue for major Conventions, Annual General Meetings, product launches and Award ceremonies. Standard capacity in this Theatre is 1,519 and maximum capacity is 1581. Areas are also available for any disabled members of your party.



Another unique feature of Goldschmidt 2006 is that you will be able to view the poster presentations all week.

Floor Plan



Venue Location

Situated on either side of the picturesque Yarra River, the Melbourne Exhibition Centre and Melbourne Convention Centre are linked by a covered footbridge enabling delegates and visitors ease of access when moving between the exhibition and conference areas.

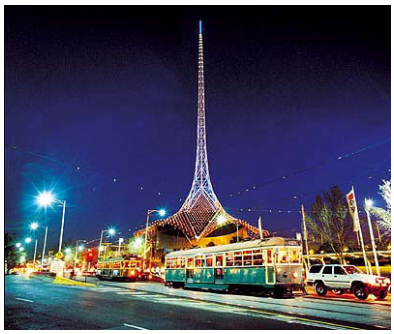
The Centre is also located just a short stroll from many of the city's restaurants, hotels and shopping areas making it easily accessed by foot or public transport.

The accessibility of Melbourne is also a key consideration for attending an event at the MECC. Just a short distance from the City is a wealth of sightseeing attractions perfect for day tours and with regular flights to other cities and tourist destinations there are ample opportunities to combine your visit with some of Australia's other famous attractions.

The Melbourne Exhibition and Convention Centre is easily accessible by tram, train, taxi or car.

Trams

There are two tram stops outside the Melbourne Convention Centre and one stop at the Melbourne Exhibition Centre.



Trains

Spencer and Flinders Street stations are a short stroll from the Melbourne Exhibition and Convention Centre.

Taxis

Taxi ranks are located at both the Melbourne Exhibition Centre and the Melbourne Convention Centre as well as all major hotels, Crown Entertainment Complex and Spencer and Flinders Street stations.

Skybus

Skybus Super Shuttle is the official transit link between Melbourne Airport and the central business district.

Accommodation

Accommodation has been reserved for Conference delegates at the following hotels. To book, complete either the Online Registration Form or the Registration Form attached to this brochure. The Conference Managers will forward your reservation and deposit or credit card details to the hotel of your choice.

Please visit the website www.goldschmidt2006.org to view accommodation terms and conditions.

Rates

Accommodation held by the Conference Managers has been secured at highly competitive rates for Conference delegates.

HOTEL

Single (SGL): A single occupancy room with one bed
Double (DBL): A double occupancy room with one bed
Twin (TWN): A double occupancy room with two beds

APARTMENT

1 Bedroom Apartment: Either 1 double bed or 2 single beds. Separate living area.
2 Bedroom Apartment: Either 2 double beds or 1 double bed and 2 single beds. Separate living area.

	Hotel	Distance to Conference Venue	Room Type	A$ Room only rate per night	US$* Room only rate per night	EURO* Room only rate per night
4 to 4.5 Star Hotels and Apartments	Crowne Plaza Melbourne	Adjacent to Convention Centre	Bay View Room TWN Standard Queen Room SGL/DBL	A$215.00 A$205.00	US$161.42 US$153.91	EURO134.54 EURO128.28
	Crown Promenade Hotel	6 minute walk	Standard Room SGL/DBL/TWN	A$195.00	US$146.40	EURO122.02
	Grand Mercure on Swanston	15 minute walk or Tram ride from Bourke St	Standard Room SGL/DBL/TWN	A$166.00	US$124.03	EURO103.87
	Pacific International Apartments Southbank	15 minute walk or Tram ride from Flinders St	2 Bedroom Executive Apartment 1 Bedroom Standard Apartment	A$265.00 A$190.00	US$198.90 US$142.65	EURO165.83 EURO118.90
Budget to 3.5 Star Hotels	Travelodge Hotel Southbank Melbourne	6 minute walk	Standard Room SGL/DBL/TWN	A$139.00	US$104.36	EURO86.98
	Hotel Ibis Little Bourke Street	10 minute walk	Standard Room SGL/DBL/TWN	A$119.00	US$89.34	EURO74.46
	Mercure Hotel Welcome	15 minute walk or	Standard Room SGL/DBL/TWN Tram ride from Bourke St	A$116.00	US$87.10	EURO72.58
	Hotel Enterprize Melbourne	5 minute walk	Superior Room SGL/DBL/TWN Budget Room SGL/DBL/TWN	A$140.00 A$90.00	US$105.11 US$67.57	EURO87.60 EURO56.31
	Explorers Inn	5 minute walk	Standard Room SGL/DBL/TWN	A$112.00	US$84.10	EURO70.08

* All fees are to be paid in Australian Dollars. The EURO and US Dollar rates are estimates only, based on the exchange rate at the time of print.

