

Volume 12, Number 1 (February)

EARTH SCIENCES FOR CULTURAL HERITAGE

GUEST EDITORS: **Gilberto Artioli** (University of Padova, Italy) and **Simona Quartieri** (University of Messina, Italy)

Archaeometry and conservation science are connected to the geosciences in three ways. Earth scientists can perceive the complexity of natural materials and of the artifacts produced by human activities, they understand the geological and physico-chemical processes acting on them, and they have a mastery of the techniques used to investigate heritage materials at different scales. Many techniques can be applied non-invasively, preserving the integrity of art/archaeological objects that are often characterized by uniqueness, fragility, high complexity, and heterogeneity. The goal is to understand the fine interplay between human activities, georesources, and natural processes: in short, the history of mankind and human societies on Earth. This issue uses selected examples to demonstrate how the geosciences offer a way to better understand, interpret, and preserve our past.

- **The role of modern geosciences in cultural heritage studies**
Gilberto Artioli (University of Padova) and Simona Quartieri (University of Messina)

- **Non-destructive imaging techniques for heritage assessment: archaeological geophysics and built heritage applications**
Roger Sala (SOT Archaeological Prospection, Catalonia-Spain), Robert Tamba (Universitat de Barcelona), and Ekhine Garcia (Euskal Herriko Unibertsitatea)

- **Geochronology beyond radiocarbon: optically stimulated luminescence dating of palaeoenvironments and archaeological sites**
Constantin D. Athanassas (C.E.R.E.G.E., Aix-en-Provence) and Günther A. Wagner (Geographisches Institut der Universität Heidelberg)

- **The Earth sciences from the perspective of an art museum**
Federico Carò, Elena Basso, and Marco Leona (The Metropolitan Museum of Art, New York)

- **Chemical imaging at the micro- and macroscale: tools for virtual archaeology of (altered) paintings**
Koen Janssens, Frederik Vanmeert, Stijn Legrand, Geert Van der Snickt (University of Antwerp)

- **Synchrotron advanced imaging of paleontological specimens**
Pierre Gueriau (CNRS IPANEMA Synchrotron SOLEIL), Sylvain Bernard (IMPMC, Sorbonne Universités, Paris), and Loïc Bertrand (CNRS IPANEMA Synchrotron SOLEIL)



Giovinetto di Mozia, 450-440 BC

Volume 12, Number 2 (April)

THE ENIGMATIC RELATIONSHIP BETWEEN SILICIC PLUTONIC AND VOLCANIC ROCKS

GUEST EDITORS: **Craig C. Lundstrom** (University of Illinois, USA) and **Allen F. Glazner** (University of North Carolina, USA)

The relationship between silicic volcanic and plutonic rocks has long puzzled geologists. Although the compositional evolution for volcanic and plutonic rock suites are virtually identical, there is much debate whether rhyolites form as melt extracted from granite plutons or whether the two rock types reflect wholly separate origins. This issue discusses the broad set of observations from petrology, geochronology, thermal modeling, geophysical techniques, and geochemistry that lead to contradictory interpretations and no simple description for the relationship. Discerning how silicic volcanic and plutonic rocks are connected will affect important Earth science questions such as “how is continental crust formed?” and “can we predict supereruptions?”

- **Silicic magmatism and the volcanic-plutonic connection**

Craig C. Lundstrom (University of Illinois) and Allen F. Glazner (University of North Carolina)

- **Geophysical evidence for crustal melt: where, what kind, and how much?**

Matthew E. Pritchard (Cornell University) and Patricia M. Gregg (University of Illinois)

- **The pace of plutonism**

Drew S. Coleman (University of North Carolina), Ryan D. Mills (University of North Carolina), and Matthew J. Zimmerman (New Mexico Institute of Mining and Technology)

- **Experimental constraints on the formation of silicic magmas**

Bruno Scaillet (University of Orleans), François Holtz (University of Hannover), and Michel Pichavant (University of Orleans)

- **The life and times of silicic volcanic systems**

Colin J.N. Wilson (Victoria University) and Bruce L.A. Charlier (The Open University)

- **Magmatic processes in silicic systems from the perspective of heat transfer**

Catherine J. Annen and Jon D. Blundy (University of Bristol)



Volume 12, Number 3 (June)

