Thematic Topics in 2010

Volume 6, Number 1 (February)

MINERAL EVOLUTION

Guest Editor: **Robert M. Hazen** (Geophysical Laboratory)

Stage 10 of mineral evolution saw the increasing influence of life on mineralization. The trilobite Hoplolichas (6 cm in length) from the Ordovician of Russia displays an elaborately sculpted calcitic shell. Robert Hazen collection, Smithsonian Institution

"Mineral evolution," the study of Earth's changing near-surface mineralogy, frames Earth materials research with a historical narrative. This 4.5-billion-year story integrates themes of planetary science, including geodynamics, petrology, geochemistry, thermodynamics, geobiology, and more. Mineralogy thus holds the key to unlocking our planet's history and assumes its rightful central role in the Earth sciences. The mineralogy of terrestrial planets evolves as a consequence of physical, chemical, and biological processes. Starting with ~12 refractory minerals in prestellar molecular clouds, processes in the solar nebula led to the ~250 different minerals found in meteorites. Initial mineral evolution of Earth's crust depended on a sequence of geochemical and petrologic processes that resulted in an estimated 1500 different mineral species. Ultimately, biological processes produced large-scale changes in atmospheric and ocean chemistry that may be responsible, directly or indirectly, for most of Earth's 4400 known mineral species. Mineral evolution thus highlights the coevolution of the geo- and biospheres.

Mineral Evolution: Mineralogy in the Fourth Dimension
Robert M. Hazen (Geophysical Laboratory) and John M. Ferry (Johns Hopkins University)

The Evolution of Elements and Isotopes
Hendrik Schatz (Michigan State University)

Mineral Evolution of Meteorites
Timothy J. McCoy (Smithsonian Institution)

Mineral Environments on the Earliest Earth
Dominic Papineau (Geophysical Laboratory)

The Great Oxidation Event and Mineral Diversification
Dimitri A. Sverjensky and Namhey Lee (Johns Hopkins University)

The Rise of Skeletal Biominerals
Patricia M. Dove (Virginia Tech)

Themes and Variations in Complex Systems
Robert M. Hazen (Geophysical Laboratory) and Niles Eldredge (American Museum of Natural History)

Volume 6, Number 2 (April)

SULFUR

Guest Editor: **Charles Mandeville** (American Museum of Natural History)

Translucent orthorhombic crystals of native sulfur on aragonite (AMNH 93) from near Cinciana, Arigento, Sicily. The larger of the two crystals is 3.0 cm in diameter x 3.7 cm high. Photo by Arthur Singer, courtesy of American Museum of Natural History

This issue of *Elements* focuses on the geochemistry of sulfur in high-temperature, low- temperature, and biogenically mediated processes over a wide range of scales, environments, and time intervals. Sulfur's multiple valence states (S^{2-} to S^{6+}) allow for its participation in a large variety of geochemical and biogeochemical processes. Sulfur may be one of the light elements contained in the Earth's core and may have been crucial in core formation. Sulfur is an essential component in all life on Earth. Sulfur geochemistry continues to be used in delineating the early evolution of Earth's atmosphere and hydrosphere, as a monitor of volcanic SO_2 and H_2S, and as a tracer of anthropogenic sources. Recent advances in the use of multiple sulfur isotopes (^{32}S, ^{33}S, ^{34}S, and ^{36}S) and in situ isotopic measurements will allow sulfur stable isotopes to develop as vital tracers in the Earth and planetary sciences, with applications to inorganic and biogenic processes.

Sulfur: A Ubiquitous and Useful Tracer in Earth and Planetary Sciences
Charles W. Mandeville (American Museum of Natural History)

Sulfur in Magmas
Nicole Métrich (CNRS-CEA, France) and Charles W. Mandeville (American Museum of Natural History)

Touring the Biogeochemical Landscape of a Sulfur-Fueled World
David T. Johnston (Harvard University)

Sulfur on Mars
(Penelope L. King (University of New Mexico and The University of Western Ontario) and Scott M. McLennan (State University of New York at Stony Brook)

Ultraviolet Sensing of Volcanic Sulfur Emissions
Clive Oppenheimer (University of Cambridge)

