Zircon
Tiny but Timely

The Growth of the Crust

Thermal History of Mountain Chains

Deep Subduction

Rare Earth Elements in Zircon and Melts

Reactions with Fluids and Melts
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The Mineralogical Society of America is composed of individuals interested in mineralogy, crystallography, petrology, and geochemistry, founded in 1919, the Society promotes, through education and research, the understanding and application of mineralogy by industry, universities, government, and the public. Membership benefits include special subscription rates for American Mineralogist as well as other journals, 25% discounts on Reviews in Mineralogy and Geochemistry series and Monographs, Elements, reduced registration fees for MSA meetings and short courses, and participates in a society that supports the many facets of mineralogy. For additional information, contact the MSA business office.

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The Clay Minerals Society (CMS) began as the Clay Minerals Committee of the US National Academy of Sciences – National Research Council in 1952. By 1962, the CMS was incorporated with the primary purpose of stimulating research and disseminating information relating to all aspects of clay science and technology. The CMS holds an annual meeting, workshop, and field trips, and publishes Clays and Clay Minerals and the CMS Workshop Lectures series. Membership benefits include reduced registration fees to the annual meeting, discounts on the CMS Workshop Lectures, and Elements.

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The Geochemical Society is an international nonprofit organization for scientists involved in the practice, study, and teaching of geochemistry. Membership includes a subscription to Elements, access to the online quarterly newsletter Geochemical News, as well as an optional subscription to Geochimica et Cosmochimica Acta (24 issues per year). Members receive discounts on publications (GS Special Publications, MSA, Elsevier/Wiley/Jossey-Bass), and on conference registrations, including the V.M. Goldschmidt Conference, the fall AGU meeting, and the annual GSA meeting.

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The European Association for Geochemistry was founded in 1985 to promote geochemical research and study in Europe. It is now recognized as the premier geochemical organization in Europe encouraging interaction between geochemists and researchers in associated fields, and promoting research and teaching in the public and private sectors.

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The International Association of Geochemistry (IAGC) has been a pre-eminent international geochemical organization for over 40 years. Its principal objectives are to foster cooperation in, and advancement of, applied geochemistry, by sponsoring specialist scientific symposia and the activities organised by its working groups, and by supporting its journal Applied Geochemistry. The administration and activities of IAGC are conducted by its Council, comprising an Executive and ten ordinary members. Day-to-day administration is performed through the IAGC Business Office.

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The Association of Applied Geochemists is an international organization founded in 1970 that specializes in the field of applied geochemistry. Its aims are to promote the science of geochemistry as it relates to exploration and the environment, further the common interests of geochemists, facilitate the acquisition and distribution of scientific knowledge, promote the exchange of information, encourage research and development, advance the status of the profession, and sponsor symposia, seminars and technical meetings.

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The Geological Society of Australia is the professional body for geoscientists and geochemists in Australia, and the peak national body representing the profession outside Australia. Membership benefits include subscriptions to Geology Today, a reduced registration fee at the annual meeting.

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The International Association of Geoanalysts is a worldwide organization supporting the professional interests of those involved in the analysis of geological and environmental materials. Major activities include the management of proficiency testing programmes for both macro- and micro-analytical methods, the production and certification of reference materials and the publication of the Association’s official journal Geostandard and Geoanalytical Research.

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The Mineralogical Society of Poland, founded in 1969, develops the professional and amateur interests in mineralogy, crystallography, petrology, geochemistry and economic geology. The Society promotes links between mineralogical science and education and technology through annual conferences, field trips, invited lectures and publishing. There are two active groups: the Clay Minerals Group, with a membership affiliated with the European Clay Groups Association, and the Petrology Group. Membership benefits include subscriptions to Mineralogia Polonica and Elements.

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The International Mineralogical Association, the European Mineralogical Union, and the International Association for the Study of Clays and Clay Minerals (l latter two are now a single organization) are the highest ranked status reserved for those organizations that serve as an “umbrella” for other groups in the fields of mineralogy, geochemistry, and petrology, but that do not themselves have a membership base.
Now you see it, now you don’t

This issue of *Elements* tells the story of how tiny, rare crystals can give amazing insights into the history of rocks and the earliest days of our planet. The zircon on our cover is all of a third of a millimetre long yet contains evidence of several stages of growth, all of which could be individually dated using the U–Pb method. We can unravel the conditions of growth and crustal residence from isotypes of the common element oxygen and the rare element hafnium, more than a million times less abundant. Zircon provides a perfect marriage of mineralogy with geochemistry – a showcase for the brilliance of modern imaging and analytical methods.

