THEMATIC TOPICS IN 2015

Volume 11, Number 1 (February)

MINERALOGY OF MARS

Guest Editor: **John P. Grotzinger** (California Institute of Technology)

The Mars Science Laboratory rover *Curiosity* touched down on the surface of Mars on August 5, 2012. *Curiosity* was built to search and explore for habitable environments. The rover has a lifetime of at least one Mars year (~23 months) and a drive capability of at least 20 km. The MSL science payload can assess ancient habitability, which requires the detection of former water, a source of energy to fuel microbial metabolism, and key elements such carbon, sulfur, nitrogen, and phosphorus. Within 8 months of landing, we were able to confirm full mission success. This was based on the discovery of fine-grained sedimentary rocks, inferred to represent an ancient lake. These rocks (Sheepbed mudstone) preserve evidence of an aqueous paleoenvironment that would have been suited to support a Martian biosphere founded on chemolithoautotrophy and characterized by neutral pH, low salinity, and variable redox states for both iron and sulfur species. C, H, N, O, S, and P were measured directly as key biogenic elements. The environment likely had a minimum duration of hundreds to tens of thousands of years. These results highlight the biological viability of fluvial–lacustrine environments in the ancient history of Mars and the value of robots in geologic exploration.

Artist concept of Mars Science Laboratory. Image credit: NASA/JPL-Caltech

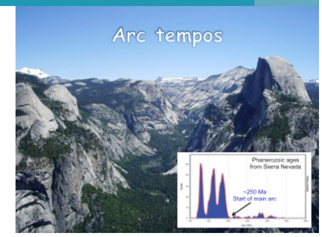
- **Mars Science Laboratory: Mission overview and results**
  John P. Grotzinger (California Institute of Technology) and the MSL Science Team
- **Determining mineralogy on Mars with the CheMin X-ray diffractometer**
  Robert T. Downs (University of Arizona) and the MSL Science Team
- **In situ chemistry measurements of rocks and soils by NASA's Mars rovers using the alpha particle X-ray spectrometer**
  Ralf Gellert (University of Guelph) and the MSL and MER Science Teams
- **Images from Curiosity: A new look at Mars**
  Linda C. Kah (University of Tennessee) and the MSL Science Team
- **Imprints of ancient Mars in volatiles and isotopes**
  Paul R. Mahaffy (Goddard Space Flight Center, NASA), Pamela G. Conrad (Goddard Space Flight Center, NASA), and the MSL Science Team
- **ChemCam: Chemostratigraphy by the first Mars microprobe**
  Roger Wiens (Los Alamos National Laboratory), Sylvestre Maurice (CESR, Université Paul Sabatier, Toulouse), and the MSL Science Team

Volume 11, Number 2 (April)

ARC MAGMATIC TEMPOS

Guest Editors: **Scott R. Paterson** (University of Southern California) and **Mihai N. Ducea**, (University of Arizona)

Research over the past decade established that magmatism in oceanic and continental arcs is not temporally or spatially steady-state. The causes of well-documented order of magnitude increases in magmatic production over relatively short-lived, high-volume events remain controversial. Since the differentiation of our planet and formation of the continental crust and its underlying mantle lithosphere is in large part the result of magmatic processes at convergent margins, it is imperative that we understand the underlying controls on the tempo of magmatic and tectonic activity in arcs and the episodic nature of magmatism. These processes also influence socially important processes such as long-term climate change, volcanic and fault hazards, and ore deposition. This issue will provide an overview of some recently developed models for episodic behavior in subduction magmatism, from global to single magmatic systems, and explore the causes of high-volume events in subduction-related magmas.



- **Episodic processes in magmatic arcs**
  Scott R. Paterson and Mihai N. Ducea
  With a link to a digital movie by Louis Moresi (University of Melbourne) entitled *Transient behaviour of congested subduction zones*
- **High-flux magmatic events in subduction systems**
  Mihai N. Ducea, Scott R. Paterson, and Peter G. DeCelles (University of Arizona)
- **Magma production rates for intraoceanic arcs**
  Brian Jicha (University of Wisconsin) and Olivier Jagoutz (Massachusetts Institute of Technology)
- **Quasi-fractal periodicities in continental arc magmatism: Integrating volcanic, plutonic and detrital records**
  Shanaka L. de Silva (Oregon State University), Andy Barth (Indiana University–Purdue University Indianapolis), and Nancy Riggs (Northern Arizona University)
- **Collisional processes and links to episodic changes in subduction zones**
  Jeroen van Hunen (Durham University) and Meghan S. Miller (University of Southern California)
- **Episodic arc magmatism, crustal carbonates, and skarns: Implications for long-term climate variability**
  Cin-Ty A. Lee (Rice University) and Jade Star Lackey (Pomona College)