Please Note:

- Visit the Conference website **www.goldschmidt2006.org** to view hotel photos and fact sheets.
- The above rates include the Australian Goods and Services Tax (GST).
- Rates may increase without notice due to changes in government charges, taxes or levies.
- Rates do not include breakfast.
- To view current foreign exchange rates, please visit **www.x-rates.com**

MELBOURNE

Melbourne is frequently touted as one of the world's most "livable" cities - which is certainly true - but it's also one of the most international places on Earth. A quarter of the three million people who call Melbourne home were born overseas, and successive waves of immigration from Europe, the Middle East and Asia have helped to create the cosmopolitan metropolis that exists today.

MELBOURNE DINING

This is a city where there are as many styles as there are chefs, with a culinary diversity as rich as anywhere around the globe.

Many of Melbourne's precincts have a culinary character all of their own, from the Greek atmosphere of Lonsdale Street or Carlton's 'Little Italy', to the wide choice of Chinatown around Little Bourke Street.

Or take a stroll over the Yarra River to the Southgate complex or a quick tram ride to Docklands, where you can enjoy striking views of the city and spectacular waterfront while you dine.

You'll find something for every palate and price range, from fine dining to fast noodles, focaccia to fish of the day. To truly discover Melbourne is to embark on an adventure for the tastebuds..

Social Program

The following event is included in the registration fee for delegates. If you require additional tickets please indicate when registering online.

INCLUDED SOCIAL PROGRAM

The following event is included in the registration fee for delegates. If you require additional tickets please complete the Social Program section on the registration form.

Welcome Reception/Ice Breaker

Date: Sunday 27 August 2006

Time: 1700 - 1830

Venue: Melbourne Exhibition and Convention Centre

Dress: Smart Casual

An invitation is extended to all delegates to attend the Welcome Reception to be held at Melbourne Exhibition and Convention Centre. Renew old friendships and make new acquaintances as we welcome you to Melbourne.

Additional tickets: A$55.00 per person

Registration for the Conference will also take place at the Conference venue before the Welcome Reception.

OPTIONAL SOCIAL PROGRAM

The following events are not included in the registration fee for delegates. If you would like tickets to these events please complete the Optional Social Program section on the registration form.

S01: Goldschmidt 2006 Gala Dinner

Date: Thursday 31 August 2006

Time: 1830 - 2230

Venue: Rivers Reception Centre, South Bank

Dress: Smart Casual

Cost: A$120.00 per person

A memorable highlight of the Conference is the Dinner at Rivers Reception Centre, which is situated within easy walking distance of the Conference venue. Enjoy a three-course dinner and live entertainment. An ideal opportunity to mingle and meet fellow delegates.

S02: Dinner at the Colonial Tramcar Restaurant

Date: Wednesday 30 August 2006

Time: 2035 – 2330

Venue: departs from Tramstop #125 Normanby Road, near the corner of Clarendon Street, South Melbourne (near Crown Casino). Guests must arrive 15 minutes prior to departure.

Cost: A$93.50 per person

Melbourne is known for its trams, leafy boulevards and grand culinary experiences. Experience all three during an unforgettable night aboard the Colonial Tramcar Restaurant. On this lovingly restored and decorated 1920's tramcar, journey along stylish Toorak Road, elegant Collins Street and through trendy bayside St. Kilda. Cross the Yarra River and pass the floodlit Victorian Arts Centre. Enjoy a gourmet 5 course dinner including beverages on the world's only travelling tramcar restaurant – as you experience the passing parade of magnificent Melbourne.

S03: Evening at the Arts Centre – Musica Viva presents Paul Lewis

Date: Tuesday 29 August 2006

Time: 2015

Venue: Hamer Hall, The Arts Centre

Cost: $67.00 per person

Tonight guests will enjoy a performance by Paul Lewis on Piano. A protégé of the legendary Alfred Brendel, Paul Lewis has received the Royal Philharmonic Society's Instrumentalist of the Year award and has been widely acclaimed as one of the great new talents of the century.

This all-Beethoven program features two of Beethoven's most famous sonatas, and the opportunity to hear the 'Appassionata' and the 'Moonlight' performed by such a dazzlingly gifted musician makes this an ideal program for both the aficionado and those new to classical music.

Disclaimer

The services specified in the social program are available at the time of writing. However, in the event that any service(s) become unavailable or minimum numbers are not met. Tour Hosts Corporate Special Events reserves the right to alter or cancel the event.