COSMIC DUST

GUEST EDITORS: **Susan Taylor** (Cold Regions Research and Engineering Laboratory, USA), **Donald E. Brownlee** (University of Washington, USA), and **George Flynn** (SUNY-Plattsburg, USA)

Cosmic dust is submillimeter debris shed by comets, asteroids, moons, and planets. In the Solar System, this dust scatters sunlight (the zodiacal light), and it is detected around other stars by its infrared emission. Cosmic dust enters Earth's atmosphere at high speeds and at a rate of 100 tons a day. These small particles are the largest source of extraterrestrial material accreting on the present-day Earth and include interplanetary dust particles and micrometeorites. Although atmospheric entry heating and terrestrial weathering have modified many, some particles are pristine primitive extraterrestrial materials that contain high abundances of isotopically anomalous presolar grains and primitive carbon compounds that have not been altered since their formation. Cosmic dust analysis provides invaluable information on initial planetary building materials.

- **Cosmic dust: building blocks of planets – falling in our backyard**

Donald Brownlee (University of Washington)

- **Dust in the cosmos**

Diane Wooden (NASA Ames Research Center), John Bradley (University of Hawaii), and Hope Ishii (University of Hawaii)

- **Collecting cosmic dust: finding a needle in a haystack**

Susan Taylor (Cold Regions Research and Engineering Laboratory), Luigi Folco (University of Pisa), and Scott Messenger (NASA Johnson Space Center)

- **Cosmic dust: sources, compositions and implications for the early solar system**

George Flynn (SUNY-Plattsburg), Cecile Engrand (CNRS/Université Paris), and Larry R. Nittler (Carnegie Institution)

- **Carbon, nitrogen and water in cosmic dust: astrobiological implications**

Scott Sandford (NASA Ames Research Center), Cecile Engrand (CNRS/Université Paris), and Alessandra Rotundi (Parthenope University of Naples)

- **Geochemical tracers of extraterrestrial matter in sediments**

Bernhard Peucker-Erhenbrink (Woods Hole Oceanographic Institution), Gregory Ravizza (University of Hawaii), Gisela Winckler (Lamont-Doherty Earth Observatory)



Cosmic dust particles: a smooth, 200 µm micrometeorite (top) and a porous, 1 µm interplanetary dust particle (bottom)

Volume 12, Number 4 (August)

DEEP-MINED GEOLOGICAL DISPOSAL OF RADIOACTIVE WASTE

GUEST EDITORS: **Bruce Yardley** (Radioactive Waste Management Ltd., UK), **Rodney Ewing** (Stanford University, USA), **Robert Whittleston** (Hitachi Europe Ltd., UK)

The construction of geological disposal facilities for radioactive waste has been a long time in the discussion and planning, but will become a major focus of geological, mineralogical, and geochemical effort in coming years. Underground laboratories have been operating for many years in a variety of rock types. A number of national projects that will dispose of heat-producing waste are nearing the licencing stage: sites have been selected, and planning is moving forward in many countries. Geological disposal raises complex technical issues, but it is also at the centre of social and political controversy.

Different countries have very different waste inventories and quantities of waste; they may also have different geological settings available to host a repository. The issue of *Elements* will present case studies of the concepts for repositories hosted in the range of possible host rocks that have been considered worldwide. The varied approaches to selecting a site that is acceptable to local communities will be reviewed.

- **Introduction to radioactive waste and geological disposal**

Rod Ewing (Stanford University), Bruce Yardley (RWM), Rob Whittleston (Hitachi Europe)

- **Geological disposal in clay**

Bernd Grambow (SUBATECH, Université de Nantes, France)

- **A Repository for spent nuclear fuel in crystalline rock**

Allan Hedin, Olle Olsson (SKB, Sweden)

- **Geologic repository in salt**

Thilo v Berlepsch, Bernt Haverkamp (DBE Technology, Germany)

- **Geological disposal in tuff: Yucca Mountain**

Peter N. Swift, Evaristo J. Bonano (Sandia National Laboratories)

- **Selecting a site for a radioactive waste repository**

Daniel S. Metlay (US Nuclear Waste Technical Review Board)



The prototype Cannister Hole Boring Machine "Sanna", developed by Posiva, Finland. Source: Posiva Oy

- **History and evolution of the LA-ICPMS technique**

Paul J. Sylvester (Texas Tech University) and Simon E. Jackson (Geological Survey of Canada)



Progressive ablation of feldspar from left to right over 60 sec.

