THIS ISSUE

"Nano" has become a very fashionable word, and as guest editor Mike Hochella points out in his lead article, nanotechnology is now a multibillion-dollar business. This issue brings to the fore the fact that nanoparticles have always been part of our environment, hence the importance of studying natural nanoparticles and their impact on our health and environment in order to illuminate the potential impact of engineered nanoparticles. This issue also makes clear that every crystal goes through a "nano" phase in its growth. One can also be awed by the fact that we are on the verge of acquiring the technological capability to image the structure of single nanoparticles.

FOUR YEARS OLD!

With this issue, we close our fourth year of publication. We have now explored 23 widely ranging topics of relevance to our scientific community and beyond, and the list of potential topics seems to get longer and longer. This is a reminder that we are always looking for proposals for future topics. If you have an idea, contact one of the principal editors. We are now booking themes for 2010.

Among this year's milestones are a rising impact factor (2.23 in 2007), a print run that has reached 13,000 copies for the last three issues of this year, and an updated website.

OUR 2009 LINEUP

In the following two pages, we proudly present an overview of the topics selected for 2009. All the guest editors and authors for these issues are hard at work already.

THANKS TO THE AUTHORS AND GUEST EDITORS OF VOLUME 4

Once again we are indebted to a multitude of persons who have helped *Elements* along, especially the guest editors and authors who have worked diligently to write at the level we are striving for in the journal. Our thanks go to volume 4 guest editors Jay D. Bass, James M. Brenan, David R. Cole, Michael F. Hochella Jr., Calvin F. Miller, James E. Mungall, Eric H. Oelkers, John B. Parise, David A. Wark, and Eugenia Valsami-Jones.

We are also grateful to the authors of volume 4: Kouji Adachi, E. Eric Adams, Olivier Alard, Olivier Bachmann, James Badro, John R. Bargar, Jay D. Bass, Sally M. Benson, George Bergantz, Rizlan Bernier-Latmani, Stephen Blake, James M. Brenan, Peter R. Buseck, Ken Caldeira, Richard W. Carlson, David R. Cole, Gabriel M. Filippelli, Guillaume Fiquet, Daniel J. Frost, Daniel E. Giammar, Siggi R. Gislason, François Guyot, Martin Hassellöv, Kei Hirose, Michael F. Hochella Jr., Shaul Hurwitz, Shun-ichiro Karato, David A. John, Thorne Lay, Baosheng Li, Jean-Pierre Lorand, Jacob B. Lowenstern, Ambre Luguet, David A. C. Manning, Juerg Matter, Jean-Marc Montel, Gregory M. Morrison, James E. Mungall, Anthony J. Naldrett, Eric H. Oelkers, Herbert Palme, John B. Parise, Simon A. Parsons, Jill D. Pasteris, Sebastien Rauch, Mary R. Reid, Edward S. Rubin, Maria Schönbächler, Stephen Self, Steven B. Shirey, Stanislav V. Sinogeikin, Jennifer A. Smith, Bradley M. Tebo, Benny K. G. Theng, Eugenia Valsami-Jones, Frank von der Kammer, Donald J. Weidner, Glenn A. Waychunas, Colin J. N. Wilson, Brigitte Wopenka, Zhengjiu Xu, Guodong Yuan, Hengzhong Zhang, and Youzue Zhang.

Bruce Watson, Susan Stipp, David Vaughan, and **Pierrette Tremblay**

EDITORIAL *(Cont'd from page 363)*

Finally, to answer the question posed in the headline to this editorial, I do believe that great (nanogeo)science is being done, as the following articles attest. As for our being turned into grey goo, I would put the risks of that at around a zillion to one against – but we certainly do need rigorous studies of the environmental and health risks of nanotechnology.

David J. Vaughan
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WANTED

The Hudson Institute of Mineralogy, a not-for-profit organization chartered by the Board of Regents of the State University of New York, is seeking used analytical equipment, thin sections, and mineral specimens for its descriptive mineralogical laboratory and educational programs. We are dedicated to classical mineralogical research, preservation of mineral specimens, and educational outreach to primary and secondary school teachers and students. If your institution is upgrading its analytical equipment, we want your used, working devices. Further, if you are disposing of minerals, thin sections, or similar geological artifacts, let us put them to good use; æsthetics are unimportant, labels are! Please contact:

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Deserving special mention are RockWare and Excalibur, both regular advertisers since our inaugural issue and continuing in 2009. Next are Rigaku and Meiji, both of which have advertised since volume 1, number 2.