Optional Tours

Food, wine and the arts are a major part of life in Melbourne and an exciting program will be developed to give delegates and their companions an opportunity to enjoy this wonderful city and surrounding area.

These tours have been designed by Tour Hosts Pty Limited for participating delegates and accompanying persons. Only the best aspects of Melbourne and its environs have been incorporated to provide value for money for persons whose time is at a premium. All sightseeing tours include the services of a guide, all entry fees and meals where specified. All tours are based on a minimum number of participants. If this number is not reached, alternative places will be allocated strictly in order of receipt of bookings. Where participants cancel their day tour bookings prior to 25 July 2006, payment will be refunded in full. Thereafter, no refund will be made. It is recommended that comfortable shoes and informal dress be worn on all tours.

Tours Departure Point

All tours except the Majestic Melbourne tour will depart from official conference hotels. The Majestic Melbourne tour will leave from the Tours Departure Point which is located in the Atrium of the Melbourne Convention and Exhibition Centre.

Optional Tours Program

OT1: Majestic Melbourne

Date: Sunday 27 August 2006

Time: 1000 – 1400hrs

Cost: A$50.00 per person

Melbourne has a well-earned reputation for its culture, sporting events and feast of flavours as the culinary centre of Australia. The city's elegant 19th century architecture and beautiful public gardens are stunning reminders of an optimistic age.

Highlights during today's program include the bustling city centre, the Shrine of Remembrance, Victorian Arts Centre, Melbourne Cricket Ground and Olympic Park, Spenser Street Station, Federation Square, the Royal Botanic Gardens and Albert Park Lake and the Grand Prix site.

OT2: Australian Wildlife & Puffing Billy

Date: Available Daily

Time: 0840 – 1730hrs

Cost: A$151.00 per person

Travel through lush rainforest aboard "Puffing Billy" – a century-old steam train. At Healesville Sanctuary, stroll amongst the kangaroos, meet an emu on the path and watch the flight and hunting skills of magnificent birds of prey. Lunch included.

OT3: Penguin Parade at Phillip Island

Date: Available Daily

Time: 1530 – 2300hrs

Cost: A$112.00 per person

Depart Melbourne for Phillip Island, where the Little Penguins that nest there perform a "parade" every evening – emerging from the sea and waddling up the beach to their burrows. Be privy to one nature's most spectacular shows – a few minutes after sunset. The tour includes entrance to the Nature Park and access to the premium viewing area.

OT4: Yarra Valley

Date: Available Daily

Time: 1000 – 1730hrs

Cost: A$140.00 per person

Travel through the Dandenong Ranges and enjoy sweeping views of the beautiful Yarra Valley as you visit three premier wineries. Includes personalised wine tasting, cheese platter, guided tour, morning tea, and lunch.

OT5: Sport Lovers Tour of Melbourne

Date: Available Daily

Time: 0830 – 1300hrs

Cost: A$95.00 per person

Explore the history and excitement of Sporting Melbourne, including a visit to the venues that play host to some of Australia's favourite sporting events, access to the coach's box, media facilities, exclusive member areas, as well as the change rooms. Guests will have the privilege to tour behind the scenes and walk on the hallowed turf of the MCG. Lunch is included in the cost of this tour.

Post Conference Tours

Post Conference Tours will be specially arranged to enable participants to experience the contrasts of this vast southern continent. View the spectacular Monolith of Uluru (Ayers Rock), discover the Australian Outback in Alice Springs and explore the Great Barrier Reef with its prolific coral wonderland.

The following Post tours have been specially designed by Tour Hosts Destination Management (license No. 2TA001144) for participants of the 16th Annual V.M. Goldschmidt Conference 2006 . Please visit the website at www.goldschmidt2006.org for more information including itineraries and terms and conditions. Alternatively, complete Section G of your Registration Form to make a reservation. Please note flights are not included in the cost of the Post Tour.

PTA: **Reef and Rainforest**

5 Days/4 Nights

Saturday 2 September – Wednesday 6 September 2006

A relaxing tour to Far North Queensland based in the beachside village of Palm Cove. Features a full day cruise to the Great Barrier Reef where participants can snorkel alongside a marine biologist, learn to scuba dive or view tropical fish from a semi-submersible. Also includes a trip to the World Heritage Daintree National Park.

PTAD: A$1,280.00 per person (Based on Double Occupancy)

PTAS: A$2,100.00 per person (Based on Single Occupancy)

PTB: **Dramatic Red Centre**

4 Days/3 Nights

Saturday 2 September – Tuesday 5 September 2006

Features the highlights of Australia's Outback including Uluru (Ayers Rock), Kings Canyon and Kata Tjuta (the Olgas). Includes a visit to the base of Uluru, a tour to Kings Canyon and dinner with sunset views of the Olgas is also included.