Using the very small to understand the very large is a recurrent theme in Earth sciences and one that has always fascinated me. I haven’t been bold enough to make contributions on a planetary scale, but looking back I get enormous satisfaction from having been a member of a team involved in the production of some primary geochemical maps. So, I’ve looked closely at parts of the Earth on a scale of 100 km (10^5 m) using a hammer, a hand lens, a tent, and most fun of all, a helicopter. More unusually, I’ve also spent many hours, in near-complete darkness, with expert electron microscopists, producing images of mineral textures that can go down to the scale of the crystal lattice, say 1 nm (10^-9 m). That’s a range of 14 orders of magnitude. From the textures I see with these high-resolution microscopes, using the extremely short wavelength of electrons, I can make deductions about the cooling history of the rock, identify phases of fluid–rock interaction, and make progress in understanding the mechanisms by which such reactions occur.

This brings me to the main point of this editorial. Our cover picture is an optical micrograph of a zircon grain mounted between crossed polarizers, a technique invented in 1828 by William Nicol, right here in the University of Edinburgh – a beautiful example of a classic mineralogical image. But what is so special about images taken with a light microscope? Readers who have signed up for MSA’s electronic discussion forum will have seen, a few months ago, a flurry of messages bemoaning pressures inside US universities to reduce the time spent teaching optical mineralogy. Similar pressures exist in the UK and no doubt elsewhere in Europe. In our August issue we ran an article by Dan Kile, of the US Geological Survey, who made a strong case for continuing to teach formal crystal optics in first-degree courses. It may surprise readers to learn that when the editors of *Elements* discussed Dan’s article (by e-mail) we all agreed that long courses of formal instruction in optics were not now necessary for a useful career in Earth sciences. They should not be retained if the price is exclusion of other imaging methods. We respected Dan’s viewpoint, and as we often point out, *Elements* is your magazine, but if push came to shove, your editors would not shed many tears if formal optics took a lesser role. We should use the time to introduce students to the huge range of imaging techniques now available, from the mind-boggling atomic force microscope to expensive techniques like isotopic mapping using an ion probe.

Of course, thin-section work is a vital ingredient in any geologist’s training. It is cheap, quick and particularly good at revealing textural relationships between grains. Without it students would never get a feel for what the Earth is made of and what rocks actually are. But in the UK it is still common to find students dragged early on through a mighty crystal optics course – Fletcher’s indicatrix, determination of optic orientation, pleochroic schemes, interference figures and so on. Is all this really necessary to make routine use of a polarizing microscope? I personally think not. I’d go further. By hitting the unformed student mind early on with crystal optics as the ultimate technique, several generations of petrologists and geochemists have been implanted with the belief that if you can’t see an object under high power in an optical microscope, it isn’t there! I’m reminded of the notice that appears on the mirrors of American cars – ‘Objects in mirror are closer than they appear’. Perhaps lab microscopes should have, engraved around their ocular(s), ‘Objects less than 1/1000 of a mm across will be invisible’. 

Cont’d on page 4
INTRODUCING SUSAN STIPP

It is with great pleasure that the *Elements* editorial staff welcomes Professor Susan Stipp, Geological Institute, Copenhagen University, Denmark, as our next principal editor. Her term began officially on January 1, 2007. She replaces outgoing editor Michael Hochella. Susan brings a wealth of scientific and international experience to her new role. A Canadian by birth, she obtained her BS and MS degrees from the University of Waterloo, where she did graduate work in hydrogeology in one of the most famous natural water science groups in the world. Her PhD, which focused on mineral surface processes relevant to groundwater remediation, was obtained from Stanford University in 1989. Since that time, she has carried out research and taught at the University of Geneva and ETH of Lausanne, Switzerland.

