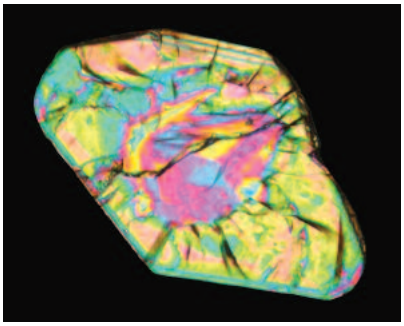
Thematic Topics in 2007

A PREVIEW

Volume 3, Number 1 (February 2007)

ZIRCON – TINY BUT TIMELY

GUEST EDITORS: **Simon L. Harley** and **Nigel M. Kelly** (University of Edinburgh)



Photomicrograph (transmitted light, crossed polarizers) of a single zircon crystal (360 microns long) from the Adirondack Mountains, New York State. The zoned crystal has experienced radiation damage, which can be inferred from the decreased interference colours in some zones, in comparison with the high birefringence of the low-actinide core, typical of well-crystallized zircon. For details, see Nasdala et al. (2005) Chemical Geology 220: 83-103.

Where would Earth science be without zircon? As Earth's timekeeper, zircon has proven to be a remarkable and versatile mineral, providing insights into deep time and ancient Earth processes. However, there is still much to learn about Earth's history from zircon and its behaviour. Zircon cannot be treated simply as a passive "safehouse" of stored isotopic and chemical information but must instead be interpreted carefully, in its petrological, mineralogical, and geological contexts, and in the light of all possible lines of evidence. Zircon has been a wonderful servant in our quest to unravel the history of the Earth—and has so much more to offer as we unlock the secrets of its chemical and physical responses to the processes operating in the Earth.

Rare earth element partition coefficients in zircon–melt systems: Uses, limitations and abuses – John M. Hanchar (Memorial University of Newfoundland) and Wim van Westrenen (Vrije Universiteit)

Zircon behaviour and the thermal histories of hot orogens – Simon L. Harley, Nigel M. Kelly (University of Edinburgh) and Andreas M. Möller (Potsdam University)

Zircon behaviour in deeply subducted rocks – Daniella Rubatto and Jörg Hermann (Australian National University)

Zircon as a monitor of crustal growth and inheritance – Eric E. Scherer (Universität Münster), Martin Whitehouse (Swedish Museum of Natural History), and Carsten Münker (Universität Bonn)

Re-equilibration of zircon in aqueous fluids and melts – Thorsten Geisler (Universität Münster), Urs Schaltegger (Université de Genève), and Frank Tomaschek (Universität Münster)

Volume 3, Number 2 (April 2007)

TEACHING MINERALOGY, PETROLOGY, AND GEOCHEMISTRY

GUEST EDITOR: **David Mogk** (Montana State University)

New advances in research on learning have important implications for teaching mineralogy, petrology, and geochemistry. Effective instructional practices are increasingly student centered, address diverse student learning styles, and employ a variety of active-learning strategies. Teaching practices should be redirected from *learning about science* to *learning to be scientists*, emphasizing inquiry, discovery, critical thinking, problem solving, and the skills required to observe, analyze, and interpret the world around us. This issue of *Elements* describes some of these findings and provides examples of how they can be applied to teaching mineralogy, petrology, and geochemistry.

Random selection of a rock sample (field work) for the semester-long Pet Rock Project. PHOTO COURTESY DARRELL HENRY

Teaching mineralogy, petrology and geochemistry: The intersection of research about Earth and research on learning – David W. Mogk (Montana State University)

Improving instruction in mineralogy, petrology, and geochemistry: Lessons learned from research on learning – Cathryn A. Manduca (Carleton College)

What and how should students learn? – Dexter Perkins III (University of North Dakota)

Teaching for deeper understanding and lifelong learning – Karl R. Wirth (Macalester College)

Teaching with visuals: Do you see what I see? – Barb Dutrow (Louisiana State University)

Using alignment and reflection to improve student learning in mineralogy, petrology and geochemistry – Alan P. Boyle (University of Liverpool)

Volume 3, Number 3 (June 2007)

ENERGY: A GEOSCIENCE PERSPECTIVE

GUEST EDITOR: **Allison Macfarlane** (George Mason University)

An eruption from Crystal Geyser, Utah. Eruptions commonly reach 5-10 m height. PHOTO S. JULIO FRIEDMANN

The issue of energy resources in the future will be one of the most important in the 21st century. Future climate change and the ways to abate it while still supplying needed energy will impact future political relations, world economics, human health, and the environment. Earth scientists have much to add to the debate, but are often not heard. This issue will provide a geologic perspective on some of the issues and offer some potential solutions to the problems. Detailed discussions include issues of climate change, geologic sequestration of carbon dioxide from fossil fuel plants, natural gas resource expansion via methane hydrates, and the potential uranium resource for nuclear energy.

Energy for the global future – Allison Macfarlane (George Mason University)

Climate change – Dan Schrag (Harvard University)

Geological carbon sequestration: A key component pathway to a decarbonized energy system – S. Julio Friedmann (Lawrence Livermore National Laboratory)

Tapping methane hydrates for unconventional natural gas – Carolyn Ruppel (Georgia Institute of Technology)

Nuclear energy and uranium resources – Allison Macfarlane (George Mason University) and Marvin Miller (Massachusetts Institute of Technology)

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Volume 3, Number 4 (August 2007)

FRONTIERS IN TEXTURAL AND MICROGEOCHEMICAL ANALYSIS: FOCUS ON IGNEOUS PETROLOGY

GUEST EDITORS: **Dougal A. Jerram** and **Jon P. Davidson** (Durham University)

X-ray CT 3D rock texture being explored using a state-of-the-art 3D visualisation system at Durham University. The volcanic rock is from the Teide volcano. Feldspar crystals are shown in orange and vesicles in blue.