PTBD: A$1,450.00 per person (Based on Double Occupancy)

PTBS: A$2,000.00 per person (Based on Single Occupancy)

Field Trips

For a detailed summary of each field trip please visit the Conference website **www.goldschmidt2006.org/field.asp**

Pre-Conference field trips include:

1. Mt Isa: Precambrian tectono-magmatic evolution of the Mount Isa Inlier: insights into the metallogenic and geodynamic significance of potassic 'A-type' magmas.
2. The Great Barrier Reef: A record of Holocene environmental change.
3. Looking below Lachlan Batholiths: Partial melting and intrusive mechanisms in Mid Palaeozoic batholiths, southern NSW.
4. The Taupo Volcanic Zone, New Zealand: Geochemistry in volcanic systems.
5. A geological tour of Western Victoria.

Post-Conference field trips include:

6. New Caledonia: Western Pacific Tectonics and High Pressure-Low Temperature Metamorphism.
7. Proterozoic mineralisation and metamorphism at Broken Hill.
8. The Pilbara Region of Western Australia: Early Archaean environments and evidence for early life.

The final costs for each field trip will be available in April through the Conference website.

FIELD TRIP NO. 1 - PRE-CONFERENCE

Mt Isa: Precambrian tectono-magmatic evolution of the Mount Isa Inlier: insights into the metallogenic and geodynamic significance of potassic 'A-type' magmas.

Leaders: Geordie Mark , Patrick Williams, Lesley Wyborn and others

Precambrian 'A-type' igneous rocks represent a globally important class of magmatism whose petrogenetic and metallogenic significance is highly controversial. The Mount Isa Inlier represents one of the best localities in the world to examine the controversies relating to the geodynamic setting of potassic 'A-type' intrusions, and their potential contributions to terrane metal endowment.

The main of objective of this field trip will be examine the tectono-magmatic evolution of the Mount Isa Inlier, and outline the potential petrochemical and tectonic correlations between magmatism and metallogenesis. In particular, the field trip will focus on the petrogenesis of 1.67-1.50 Ga 'A-type' magmatism, and will highlight the relations between magmatism, mantle activity, tectonic setting and regional plumbing systems. Furthermore, the field trip will examine the broader-scale correlations between

Field Trips

FIELD TRIP NO. 2 - PRE-CONFERENCE

The Great Barrier Reef: A record of Holocene environmental change

Leader: Malcolm McCulloch

Australia's Heritage listed Great Barrier Reef, extends for over 1500 kms and is the worlds largest reef complex made up of more than 2900 individual reefs that began forming more than 2 millions years ago. Several reef tours will be undertaken over a 3-day period from the coastal ports of Cairns and Port Douglas using large luxury wave piercing catamarans. Activities such as snorkelling and swimming can be experienced as well as just relaxing and enjoying the natural beauty of the reef. Overlooking the Great Barrier Reef is an expanse of coastal cliffs, escarpment retreats and volcanic crater lakes that contain world-class rainforests. These scenic variations with a rich array of biodiversity will be visited in a day-trip via coach and Sky Rail. Cairns is accessible via direct international flights.

FIELD TRIP NO. 3 - PRE-CONFERENCE

Looking below Lachlan Batholiths: Partial melting and intrusive mechanisms in Mid Palaeozoic batholiths, southern NSW.

Leaders: Bill Collins and Simon Richards

This excursion examines open-system processes associated with emplacement, growth and chemical evolution of I- and S-type plutons in the Lachlan Fold Belt in SE Australia. Field criteria for recognising pluton stratigraphy, "way-up" structures, syn-plutonic dyke injection, magma mixing and mingling are assessed. A feature is the opportunity to look below plutons, particularly in the I-type Bega and S-type Murrumbidgee batholiths, to examine the various source components that contribute to the chemical character of these "contrasting" plutonic regimes. It will visit classic localities in the coastal Bega Batholith and the well-known migmatite complex at Cooma (a source component of the Murrumbidgee Batholith).

FIELD TRIP NO. 4 - PRE-CONFERENCE

The Taupo Volcanic Zone, New Zealand: Geochemistry in volcanic systems.

Leaders: Ian Smith and Richard Price

The trip will look at geochemical processes in volcanic systems from upper crustal depths through to the surface. This will involve a field trip from the Coromandel Gold Field (conceptually the upper crustal hydrothermal system) through the Bay of Plenty/Rotorua region (surface geothermal activity, White Island) to Ruapehu. Geochemical aspects are water/rock interaction and magmatic processes. Because of the time of year the excursion will not involve visits to the higher (snow-covered) Taupo volcanoes.