Since 1995, she has been on the faculty of Copenhagen University, where she founded and leads the NanoGeoScience Laboratory. She is currently director of the Nano-Chalk High Tech Fund, a new and very large research effort funded by the Maersk Oil and Gas Venture. She and leads the NanoGeoScience Laboratory. She is currently director of the Nano-Chalk High Tech Fund, a new and very large research effort funded by the Maersk Oil and Gas Venture. She is a member of the Danish Parliament Technology Advisory Panel. In 2004, she organized and ran the international Goldschmidt Conference at her university. Professor Stipp’s vast research, publishing, and editorial experience in low-temperature water-rock interaction, biogeochemistry, and hydrogeology will complement the editorial team nicely. We welcome her to the *Elements* editorial team!

A WORD FROM SUSAN

I am honored to be joining the *Elements* team. When Rod Ewing described the goals of a new publication to the board members of the European Association for Geochemistry and the Geochemical Society at Goldschmidt 2002 in Davos, he dreamed of creating a colourful periodical that would unite mineralogists, petrologists and geochemists and put attractive and understandable information about our work into the hands of people in industry and government. The aim was to show the size and breadth of our community and the power of the research we do. This would strengthen our profile and would provide information for industrial applications, policy making and decisions about research funding.

In its two years of publication, *Elements* has come a long way. It is already uniting our community. Its scientific quality is high. It is now included in the citation index and is doing very well. People outside our field are beginning to know of its existence and ask for it, and it has already become a teaching tool in undergraduate and graduate courses. During my term on the team of principal editors, I hope to help *Elements* become a means for encouraging links between academics and industry through applied research. I hope to help create thematic issues that will allow government officials to understand some of today’s important scientific topics and to see that funding basic research is fundamental to national economic well-being. These goals are not contradictory. Through better communication, academics, industry and government will have a better understanding of geoscience topics and will be able to see the benefits for society of both types of research. *Elements* can be a key player in this communication.

Susan L.S. Stipp

WELCOMING FIVE NEW SOCIETIES

We are thrilled to welcome five new societies to the *Elements* family as of January 2007: the Association of Applied Geochemists, the Deutsche Mineralogische Gesellschaft, the Società Italiana di Mineralogia e Petrologia, the International Association of Geoanalysts, and the Polskie Towarzystwo Mineralogiczne (Mineralogical Society of Poland). This translates into about 2000 new readers. We look forward to their contribution.

ADVERTISERS IN 2007

Our 2006 regular advertisers—RockWare, Rigaku, PANalytical, Meiji, Excalibur, Materials Data, Actlabs, CrystalMaker—all booked advertising again in 2007. We are thankful for their continued business. We also welcome new advertisers in this issue: among others, Thermo Scientific, Australian Scientific Instruments, and Bayerisches Geoinstitut. *Elements* puts our advertisers’ messages in the hands of more than 9,000 mineral scientists, and the income generated from advertising goes a long way towards printing the magazine. This is a mutually beneficial partnership. Currently, advertising content is about 10% of the magazine. One way you, our readers, can help us with advertising is by telling your advertisers you have noticed their ads in *Elements*.

WELCOMING 2000 NEW READERS

If you receive an issue of *Elements* for the first time, you have either just joined one of *Elements* founding Societies or you belong to one of the five societies that joined as of January 2007.

MEMBERS OF THE FOLLOWING SOCIETIES RECEIVE *ELEMENTS* AS A MEMBER BENEFIT.

- European Association for Geochemistry
- Geochemical Society
- International Association of GeoChemistry
- Mineralogical Association of Canada
- Mineralogical Society of America
- Mineralogical Society of Great Britain and Ireland
- Società Francese di Mineralogia et Cristallographie
- The Clay Minerals Society

NEW SOCIETIES AS OF JANUARY 2007

- Association of Applied Geochemists
- Deutsche Mineralogische Gesellschaft
- Società Italiana di Mineralogia e Petrologia
- International Association of Geoanalysts
- Polskie Towarzystwo Mineralogiczne (Mineralogical Society of Poland)

SUBSCRIBERS TO THE FOLLOWING JOURNALS ALSO RECEIVE ONE COPY OF *ELEMENTS*

- American Mineralogist
- Clay Minerals
- Clays and Clay Minerals
- MINABS Online
- Mineralogical Magazine
- The Canadian Mineralogist