Recent advances have been made in high-resolution in situ methods to image mineral growth patterns, analyse compositional and isotopic zonation, and improve our ability to visualize, study, and model rock textures in three dimensions. These advances provide a significant step forward in the understanding of how rocks form and the history they can tell us. Computer-aided reconstructions and 3D modelling of textures, advanced models of crystallisation and very high-resolution sampling of within-crystal geochemical variations are at the frontiers of current studies in igneous petrology. This thematic issue will highlight the integration of textural and geochemical information as a powerful tool in the understanding of igneous rocks, and will provide examples that researchers in other disciplines may use to further advance their studies.

3D textural analysis of rocks – Dougal A. Jerram (University of Durham) and Michael Higgins (Université du Québec à Chicoutimi)

Modelling textures and crystallization – Bruce D. Marsh and Taber Hersum (Johns Hopkins University)

Isotopic microsampling of magmatic rocks – Jon P. Davidson (Durham University) and Dan Morgan (The Open University)

Crystal zoning as archive for magma evolution – Catherine Ginibre (Université de Genève), Gerhard Wörner, Andreas Kronz (Universität Göttingen)

Measuring timescales of magmatic processes – Simon Turner and Fidel Costa (Macquarie University)

Volume 3, Number 5 (October 2007)

THE CRITICAL ZONE

GUEST EDITORS: **Susan L. Brantley**, **Tim White** (Pennsylvania State University), and **Vala Ragnarsdottir** (University of Bristol)

The Critical Zone (CZ) encompasses all fluid, mineral, gaseous, and biotic components from the outer envelope of vegetation down to the lower limit of groundwater. It supports much of life on Earth. Important, relevant societal challenges related to CZ science to be addressed in the next decade are: (1) what processes control fluxes of carbon, particulates, and other reactive gases into and from the CZ? (2) how do weathering processes in the CZ nourish ecosystems? (3) how do chemical and physical weathering processes shape the CZ? and (4) how do biogeochemical processes in the CZ govern long-term sustainability of water and soil resources?

Earth's weathering engine: Fundamental questions and approaches – Susan L. Brantley (Penn State), Marty Goldhaber (USGS), Vala Ragnarsdottir (University of Bristol)

The interrelationship of physical and chemical processes in the Critical Zone – Suzanne Anderson (University of Colorado), Art White (USGS), Freidhelm von Blankenburg (Universität Hannover)

Biogeochemical processes at Critical Zone interfaces: Effects on soil and water sustainability – Jon Chorover (University of Arizona), Donald Sparks (University of Delaware), and Ruben Kretzschmar (Swiss Federal Institute of Technology)

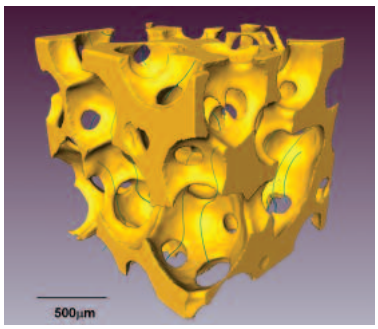
Coupling between biota and Earth materials in the Critical Zone – Ronald G. Amundson (University of California, Berkeley), Daniel D. Richter Jr (Duke University), Geoffrey S. Humphreys (Macquarie University), and Jérome Gaillardet (IPG, Paris)

Dust, gas, and soil: Critical Zone–atmosphere interactions – Lou Derry (Cornell University) and Oliver Chadwick (University of California, Santa Barbara)

Volume 3, Number 6 (December 2007)

MEDICAL MINERALOGY AND GEOCHEMISTRY

GUEST EDITOR: **Nita Sahai** (University of Wisconsin–Madison)



X-ray microtomography image of a bioactive calcium silicate glass scaffold, with calculated fluid flow lines, used as a bone-regenerative scaffold for regions with low tensile loading, e.g. in facial or spinal applications. COURTESY OF GOWSIHAN POOLOGASUNDARAMPILLAI, IMPERIAL COLLEGE

Medical mineralogy and geochemistry is an emergent, highly interdisciplinary field concerned with both normal and pathological interactions between minerals or amorphous inorganic solids and biomolecules or cells within the human body, and the transport and fate of prions and protein toxins in the soil environment. Prior research has, appropriately, focused on the complex genetic and molecular biological aspects, but there is a growing recognition of the vital need for understanding the surface and bulk properties and reactivities, especially at the challenging nanoscale characteristic of biomacromolecules and biominerals. Geochemists and mineralogists are uniquely trained to contribute to this new field because of their knowledge of mineral stability, surface reactivity, mineral precipitation/dissolution kinetics, and mineral–sorbate interactions, as well as their ability to study complex systems using state-of-the-art spectroscopic and microscopic techniques.

Emergence of medical mineralogy and geochemistry – Nita Sahai (University of Wisconsin–Madison)

Mineralization of bones and teeth – Adele Boskey (Cornell University)

Bioactive glass based scaffolds for bone tissue engineering – Julian R. Jones, Eileen Gentleman, and Julia M. Polak (Imperial College)

Environmental consequences of protein interactions with soil solid surfaces – Hervé Quiquampoix (Institut National de la Recherche Agronomique, Montpellier)

Toxic potential of inhaled mineral dusts – Bice Fubini and Ivana Finoglio (Università di Torino)

Unraveling pathological biomineralization – Michael D. Ward, (New York University) and Jeffrey Wesson (Department of Veterans Affairs and Medical College of Wisconsin–Milwaukee)