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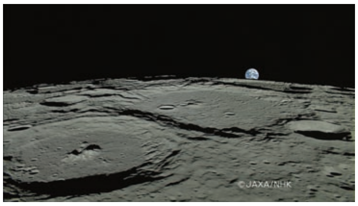
Carleton University, National Science Fondation, Laurentian University, Pacific Northwest, National Laboratory, Stony Brook University, Rensselaer Polytechnic Institute, Rigaku, Texas A & M, University of Bayreuth, University of Buffalo, University of Calgary, University of Delaware, University of Manitoba, University of British Columbia, University of New Brunswick, University of Michigan, University of Wyoming, Vanderbilt University, Washington University.

Thematic Topics in 2009

Volume 5, Number 1 (February 2009)

SCIENTIFIC EXPLORATION OF THE MOON

GUEST EDITOR: **John W. Delano**
(University at Albany, State University of New York)



An HDTV instrument on board Japan's KAGUYA spacecraft acquired this image from lunar orbit on April 5, 2008. The large crater in the foreground is Plaskett (109 km diameter). The large crater in the background is Rozhdestvenskiy (177 km diameter). Earth is visible on the horizon. IMAGE COURTESY OF THE JAPAN AEROSPACE EXPLORATION AGENCY (JAXA) AND NHK

Our current understanding of the Moon's history, interior structure, and chemical composition is based in large part on geochemical data acquired from samples from the U.S. Apollo and Soviet Luna missions; data acquired by Apollo geophysical instruments; orbital geochemical and spectral data acquired by robotic missions from the U.S., Japan, and China; analysis of lunar meteorites derived from previously unsampled regions of the Moon; and Earth-based radar observations and infrared spectral reflectance data. All of these efforts have contributed to a preliminary understanding of the origin of the Moon and the processes that have affected its surface and interior. Isotopic analyses of impact-generated samples have placed constraints on the time-dependent meteorite flux that not only affected the Moon but also the Earth and other objects in the inner solar system. In this issue of *Elements*, leading scientists discuss the major concepts that underpin our current understanding of the Moon, as well as scientific plans for international scientific exploration by robotic and human missions.

Ancient lunar crust: Origin, composition, and implications
G. Jeffrey Taylor (University of Hawai'i)

The lunar cataclysm: Reality or 'mythconception'?
Marc D. Norman (Australian National University)

Lunar mare volcanism: Where did the magmas come from?
Timothy L. Grove (Massachusetts Institute of Technology)

The interior of the Moon: What does geophysics have to say?
Mark Wieczorek (Institut de Physique du Globe de Paris)

The poles of the Moon
Paul G. Lucey (University of Hawai'i)

Volume 5, Number 2 (April 2009)

BENTONITES – VERSATILE CLAYS

GUEST EDITOR: **Derek C. Bain** (The Macaulay Institute)

The "Piepans" is a strongly uplifted, middle-Cretaceous, Na-bentonite deposit located in the Frontier Formation in the Big Horn Basin of northwestern Wyoming, USA. The deposit is a unique example of erosional sculpturing. Each "pan" is approximately 15 metres wide at the base and 35 metres high, while the bentonite layer is approximately 3 metres thick. PHOTOGRAPH BY WYO-BEN, INC.

Of all naturally occurring clays, bentonites are arguably the most interesting, versatile and useful. This issue of *Elements* describes how these fascinating materials occur and how they are used in all manner of applications. Composed predominantly of swelling minerals (smectites) and formed mainly from the alteration of volcanoclastic rocks, bentonites are used by geologists for stratigraphic correlation. Bentonite deposits are mined worldwide as they are commercially very valuable. Because of their physicochemical properties, bentonites are used in a wide variety of industrial applications, including the drilling industry, foundries, civil engineering, adsorbents, filtering, etc. Recent formulations of polymer–smectite nanocomposites have been used in industry to make new materials with amazing properties and diverse applications. Bentonites play an important role in the protection of the environment from industrial waste and pollutants and have also been used in medical applications in human health.

Bentonites – Clays for many functions
Necip Guven (Texas Tech University)

Geological aspects and genesis of bentonites
George E. Christidis (Technical University of Crete) and Warren D. Huff (University of Cincinnati)

Bentonite and its impact on modern life
Don D. Eisenhour (Amcol International) and Richard K. Brown (Wyo-Ben Inc.)