Cont’d from page 3

Now you see it, now you don’t

A cubic micron of a typical silicate contains around a billion unit cells, each composed of several tens of atoms – plenty of space for all manner of defects, dislocations, twins, exsolution textures, zoning, subgrains, solid inclusions, fluid inclusions... For routine exsolution textures, zoning, subgrains, solid inclusions, fluid inclusions... For routine microscopy, we may be on very shaky ground indeed. And the ‘ordinary’ crystals to which we later apply these coefficients are each likely to be replete with an inventory of sub-optical features which may or may not be relevant. New devices are on inventory of sub-optical features which may or may not be relevant. New devices are on shaky ground indeed. And the ‘ordinary’ crystals to which we later apply these coefficients are each likely to be replete with an inventory of sub-optical features which may or may not be relevant. New devices are on the horizon, such as cheap, miniaturized Raman spectrometers, that will make the identification of many minerals semi-auto-matic. Optical microscopy will remain the method of choice for petrography, but we should trade the time that students often now spend on optical theory for at least a superficial introduction to the whole wonderful world of imaging techniques that the 21st century provides.

Ian Parsons
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From the Editors
ADVERTISING
We recently celebrated the 50th anniversary of the discovery of DNA. I studied with a social problem in scientific questions that have already been well studied. Relevant issues produce the same effect, as it is easier to find a link. Application reviewers will easily agree with us? Obviously, both the risks and the information provided by the project are reduced. The need to study relevant issues produces the same effect, as it is easier to find a link with a social problem in scientific questions that have already been well studied.

We recently celebrated the 50th anniversary of the discovery of DNA. I wonder what Lawrence Bragg, then Head of the Cavendish Laboratory, would have needed to write in a modern project proposal to obtain funds for the projects in which Watson and Crick would work. For example, “Risks: the postdoctoral research associate (Watson) or PhD student (Crick) may neglect their respective research projects and engage in some other study of their fancy (as they did). Expected results: they may end up discovering something of far greater importance. Relevance: …” The relevance of their discovery needs no comment. I suppose that a modern funding agency would have banned Bragg from receiving further funds as he proved to be such a poor project manager.

This is only one example, but it is a paradigm of how science works. Science is a mental activity more than a commercial operation, and scientific discovery is not driven by relevance but by curiosity. Scientists are stimulated to pursue answers to scientific questions by the desire to know, and not by the desire to solve socio-economic problems. All of us have colleagues who admit that they engage in some scientific projects so as to have the resources to work on the projects that really interest them. I believe that funding bodies should maintain a strong financial support of curiosity-driven science, as this type of research has produced and will continue to produce the important scientific quantum leaps and the most relevant information.

Javier Cuadros
London, United Kingdom

I have just finished reading your thoughtful “Triple Point” editorial in the October issue of Elements. I am now retired from the Smithsonian, but I would like to tell you how I dealt with the problem of anonymity in the peer-review process for over 40 years. Early in my scientific career, whenever I was given the option, I always signed my reviews. My reasoning was that if I hid behind the veil of anonymity I could easily make “pot-shot” criticisms. However, if I signed my review I would have to keep it fair and balanced...

I have made it my personal policy always to write a separate letter to every author whose paper I review. I tell the author that I am writing simply to inform him/her that I have been asked by the editors to referee the paper. I further state that if he/she did not receive a copy of my signed review from the editors, or wished to discuss some aspect of it with me, they should feel free to contact me. This has allowed me to be as objective and respectful as possible, whether critical or not, and it has avoided the usual speculation on the part of the author as to who the critic might be. After hundreds of reviews I have found this approach to be very satisfying.

As a former editor or associate editor myself (Clays and Clay Minerals; Journal of Foraminiferal Research; American Mineralogist), I was able to see how authors and referees treated one another. I concluded that the signed reviews were the best and most respectful, but I also noted that usually they were signed only when the paper was deemed worthy or there were only minor suggestions and criticisms. Referees recommending outright rejection rarely wanted their names added.

Clearly, there is no simple solution to the problem. For me, however, making myself known to the author has forced me to tone it down on occasion and be sure of my position. I consider open review “vital to the integrity” of my system. The scientific enterprise is not seriously threatened by the open review. It is dogmatists who don’t have the courage of their convictions to stand behind their criticisms who are threatened!