New Perspectives on Ancient Sulfur Cycling and Coupled Biospheric Oxygenation
Timothy W. Lyons and Benjamin C. Gill (University of California, Riverside)

Volume 6, Number 3 (June)

METAMORPHISM AND THE ROLE OF FLUIDS

Guest Editor: **Bjørn Jamtveit** (University of Oslo)

Satellite images from the Loriesfontein area, Karoo Basin, South Africa. Bright circular areas (100–150 meters in diameter) are hydrothermal pipes filled with brecciated and cooked shale. The pipes formed as a result of methane degassing during contact metamorphism of black shale. This may have triggered global warming in the Early Jurassic.

Fluids play a critical role during metamorphic processes. They have first-order influence on both reaction kinetics and mass transfer, and thus also on the rate of metamorphism. "Volatile components," such as H_2O and CO_2, may strongly influence rock rheology even in the absence of a free fluid phase. Metamorphic fluids therefore control the coupling between chemical reactions, mass transport, and deformation. Microstructures, compositional gradients at various scales, and larger-scale deformation features all reflect the dynamics of fluid–rock interactions. Moreover, the migration of fluids produced during prograde metamorphic processes or consumed during retrogression links metamorphism with the hydrosphere, the atmosphere, and the biosphere. This issue sheds light on the origin of the various patterns that emerge in metamorphic rocks as a response to changes in pressure, temperature, and the composition of pore-filling fluid. By following the metamorphic fluids to or from the Earth's surface, we also aim to explain how metamorphism may affect our own environment.

Metamorphism and the Role of Fluids
Bjørn Jamtveit and Haakon Austrheim (University of Oslo)

Mineral Replacement Reactions during Metamorphism
Andrew Putnis and Timm John (University of Münster)

Metamorphic Devolatilization and Fluid Flow: Time and Spatial Scales
James A.D. Connolly (ETH-Zürich)

Hydration of the Oceanic Lithosphere and its Implications for Sea-Floor Processes
Wolfgang Bach (University of Bremen and Woods Hole Oceanographic Institution) and Gretchen Früh-Green (ETH-Zürich)

Global Climate Change Driven by Metamorphic Devolatilization
Henrik Svensen and Bjørn Jamtveit (University of Oslo)

Thematic Topics in 2010

Volume 6, Number 4 (August)

ATMOSPHERIC PARTICLES

Guest Editor: **Reto Gieré** (Albert-Ludwigs-Universität Freiburg)

In addition to CO_2 and other gases, considerable amounts of particulate matter are emitted into the atmosphere by various industrial facilities, including this sugarcane processing plant in Queensland, Australia. Photo by Reto Gieré

Solid atmospheric particles range in size from a few nanometers to several micrometers and are generated through both natural processes and human activity. Even though these particles are derived from spatially limited source areas and typically become airborne during short-term events, they are ubiquitous globally due to atmospheric circulation. Depending on their physical and chemical properties, these solid aerosols have a major impact on the radiative properties of the atmosphere and glaciers, on cloud condensation, and on the chemical composition of oceans and soils. Because these particles affect transportation and human health, they have recently become the focus of government attention and regulation.

This issue of *Elements* will explore the atmosphere as an exciting new research area for mineralogists and geochemists. It will illustrate the most prominent types of atmospheric particles and discuss their key effects on climate and ecosystems worldwide.

Atmospheric Particles
Reto Gieré (Albert-Ludwigs-Universität Freiburg) and Xavier Querol (IDAEA-CSIC, Spain)

Airborne Particles in the Urban Environment
Bernard Grobéty (Université de Fribourg), Peter Stille (Université de Strasbourg), Volker Dietze (German Meteorological Service), and Reto Gieré (Albert-Ludwigs-Universität Freiburg)

Volcanic Ash Plumes
Adam Durant (University of Cambridge), Costanza Bonadonna (Université de Genève), and Claire Horwell (Durham University)

Global Dust Events
Edward Derbyshire (Royal Holloway College) and Johann Engelbrecht (Desert Research Institute, Reno, USA)