Bentonite, bandaids, and borborygmi
Lynda B. Williams and Shelley E. Haydel (Arizona State University), and Ray E. Ferrell Jr. (Louisiana State University)

Bentonite clay keeps pollutants at bay
Will P. Gates and Abdelmalek Bouazza (Monash University), and G. Jock Churchman (University of Adelaide)

Acid activation of bentonites and polymer–clay nanocomposites
Kathleen A. Carrado (Argonne National Laboratory) and Peter Komadel (Slovak Academy of Sciences)

Volume 5, Number 3 (June 2009)

GEMS

GUEST EDITORS: **Emmanuel Fritsch** and **Benjamin Rondeau**
(Université de Nantes)

The term "gem" covers a large range of products: single crystals (diamond), amorphous minerals (opal), organics (pearl), rocks (lapis, jade), imitations (glass), synthetics, treated stones (Be-diffused corundum), faceted or rough objects, and even assemblages of various materials (inlay or intarsia). This composite picture shows, from top to bottom: a natural jadeite-jade carving; lapis lazuli with matrix, accompanied by a high-quality lapis cabochon in front; a precious boulder opal-A from Queensland, Australia; a pear-shaped, briolette-cut near-colorless glass; a slightly dissolved octahedral diamond crystal; a gem intarsia by N. Medvedev (containing malachite, opal, lapis, turquoise, and purple sugilite); a red andesine feldspar; a beryllium-diffused orangy-red sapphire; a dyed green jadeite cabochon; and five white to golden South Sea beaded cultured pearls. PHOTO BY R. W ELDON, COURTESY GIA

Most gems are natural minerals, which, although scarce and small, have a major impact on society. Their value is directly related to proper identification. The determination of the species is key, of course, and must be done non-destructively. This is where classical tools of mineralogy come into play. However, other issues are paramount: Has this gem been treated? Is it natural or was it grown in a laboratory? For certain varieties, being able to tell the geographical provenance may enhance value considerably. These issues necessitate cross-linking the formation of gems with their trace-element chemistry. These unusual mineralogical and geochemical challenges make the specificity of gemology, a new and growing science, one of the possible futures of mineralogy.

Gemology, the emerging science of gems
Emmanuel Fritsch and Benjamin Rondeau (Université de Nantes – CNRS)

The formation of gem minerals: When Mother Nature cooks the right recipe
Lee Groat (University of British Columbia) and Brendan Laurs (Gemological Institute of America)

The geochemistry of gems and its relevance to gemology: Different traces, different prices
George Rossman (California Institute of Technology)

The identification of faceted gemstones: From the naked eye to laboratory techniques
Franck Notari (GemtechLab) and Bertrand Devouard (Université Blaise Pascal – CNRS)

Seeking cheap perfection: Synthetic gems
Robert E. Kane (Fine Gems International)

Cont'd on page 366

Thematic Topics in 2009

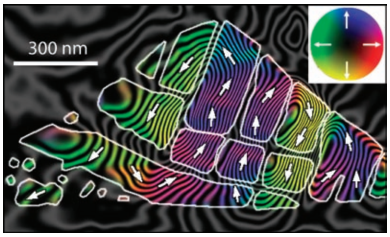
Improving on nature: Treatments
James E. Shigley and Shane F. McClure (Gemological Institute of America)

Pearls and corals: Trendy biomineralizations
Jean-Pierre Gauthier (Lyon) and Stefanos Karampelas (University of Thessaloniki and Université de Nantes)

Volume 5, Number 4 (August 2009)

MINERAL MAGNETISM: FROM MICROBES TO METEORITES

Guest Editors: **Richard J. Harrison** (University of Cambridge) and **Joshua M. Feinberg** (University of Minnesota)



An example of a fully processed electron hologram showing a cross-section through a magnetite/ulvöspinel inclusion exsolved in clinopyroxene. This particular image was collected at 89 K (-184°C). White lines indicate the outline of individual magnetite grains. The magnetization in the plane of the image is indicated using contours, colors, and arrows. The hologram shows the magnetic induction within and between magnetite grains, allowing for the study of non-uniform magnetization within individual grains as well as magnetostatic interactions among populations of grains.

Magnetic minerals are ubiquitous in the natural environment. They are also present in a wide range of biological organisms, from bacteria to human beings. These minerals carry a wealth of information encoded in their magnetic properties. Mineral magnetism decodes this information and applies it to an ever increasing range of geoscience problems, from the origin of magnetic anomalies on Mars to quantifying variations in Earth's paleoclimate. The last ten years have seen a striking improvement in our ability to detect and image, with higher and higher resolution, the magnetization of minerals in geological and biological samples. This issue is devoted to some of the most exciting recent developments in mineral magnetism and their applications to Earth and environmental sciences, astrophysics, and biology.