Kenneth M. Towe, Tennille, GA

The review process is best when done openly, as a conversation amongst the author, reviewers and editor. The goal of this conversation is to create the best possible science, written to the best possible standards of clarity and quality. Obviously, this conversation must examine the merits of the science and the presentation in a thorough and, yes, critical fashion. I looked up “criticism,” and found that only one of the six definitions is a thoroughly negative act. If one denies that both the capacity to evaluate a piece of science critically and an ability to respond to such criticism are part of the scientific enterprise, one doesn’t fully understand science... Discourse has been a part of science since Aristotle, but effective discourse cannot take place when everyone is hiding behind a mask!

Sorena Sorensen
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MINERALOGY AND THE COMPOSITION OF AN AMERICAN SCIENCE

On February 1, 1958, Leonard Bernstein conducted the second of his Young People's Concerts in Carnegie Hall. He entitled his lecture “What is American Music?” It is telling that Bernstein selected this topic near the beginning of his decade-long series – before his dissection of symphonic form or even his review of the instruments in the orchestra. Americans are afflicted with a restless itch to define themselves, and only four months after the launch of Sputnik and at the height of the Cold War, Bernstein was trying to satisfy the country’s craving for a righteous national identity.

Not surprisingly, Bernstein focused on that most democratic of musical idioms – jazz, which was born in the saloons and brothels of America’s inner cities and which eschewed the formal structures created by the great European masters. Bernstein argued that classical music in America matured along a prescribed path. In its infancy, native composers weakly mimicked the styles of Beethoven and Brahms. Later, under the benign influence of Antonin Dvorak, serious music in this country drew from Native American and African American songs and spirituals for their ideas, but it was so self-consciously imitative that these works are largely forgotten.

Classical music that could justly claim the label of “American” required the emergence of an art form that borrowed from as many sources as there are ethnicities in this melting pot of a country. In the 1920s, Bernstein asserted, “the jazz influence became a part of living and breathing, became a habit, and the composers didn’t have to think twice about using jazz; they just wrote music, and it came out American, all by itself.” Even when pieces were not intentionally jazzy, the syncopations and harmonics of jazz had infused themselves so integrally into the sinew of musical culture that they have come to embody a sound that the world recognizes as American. Bernstein’s rapturous discourse on the birth of an American musical style must strike a chord with many readers of this journal. The evolution of the dynamo that is modern American science can be rendered using precisely the same motifs. And mineralogy is the jazz of American science.

The Gershwynesque figure in this history is Benjamin Silliman. Vaguely known to most geologists today through the eponymous aluminosilicate mineral, Silliman was unarguably the most famous scientist in the United States during the first half of the nineteenth century. A professor of chemistry and mineralogy at Yale from 1801 to 1853, he was the first president of the Association of American Geologists (known today as the American Association for the Advancement of Science). For three decades, he was one of the most actively sought members of the lyceum circuit and lectured all over the country. He also served as a founding member of the National Academy of Sciences.

Yet even Chandos Brown, his most trenchant biographer, is forced to acknowledge an uncomfortable fact: “Silliman’s contributions to science, as such, were negligible.” Unlike his younger contemporaries, who included Lyell and Darwin in Europe and Agassiz in the States, Silliman fomented no revolutions that are grist for today’s undergraduate textbooks. What distinguished Silliman from his colleagues was a vision of science as a national ambition. As with music, American science in 1800 was a pale and fragmentary facsimile of the European model. With a clarity of insight that seems breathtaking in retrospect, Silliman knew that American scientists were destined to labor in the shadow of those intellectual giants across the Atlantic unless they unshackled themselves from local allegiances and united as a professional society. What could bind a severely balkanized assortment of intellectuals? Silliman realized that a magazine to which naturalists from every region of the country could contribute would rivet the community together.

The prototype for such a periodical already existed. It was The American Mineralogical Journal, which one historian has called “the first purely scientific journal in North America.” Founded by Dr. Archibald Bruce, a professor of materia medica and mineralogy at the College of Physicians and Surgeons in New York, it appeared in 1810. A lack of financial support and medical rivalries that entangled Bruce, however, led to its sporadic publication and ultimate demise in 1817. Anxious that the loss of this organ would seriously inhibit the growth of science, Silliman single-handedly gave birth to its successor, The American Journal of Science, which thrives to this day.