Volume 11, Number 3 (June)

APATITE: A MINERAL FOR ALL SEASONS

Guest Editors: **Daniel E. Harlov** (GeoForschungsZentrum, Potsdam) and **John Rakovan** (Miami University)

At the intersection of the biological, geological, and materials science realms, the topic of apatite is highly diverse and interdisciplinary. Apatite-group minerals are the dominant phosphates in the geosphere and biosphere. They are found in virtually all rock types as the principal sink for phosphorus and fluorine, and in many cases yttrium and the rare-earth elements. They form the major mineral component in vertebrate bones and are the base of the global phosphorus cycle. The isotope chemistry of U, Th, and Pb in apatite has led to their broad application in geochronology. Last, the physical and chemical properties of apatite-group minerals make them ideal for many technological applications, including phosphors, lasers, prosthetics, ceramics, metal sequestration agents, and potential solid nuclear waste forms. This issue of *Elements* presents cutting-edge research on apatite with regard to (1) geochemical investigations on crustal and mantle processes on Earth, (2) biological processes, (3) practical applications in industry, and (4) geochemical processes in extraterrestrial environments.

Fluorapatite and magnetite from the Kiruna-type deposit, Cedar City, Iron Co., UT. Jeff Scovil photo

- **Structure and chemistry of apatite and apatite-supergroup minerals**
  John M. Hughes (University of Vermont) and John Rakovan (Miami University)
- **Apatite and fluids: A recorder of metasomatic processes**
  Daniel E. Harlov (GeoForschungsZentrum, Potsdam)
- **Magmatic apatite: A utilitarian, yet deceptive, mineral**
  James Webster (American Museum of Natural History) and Phil Piccoli (University of Maryland)
- **From mineralogy to astrobiology: The importance of extraterrestrial apatite**
  Francis McCubbin and Rhian Jones (University of New Mexico)
- **Geochronology and thermochronology using apatite: U–Pb, Lu–Hf, fission track, and (U–Th)/He3**
  David Chew (Trinity College, Dublin) and Richard Spikings (University of Geneva)
- **A technological gem: Materials, medical, and environmental mineralogy of apatite**
  John Rakovan (Miami University) and Jill D. Pasteris (Washington University, St. Louis)

THEMATIC TOPICS IN 2015

Volume 11, Number 4 (August)

GEOCHEMISTRY AND THE IMPACT AGENDA

Guest Editors: **John Ludden** (British Geological Survey), **Francis Albarède** (École Nationale Supérieure, Lyon), and **Max Coleman** (Jet Propulsion Laboratory, Caltech)

As geochemists and mineralogists, we are well aware of the impact of our science and when pushed we can often reel out great examples where our discoveries have influenced industry and the social well-being on the planet. However, this sort of drum-beating is not intuitive, and the explicit need to demonstrate impact in our science is, in many nations, being used as a measure of the required funding level for our discipline. The papers in this issue will show how we use geochemistry to achieve impact, and they will provide the basic science coupled to case studies from the hydrocarbon, mineral, environmental, and health and nutrition fields. The authors will document economic estimates of the benefits of their science; an example is the role of mass spectrometry in the oil and gas sector, in disease control, and as isotopic tracers in mineral exploration.