Mineral magnetism: Providing new insights into geoscience processes
Richard J. Harrison (University of Cambridge) and Joshua M. Feinberg (University of Minnesota)

Magnetic monitoring of climate and environmental health
Barbara Maher (Lancaster University)

Single-crystal paleomagnetism
John Tarduno (University of Rochester)

Insights into biomagnetism using electron holography and electron tomography
Mihaly Posfai (University of Pannonia) and Rafal Dunin-Borkowski (Technical University of Denmark)

Extraterrestrial magnetism
Benjamin Weiss (MIT) and Pierre Rochette (CEREGE)

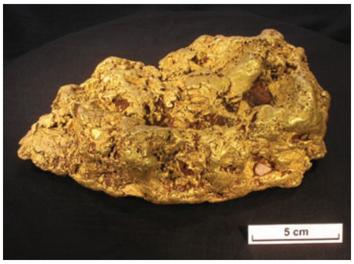
Sedimentary magnetism
Lisa Tauxe (University of California–San Diego)

Volume 5, Number 5 (October 2009)

GOLD

Guest Editors: **Robert Hough** and **Charles Butt** (CSIRO Exploration and Mining, Australia)

Gold fascinates researchers in many sciences. As well as being attractive as a precious metal, gold has important physical and electrical properties that cause it to be an 'advanced material' for manufacturing and drug delivery in medical science. Geologically, gold can be transported in solution in ambient- as well as high-temperature fluids, and its mineralogy, composition and crystallography are often used to decipher and interpret the genesis of different gold-bearing ore systems. Because gold is a metal, its study requires a detailed understanding of metallography.



Finally, nanocrystals of gold and its alloys display unique properties, and these products are finding widespread application in manufacturing and are also seen in the natural environment. This issue of *Elements* describes new observations about a metal that has fascinated humans since early times. Current research spans the fields of geochemistry, crystallography, and metallurgy, and includes novel studies in the materials sciences.

New developments in the geology of gold deposits
Dick Tosdal (University of British Columbia)

Gold in solution
Anthony Williams-Jones (McGill University)

Mineralogy, crystallography and metallography of gold
Rob Hough, Charles Butt (CSIRO Australia); Joerg Fischer Buhner (Lego Gp, Italy)

The biogeochemistry of gold
Gordon Southam (University of British Columbia)

Gold and nanotechnology
Younan Xia (Washington State University)

Volume 5, Number 6 (December 2009)

LOW-TEMPERATURE METAL STABLE ISOTOPE GEOCHEMISTRY

Guest Editor: **Thomas D. Bullen** (U.S. Geological Survey)

During the past decade it has been recognized that the stable isotope compositions of several metallic elements vary significantly in nature due to both biotic and abiotic processing. While this leap in our understanding has been fueled by recent advances in instrumentation and techniques in both thermal ionization and inductively coupled plasma mass spectrometry, the field of metal stable isotope geochemistry has finally moved beyond a focus on development of analytical techniques and toward using the isotopes as source and process tracers in natural and experimental systems. Often termed the "non-traditional stable isotopes," metal stable isotope systems have found wide application in the geological, hydrological, and environmental research realms and are enjoying a rapidly expanding presence in the scientific literature. This issue of *Elements* will focus on several intriguing aspects of low-temperature metal stable isotope geochemistry.

Reconciling predicted and observed metal isotope fractionations
Edwin Schauble, Pamela Hill, and Merlin Meheut (UCLA)

Mass-dependent and mass-independent isotope fractionation of Hg: Implications for understanding Hg cycling in ecosystems
Bridget A. Bergquist (University of Toronto) and Joel D. Blum (University of Michigan)

Multi-tracer approaches for understanding paleo-redox conditions
Ariel Anbar (Arizona State University), Silke Severmann (University of California-Riverside), and Gwyneth Gordon (Arizona State University)

Cation cycling processes at local to global scales
Albert Galy (University of Cambridge), Jérôme Gaillardet (University of Paris, France), and Edward Tipper (ETH Zurich)

Forensic and biomedical applications of metal stable isotopes
Thomas Bullen (U.S. Geological Survey), Thomas Walczyk (University of Singapore), and Thomas Johnson (University of Illinois/Urbana-Champaign)

The metal stable isotope biogeochemistry of higher plants
Friedhelm von Blanckenburg (GFZ-Potsdam), Dominik Weiss (Imperial College London), Monica Gulke (University of Hannover), and Thomas Bullen (U.S. Geological Survey)