Two features of this infant magazine strike the modern reader. The first is its unabashed appeal for a scientific nationalism. Silliman stated that it was “designed as a deposit for original American communications” that would lead “in no small degree to nourish enlarged patriotism, by winning the public mind from the odious aspersities of party.” As biographer Brown eloquently describes, Silliman’s efforts to distribute the Journal throughout the fledgling country required herculean persistence. No public mail system existed for the national dissemination of the volumes, and Silliman in effect had to create a countrywide delivery network by contracting subscription agents. Moreover, only 400 of the 1200 recipients of the first volume remitted payment, and Silliman was forced time and again to dip into his personal financial reserves to keep the Journal alive.

Secondly, it is no accident that mineral sciences served as the focus of Bruce’s journal and of Silliman’s. The extended title of the original version is a testament: The American Journal of Science, More Especially of Mineralogy, Geology, and the Other Branches of Natural History. The intimate connection between mineralogy and the rise of a national science is captured in Bernstein’s thesis. Astronomy, physics, and chemistry can be equally well studied on any part of the Earth, but the Old World boasted an insuperable lead in these subjects. Americans had to distinguish themselves from their foreign counterparts by excelling in a branch of science that sprung from native roots and was protected from alien encroachment. Mineralogy filled that promise, because mineralogy is uniquely local and global. The rocks from Maine to Georgia may have analogs in the Alps and the Himalayas, but they are still the tissue of the North American continent. Native mineralogy may be applied across the oceans, but it is always particular to its home. It is the folk music from which a young country can craft a scientific identity.

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FROST AND ERNST HONORED AT 2006 MSA AWARDS LUNCHEON

The eighty-seventh annual awards luncheon of the Mineralogical Society of America was held on October 24, 2006, during the 2006 Geological Society of America meeting in Philadelphia, Pennsylvania. Medallists were Daniel Frost (MSA Award) and W. Gary Ernst (Roebling Medal).

Daniel Frost received the Mineralogical Society of America Award for outstanding research early in one’s career. Daniel Frost received a Bachelor of Science degree in geology and chemistry from the University of London, Royal Holloway College. His PhD research, at the Department of Earth Sciences of the University of Bristol under the supervision of Bernie Wood, focused on redox reactions involving fluids at high pressures and temperatures. He became a permanent member of staff of the Bayerisches Geoinstitut of the University of Bayreuth (Germany) in 2001, where he had been a research assistant since 1998. For the last few years he has investigated phase transformations in multicomponent mantle minerals and he has carried out studies on the redox state of the deep mantle and the processes that resulted in terrestrial core formation.

W. Gary Ernst was awarded the Roebling Medal, the Society’s highest honor, in recognition of lifetime scientific achievement. Gary Ernst received his BA from Carleton College (1953), MS from the University of Minnesota (1955), and PhD from the Johns Hopkins University (1959). After predoctoral and postdoctoral studies at the Geophysical Laboratory (1955–59), Ernst joined the UCLA faculty in 1960, and became Dean of the School of Earth Sciences at Stanford University in 1989. Ernst has earned many awards and honors (including the MSA Award in 1969), and has ably contributed to the Earth science field, including serving terms as president of MSA (1980–81) and president of the Geological Society of America (1985–86). Ernst has authored seven books and research memoirs, is an editor of 18 scholarly volumes, and is the author of more than 200 scientific papers on the physical chemistry of rocks, minerals, and mineraloids; Phanerozoic plate tectonics and the evolution of mountain belts, especially in central Asia, the Circum-Pacific, and the western Alps; early Precambrian petrotectonic evolution; ultrahigh-pressure subduction-zone metamorphism and tectonics; geobotanical studies in the western US; Earth system science and remote sensing; and geology and human health.

FALKO LANGENHORST AWARDED A 2007 GOTTFRIED WILHELM LEIBNIZ PRIZE

Falko Langenhorst has received a 2007 Gottfried Wilhelm Leibniz Prize awarded by the German Research Society (DFG). The Gottfried Wilhelm Leibniz Prize is the highest honour awarded in German research. Prof. Dr. Falko Langenhorst is one of 10 exceptional German scientists and academics to be so honored for their outstanding achievements in experimental and instrumentation-related fields. The prize is valued at 2.5 million euro (about US$3.2 million), and the money can be used flexibly over a period of seven years to finance independent research.