The trip will be run as a bus tour for 35 to 45 people, or as a van tour for up to 10, 20 or 30 people. Accommodation will be on a share twin basis in motels/hotels and we suggest an all inclusive meals/ accommodation package.

FIELD TRIP NO. 5 - PRE-CONFERENCE

A geological tour of Western Victoria.

Leaders: Janet Hergt and Jon Woodhead

The western districts of Victoria straddle parts of the Lachlan and Adelaide Fold Belts and are well known for their extensive Cenozoic basalt provinces and associated mantle xenoliths. This excursion is a tour of the scenic and geological highlights of the region west of Melbourne, taking in the magnificent scenery of the Great Ocean Road, remnant Gondwana rainforests, coupled with aspects of granite and basalt magmatism, and gold mineralisation. Conducted using either a coach, or minivans, the excursion fee will include all meals and accommodation.

FIELD TRIP NO. 6 - POST-CONFERENCE

New Caledonia: Western Pacific Tectonics and High Pressure-Low Temperature Metamorphism.

Leaders: Geoff Clarke and Katy Evans

New Caledonia offers a rare opportunity to observe well preserved blueschists and ecologites and a relatively complete ophiolite sequence on a beautiful Pacific island. This trip will use these rocks to investigate the mantle processes and the petrological effects of high pressure metamorphism in the context of the tectonic evolution of the southwest Pacific. Primary aims of the field trip will be to visit the New Caledonia ophiolite nappe, located within one of New Caledonia's gorgeous National Parks, and to study the high pressure Pouebo terrane at the northern end of the island. Additional visits may be made to examine a mass extinction horizon, flysch deposits, density flows, rare high Ca-boninites, and orbicular textures and chromite veins at a chromite mine.

Accommodation for the trip will be a combination of hotel and camping, as some of the key localities are remote from suitable tourist accommodation. Campsites will be equipped with basic facilities. Participants may either bring their own tents or contact the organisers to discuss alternative arrangements, Opportunities to sample the New Caledonian cuisine and wine will be offered whenever possible. This field trip is limited to 20 participants.

FIELD TRIP NO. 7 - POST-CONFERENCE

Proterozoic mineralisation and metamorphism at Broken Hill

Leader: Ian Plimer

Broken Hill is an old mining town with a long history. It is famous for its highly metamorphosed, rich, Zn-Pb-Ag Proterozoic ore deposits from which more that 700 different mineral species are known. The mine is hosted by the Palaeoproterozoic Willyama sequence. The excursion is aimed at evaluating the progenitors of the altered, deformed and metamorphosed lithologies in and around Broken Hill and will visit the mines and regional outcrops, with emphasis on hydrothermal alteration and mineralogy. The Broken Hill Domain is 900km north of Melbourne with air transport via Adelaide. The excursion is four days in length with three nights motel accommodation in Broken Hill.

FIELD TRIP NO. 8 - POST-CONFERENCE

The Pilbara Region of Western Australia: Early Archaean environments and evidence for early life.

Leader: Martin Van Kranendonk

This excursion will visit the well-exposed early Archaean granite-greenstone terrane of the Pilbara Craton, Western Australia, including the famous sites with Earth's oldest putative fossil stromatolites in ca. 3.5-3.4 billion year old rocks at North Pole. The fieldtrip will also highlight the geological setting and tectonic processes involved in the formation of the Pilbara Craton - one of Earth's oldest, best preserved pieces of crust. The fieldtrip will include stops throughout the supracrustal succession, showing the main features of the greenstone stratigraphy and the unconformable nature of the six main, autochthonous groups of rocks that were deposited over 880 million years of Earth history, from 3515-2630 Ma. The fieldtrip will also visit key geological sites that provide clues to the processes responsible for the formation of the uniquely Archaean dome-and-keel geometry of granitoid domes and synclinal greenstones. Fossicking for gold is a possibility, and the stars of the untainted Pilbara skies need to be seen to be believed.

Mineralogical Society of America

Publications Price List and Order Form

Reviews in Mineralogy and Reviews in Mineralogy and Geochemistry (25% member discount)

___v. 08: Kinetics of Geochemical Processes (1981) **$20**
___v. 9B: Amphiboles: Petrology, Phase Relations (1982) **$20**
___v. 10: Characterization of Metamorphism (1982) **$20**
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___v. 13: Micas (1984) **$28**
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___v. 39: Mineral Transformation Processes (2000) **$32**
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