Particulate Carbon in the Atmosphere
Guenter Engling (Academia Sinica, Taiwan) and András Gelencsér (University of Pannonia, Hungary)

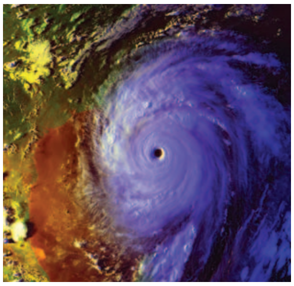
Impacts of Global Events on Oceans, Glaciers, and Climate
Santiago Gassó (University of Maryland Baltimore County), Vicki H. Grassian (University of Iowa), and Ron Miller (NASA Goddard Institute for Space Studies)

Volume 6, number 5 (October)

THERMODYNAMICS OF EARTH SYSTEMS

Guest Editors: **Pascal Richet** and **Daniel R. Neuville** (IPGP-CNRS, France), **Grant S. Henderson** (University of Toronto), and **Roger Powell** (University of Melbourne)

During the past decades, thermodynamics has become an essential tool for understanding fundamental processes that have determined the structure and evolution of our planet. From the atmosphere to the ocean and sediments, from metamorphic terranes to magmatic provinces, the lower mantle, and the core, this issue of *Elements* will illustrate how a better understanding of the manner in which free energy depends on temperature, pressure, and chemical composition allows the Earth's activity to be better deciphered. At a time when climate change has become a major concern, thermodynamic studies of the atmosphere and ocean have not only an academic interest, but also considerable practical importance.



An AVHRR (advanced very high resolution radiometer) 3-channel colour composite daytime image of the eye of hurricane Katrina on August 28, 2005. Courtesy of Steven Babin and Ray Sterner of the Johns Hopkins University Applied Physics Laboratory.

The Effects of Ocean Acidification Due to CO_2 Dissolution
Frank J. Millero and Benjamin DiTrolio (University of Miami)

Phase Changes in the Moist Atmosphere
Andreas Bott (University of Bonn)

Water–Rock Interactions
Pierpaolo Zuddas (Université Claude Bernard)

***P–T* Histories of Metamorphic Rocks**
Roger Powell (University of Melbourne) and Timothy J.B. Holland (University of Cambridge)

Magma Formation and Evolution
Pascal Richet (IPGP-CNRS) and Giulio Ottonello (Università di Genova)

The Lower Mantle and Core
Surendra K. Saxena (Florida International University)

Volume 6, Number 6 (December)

SUSTAINABLE REMEDIATION OF SOILS

Guest Editor: **Mark E. Hodson**

Nine months after addition of suitable organic amendments, grass was able to grow on this soil previously damaged and made highly acidic by coal-mining activities.

Humanity requires healthy soil in order to flourish. Soil is central to food production, regulation of greenhouse gases, and provision of amenity. But soil is fragile and easily damaged by uninformed management or accidents. One source of damage is contamination with the chemicals that are used to provide the lifestyles to which the developed world has become accustomed. Repairing or cleaning up this damage so that soil can again be used for beneficial purposes is a vitally important task. Traditionally, soil "clean up" involved removing the contaminated soil and replacing it with clean soil from elsewhere. Clearly this is not sustainable. Increasingly researchers and practitioners look to clean up contaminated soil and make it good for reuse rather than simply discarding it. Mineralogy and geochemistry are central to the design and implementation of many of these new approaches.

The Need for Sustainable Remediation
Mark E. Hodson (University of Reading)

Assisted Phytoremediation: Helping Plants to Help Us
Filip Tack and Erik Meers (University of Ghent, Belgium)

Use of Organic Amendments for Remediation
Rufus Chaney (United States Department of Agriculture)

Use of Nanoparticles for Remediation—Solving Big Problems with Little Particles
Bernd Nowack and Nicole C. Mueller (EMPA-Swiss Federal Laboratories for Materials Testing and Research)

Mineral-Based Amendments for Remediation
Peggy O'Day (University of California, Merced) and Dimitri Vlassopoulos (S.S. Papadopulos & Associates)

Bioremediation: The Work of Bacterial Alchemists
Blanca Antizar-Ladislao (University of Edinburgh)