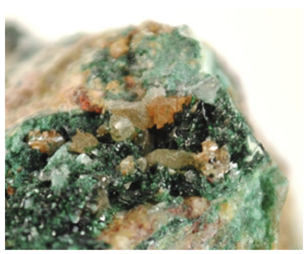
- **Novel applications of geochemistry in mineral exploration and remediation**
  Kurt Kyser (Queen's University)
- **The impact of "curiosity-driven research" on oil production through problem awareness**
  Max Coleman (Jet Propulsion Laboratory)
- **Environmental mineralogy: New challenges, new materials**
  Georges Calas (UPMC, Paris), Paul McMillan (UCL, London), and Rizlan Bernier-Latmani (EPFL, Lausanne)
- **Isotope forensics and others**
  James Ehleringer (University of Utah)
- **Isotope metallomics**
  Francis Albarède (Université de Lyon)
- **The geochemistry of London**
  John Ludden (British Geological Survey) and others

Volume 11, Number 5 (October)

SUPERGENE METAL DEPOSITS

Guest Editors: **Martin Reich** (University of Chile) and **Paulo Vasconcelos** (University of Queensland)

Supergene metal deposits form when deeply buried orebodies are exposed at the surface and undergo oxidation, dissolution, and significant reconcentration of metals. Much of the global economic and scientific interest in these ores stems from their mineralogical diversity and advantages for exploitation due to their surficial development and increased grades. Supergene deposits contribute significantly to the world's supply of metals, such as copper, aluminum, and nickel. They are also increasingly being explored and exploited as alternative sources for "critical metals," including rare earth elements and strategic metals, which are widely used in technology and low-carbon energy applications. Furthermore, supergene metal deposits provide clues about our past climate and offer an unparalleled opportunity to explore the long-term corrosion behavior and environmental impact of natural and man-made materials. This issue of *Elements* will highlight some of the most recent advances in the field, including cutting-edge research in economic geology, paleoclimate and geoarcheology studies, environmental geochemistry, geobiology, and corrosion science.



Supergene copper chlorides (green) and iodides (orange) from the Chuquicamata giant copper deposit, Chile

- **Geological and economic significance of supergene metal deposits**
  Martin Reich (University of Chile) and Paulo Vasconcelos (University of Queensland)
- **Supergene alteration of ore deposits: From nature to man**
  Harald Dill (Federal Institute for Geosciences and Natural Resources, Hannover)
- **Supergene metal deposits and past climate**
  Martin Reich (University of Chile), Paulo Vasconcelos (University of Queensland), and David Shuster (University of California, Berkeley)
- **Metal fractionation in supergene deposits**
  Ryan Mathur (Juniata College) and Matthew Fantle (Penn State)
- **Supergene minerals as corrosion analogues**
  Devon Renock (Dartmouth University) and Lindsay Shuller-Nickles (Clemson University)
- **Geomicrobiology of supergene metal deposits**
  Gordon Southam (University of Queensland)

Volume 11, Number 6 (December)

GEOMICROBIOLOGY AND MICROBIAL GEOCHEMISTRY

Guest Editors: **Greg Druschel** (Indiana University–Purdue University Indianapolis) and **Greg Dick** (University of Michigan)

Microbes drive the interplay of Earth and life to control critical processes in ocean, atmosphere, and terrestrial environments. Indeed, this unseen part of our world has regulated the cycling of key elements throughout geologic time. The field of microbial geochemistry is rapidly advancing our understanding of the chemical, biological, and geologic processes that regulate this cycling. Moreover, with the rapid developments in "omics" techniques (genomics, transcriptomics, and proteomics), a revolution is now underway. New studies are coupling these methods with our geochemical understanding of microbial populations to reveal unprecedented insights into how microorganisms shape their surroundings and how geochemistry shapes microbial populations. The authors will show how linking geochemical and microbial information brings understanding of the role of microbes in element cycling in modern and ancient environments.

- **Geomicrobiology and microbial geochemistry**
  Greg Druschel and Andreas Kappler (University of Tübingen)
- **Linking geochemistry and microbial metabolisms**
  Eric Boyd (Montana State University) and Everett Shock (University of Arizona)
- **Application of omics to geochemical cycling**
  Greg Dick and Phyllis Lam (University of Southampton)
- **Reactive intermediates as a key to understanding microbial roles in element cycling**
  Brad Tebo (University of Oregon), Colleen Hansel (Woods Hole Oceanographic Institute), and Tim Ferdelman (Max Planck Institute für Microbiologie, Bremen)
- **The past informs the present *and* the present informs the past: Microbes and element cycling through deep time**
  Tim Lyons (University of California, Riverside), David Fike (Washington University, St. Louis), and Aubrey Zerkle (St. Andrew's University)
- **Emerging frontiers of geomicrobiology and microbial geochemistry**
  Alexis Templeton (University of Colorado) and Karim Benzerara (University Pierre et Marie Curie)