Falko Langenhorst investigates the impact records of celestial bodies colliding with Earth and with other planets and moons. Impacts have played a major role in the evolution of our planet and the solar system. He focuses on the basic physics and chemistry of impact processes and their effects on the biosphere (“astromineralogy”). Falko Langenhorst was the first to detect high-pressure minerals in the Martian meteorite Zagami, which had been ejected from the surface of Mars by another meteorite and flung all the way to Earth. Langenhorst has been able to determine a pressure of about 300,000 bars and a temperature of 2400 to 2500 degrees Celsius for the impact event that produced this Martian meteorite. He has also received great international attention for his research on the crystal chemistry of perovskite, a main component of Earth’s lower mantle.

Falko Langenhorst studied mineralogy in Gießen and Münster, where he received his PhD in 1993, before he went to Lille as a postdoctoral researcher. Since 2004 he has held the chair for general and applied mineralogy in Jena. His high international reputation is reflected in numerous honors, such as his membership in the Academia Europaea and a fellowship from the Japanese Society for the Promotion of Science.
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ing events in the construction of Gondwana. This led him to carry out integrated field, microanalytical and experimental studies related to geothermobarometry and mineral assemblages, anatexis and melt-related processes, mineral monitors of fluid activity and the relationships that exist among mineral geochronometers, events and processes in the deep crust. This has stimulated his interest in zircon and its response to high-temperature metamorphism. He has applied this integrated research strategy to, amongst other things, the unravelling of the metamorphic and tectonic evolution of ancient crust in Antarctica and Greenland and to defining events in the construction of Gondwana.

John M. Hanchar is a professor and head of the Department of Earth Sciences at Memorial University of Newfoundland, Canada. He received his PhD from Rensselaer Polytechnic Institute under the direction of Professor E. Bruce Watson. Previously, he was an assistant and then associate professor of geosciences in the Department of Earth and Environmental Sciences at the George Washington University in Washington, DC. His research interests span trace element and experimental geochemistry and materials science and include designing materials for storage of radioactive waste, the effects of self-irradiation of short-lived, artificial and natural radionuclides, and the trace element, radiogenic isotope, and stable isotope compositions of accessory minerals.

Daniela Rubatto is a fellow at the Australian National University in Canberra. She moved “down under” after a degree at the University of Torino, Italy, and a PhD at the ETH in Zürich, Switzerland, where she was first introduced to zircon. She combines her experience as a metamorphic petrologist and geochronologist in studying the behavior of accessory minerals during metamorphism, particularly at high pressures and/or high temperatures. Daniela is a strong advocate of the need to link ages from accessory minerals to metamorphic conditions, particularly using trace elements. She is also interested in the rates of metamorphic processes and mountain building.

Urs Schaltegger is a professor of geochronology at the University of Zürich, Switzerland. He directs a radiogenic isotope laboratory, which features two thermal ionization mass spectrometers and one gas mass spectrometer, and carries out research on the chronometry of geological processes. His research interests have been focused for a long time on the understanding of the dynamics of orogenic processes, especially their rates and durations. For this he uses mainly high-precision U–Pb dating of zircon, monazite and other accessory minerals, as well as other radiogenic parent–daughter systems for precise age determinations. He serves on national scientific committees and on the editorial boards and as a referee for various journals.

Thorsten Geisler studied mineralogy at the University of Hamburg (Germany), where he also received his doctoral degree. After a postdoctoral period at the Curtin University of Technology in Perth (Australia) and at the Department of Earth Sciences in Cambridge (UK), he moved to the University of Münster (Germany) to take up a position, which he still holds, as assistant professor at the Institute for Mineralogy. At present, his scientific interests focus on the mechanisms, kinetics, and thermodynamics of mineral–fluid interactions.

Jörg Hermann is a fellow at the Australian National University in Canberra. He completed a master’s degree and a PhD at the ETH in Zürich, Switzerland, in metamorphic petrology, structural geology, and tectonics. At the ANU, his focus switched to experimental petrology and the trace element geochemistry of metamorphic rocks. He is currently working on an interdisciplinary approach to constrain element mobility in subduction zones using high-pressure experiments and deeply subducted rocks as a natural laboratory. Other research interests include the use of trace elements to constrain high-grade metamorphic processes and the water content of mantle minerals.

Nigel M. Kelly is a postdoctoral researcher in the Grant Institute of Earth Science, University of Edinburgh. He received his PhD in geology from the University of Sydney. His research interests include the tectonothermal evolution of ancient orogenic belts as keys to understanding the behaviour of the continental crust, both now and in the past, and involve field work in places such as Antarctica, Greenland, NW Scotland and central Australia. This work has led to a focus on the behavior of dateable accessory minerals during metamorphism and on how these minerals help us place constraints on the rates of orogenic events and act as tracers of many geological processes.