- **Major and trace**

- **element analysis of natural and experimental igneous systems**

Frances E. Jenner (Open University), Ricardo Arevalo (NASA Goddard Space Flight Center), Hugh, St. C. O'Neill (Australian National University), Ashley Norris (University of Oxford) and Charlotte Allen (Queensland University of Technology)

- **Isotopic geochemistry/geochronology of the magmatic and sedimentary rock record**

John Cottle (University of California, Santa Barbara), Jon Woodhead (University of Melbourne) and Matt Horstwood (British Geological Survey)

- **Fluid inclusion analysis of metamorphic and ore-bearing systems**

Christoph A. Heinrich (ETH Zürich) and Thomas Wagner (University of Helsinki)

- **Climate change research**

Stephen Eggins (Australian National University)

- **Applications of LA-ICPMS to forensic science**

José R. Almirall and Tatiana Trejos (Florida International University)

- **Prospects for quasi non-destructive analysis of ancient artefacts**

Patrick Degryse (Katholieke Universiteit Leuven) and Frank Vanhaecke (Universiteit Gent)

Volume 12, Number 6 (December)

THE ORIGINS OF LIFE: TRANSITION FROM GEOCHEMISTRY TO BIOGEOCHEMISTRY

GUEST EDITORS: **Nita Sahai** and **Hussein Kaddour** (University of Akron, USA)

How life originated is one of the most important, and longstanding, questions that humans have attempted to answer, as reflected in our mythologies, religions, philosophy, and science. Furthermore, our understanding of the emergence of life on Earth could potentially contribute to the search for life in other parts of the Solar System and the rest of the Universe. The objective of our thematic issue is to highlight the potential role of minerals and the critical importance of using relevant conditions, plausible on early Earth, for designing experiments to model the emergence and early evolution of life. We believe that this approach is essential to bridging the gap in the field between biochemists/organic chemists, on the one hand, and geochemists/mineralogists, on the other.

- **Transition from Geochemistry to Biogeochemistry: Outlining the Problem of the Origins of Life**

Nita Sahai and Hussein Kaddour (University of Akron)

- **Prebiotic Sources of Simple Organic Molecules**

Sandra Pizzarello and Everett Shock (Arizona State University)

- **Geochemical Evolution of Aqueous Solutions on Early Earth**

Martin Schoonen (Brookhaven National Laboratory)

- **Metal Sulfide Minerals and Enzymes and their Relevance to Prebiotic Chemistry**

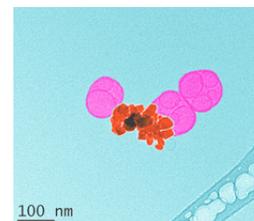
Sheref Mansy (University of Trento)

- **Ribozyme Activity under Early Earth Conditions**

Marie-Christine Maurel (Pierre and Marie Curie University)

- **Towards a Protocell: Assembling the Components of Life**

Pierre-Alain Monnard (University of Southern Denmark)



Cryo-TEM image showing formation of model protocells (pink) in close interaction with a mineral surface (red).

Volume 12, Number 5 (October)

STUDYING THE EARTH USING LA-ICPMS

GUEST EDITORS: **Paul J. Sylvester** (Texas Tech University, USA) and **Simon E. Jackson** (Geological Survey of Canada)

Laser ablation – inductively coupled plasma mass spectrometry (LA-ICPMS) is a mature, but still developing, micro-analytical technique that has allowed significant research advances in many areas of the Earth sciences. The method produces quantitative elemental and isotopic analyses on the micrometer scale of most solid, and some liquid, materials across most of the periodic table. A key strength of the method is that it can detect changing conditions or processes over time by analysis of growth zones or domains in minerals and other objects. Recent developments in rapid-wash out ablation cells and data handling software permit elemental and isotopic mapping of materials. Because both inorganic and organic materials can be analyzed, abiotic and biotic processes, and their interactions, can be studied. This issue of *Elements* highlights applications of LA-ICPMS across the broad range of disciplines of interest to the Earth, environmental, and biological sciences that now rely on the technique and their interdisciplinary nature.