Simon L. Harley is professor of lower crustal processes at the University of Edinburgh. His long-term interest in the origin and evolution of granulites, especially under extreme temperature conditions, has led him to carry out integrated field, microanalytical and experimental studies related to geothermobarometry and mineral assemblages, anatexis and melt-related processes, mineral monitors of fluid activity and the relationships that exist among mineral geochronometers, events and processes in the deep crust. This has stimulated his interest in zircon and its response to high-temperature metamorphism. He has applied this integrated research strategy to, amongst other things, the unravelling of the metamorphic and tectonic evolution of ancient crust in Antarctica and Greenland and to defining events in the construction of Gondwana.

Andreas Möller is a research fellow at the Universität Potsdam, Germany. He received a diploma in geology from the Christian-Albrechts-Universität in Kiel and in 1996 a doctorate from the same institution for his study of the petrology and geochronology of Palaeoproterozoic eclogites and Pan-African granulites in Tanzania. The radiogenic isotope work was carried out during a year at the Max-Planck-Institut für Chemie in Mainz. After postdoctoral positions at the University of New South Wales (Sydney) and the Johannes-Gutenberg Universität in Mainz, he came to Potsdam in 2001. He uses in situ analytical techniques to link textural, geochemical, and isotopic information for the understanding of metamorphic processes, with special focus on high-temperature terranes.

Carsten Münker is a professor of geochronology at Universität Bonn, Germany, since 2004. He received his doctorate at Universität Göttingen in 1997. After a postdoctoral research fellowship at the University of Tasmania, Australia, he was based at Universität Münster in Germany until 2004. His current research interests focus on cosmochemistry, the evolution of the early Earth, and igneous geochemistry. Another focus is the application of multiple collector – inductively coupled plasma – mass spectrometry (MC–ICP–MS) to current problems in Earth sciences. Major research topics include the application of short- and long-lived chronometers (Lu–Hf, Hf–W, Nb–Zr) and high-precision measurements of the concentration of trace elements such as the high field strength elements, to better assess their mass budget on Earth.
Erik E. Scherer is a junior professor at the Institut für Mineralogie, Westfälische Wilhelms-Universität Münster. He received his BA degree in geology from Colgate University and his PhD in geochemistry from the University of California–Santa Cruz. His current research interests include the early differentiation of Earth, the growth of continents, the evolution of the lower crust, and the fractionation of trace elements by eclogite and blueschist in subduction zones. He also works on improvements in geochronology, such as recalibrating decay constants and developing new ways to date metamorphic and sedimentary rocks.

Frank Tomaschek is interested in the relations between the petrological and geochronological aspects of zircon. His PhD studies at the Universität Münster focused on the zircon–xenotime miscibility gap and the factors controlling the stability and transformation mechanism of zircon solid solutions in natural and experimental systems. He enjoys blending mineralogical and geochronological approaches to address geological questions in his principal field area, the high-pressure metamorphic rocks of the Cycladic Islands.

Wim van Westrenen is a lecturer in mineralogy at the Vrije Universiteit Amsterdam. He studied geochemistry at Utrecht University and received his PhD in experimental geochemistry from the University of Bristol in 2000. Wim held postdoctoral positions in high-pressure laboratories at the Carnegie Institution of Washington and ETH Zürich before accepting a position below sea-level in the Netherlands in 2005. His research aims at understanding large-scale differentiation processes in the interiors of the Earth and the Moon using high-pressure and high-temperature experimental techniques.

Martin J. Whitehouse is a senior research fellow and director of the Nordic ion microprobe consortium (Nordsim) at the Swedish Museum of Natural History in Stockholm. His interest in applying isotope geochemistry to crustal evolution began with his PhD (University of Oxford, 1987) on the late Archean Lewisian Complex of NW Scotland. Since then his research activities have spanned nearly the entire geological age spectrum, from Hadean zircons to Miocene orogenic belts, and have recently expanded to include lunar and meteoritic samples. High-spatial-resolution radiogenic and stable isotope analyses using the ion microprobe at Nordsim now form a key component of most of his studies.
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