

PRINCIPAL EDITORS

JOHN W. VALLEY, University of Wisconsin, USA
(valley@geology.wisc.edu)
PATRICIA M. DOVE, Virginia Tech
(dove@vt.edu)
GORDON E. BROWN JR., Stanford University
(gordon.brown@stanford.edu)

ADVISORY BOARD

JOHN BRODHOLT, University College London, UK
NOBERT CLAUSER, CNRS/UdS, Université de
Strasbourg, France
WILL P. GATES, SmecTech Research Consulting,
Australia
GEORGE E. HARLOW, American Museum
of Natural History, USA
JANUSZ JANECZEK, University of Silesia, Poland
HANS KEPPLER, Bayerisches Geoinstitut,
Germany
DAVID R. LENTZ, University of New Brunswick,
Canada
ANHUI LU, Peking University, China
ROBERT W. LUTH, University of Alberta, Canada
DAVID W. MOGK, Montana State University, USA
TAKASHI MURAKAMI, University of Tokyo, Japan
TERRY PLANK, Lamont-Doherty Earth
Observatory, USA
XAVIER QUEROL, Spanish Research Council, Spain
MAURO ROSI, University of Pisa, Italy
BARBARA SHERWOOD LOLLAR, University of
Toronto, Canada
TORSTEN VENNEMANN, Université de
Lausanne, Switzerland
OLIVIER VIDAL, Université J. Fourier, France
MEENAKSHI WADHWI, Arizona State
University, USA
BERNARD WOOD, University of Oxford, UK
JON WOODHEAD, University of Melbourne,
Australia

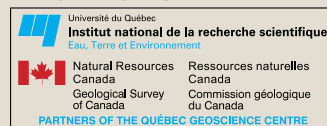
EXECUTIVE COMMITTEE

CARLOS AYORA IBÁÑEZ, Sociedad Española
di Mineralogia
THOMAS D. BULLEN, International Association
of Geochemistry
BERNARDO CESARE, Società Italiana di
Mineralogia e Petrologia
KATERINA M. DONTSOVA, The Clay Minerals
Society
BARBARA L. DUTROW, Mineralogical
Society of America, Chair
ANTON EISENHAEUER, Geochemical Society
DANIEL J. FROST, European Association
of Geochemistry
BERNARD GROBÉTY, Swiss Society of
Mineralogy and Petrology
MARK E. HODSON, Mineralogical Society
of Great Britain and Ireland
GUY LIBOUREL, Société Française de Minéralogie
et de Cristallographie
CATHERINE CORRIGAN, Meteoritical Society
MAREK MICHALIK, Mineralogical Society
of Poland
TAKASHI MURAKAMI, Japan Association
of Mineralogical Sciences
IAIN M. SAMSON, Mineralogical Association
CLIFFORD R. STANLEY, Association
of Applied Geochemists
FRIEDHELM VON BLANCKENBURG,
Deutsche Mineralogische Gesellschaft
MICHAEL WIEDENBECK, International
Association of Geoanalysts

EXECUTIVE EDITOR

PIERRETTE TREMBLAY, tremblpi@ete.inrs.ca

EDITORIAL OFFICE



490, rue de la Couronne
Québec (Québec) G1K 9A9, Canada
Tel.: 418-654-2606 Fax: 418-653-0777

Layout: POULIOT GUAY GRAPHISTES
Copy editor: THOMAS CLARK
Proofreaders: THOMAS CLARK
and DOLORES DURANT
Printer: ALLEN PRESS

The publishers assume no responsibility for any statement of fact or opinion expressed in the published material. The appearance of advertising in this magazine does not constitute endorsement or approval of the quality or value of the products or of claims made for them.

www.elementsmagazine.org

ASTEROID WHAT?



John Valley

Asteroids have a PR problem. The name, ending in -oid, connotes being sort of like something else, but not quite. *Aster* means “star” in Latin; so what is an asteroid? There are no constellations of heroic warriors immortalizing asteroids because the Greeks couldn’t see them. Most were only found in the last decade. Today,

the popular dream of space travel might mean going to the planets or beyond, but probably not to YP139. Most people, if they think about asteroids at all, consider them either far away and obscure or nearby and menacing, perhaps coming to end civilization.

This view has been fueled by the motion picture industry. In the summer of 1998, two disaster movies captivated millions with images of asteroids (or comets), death, and destruction. The plot lines were identical: heroic attempts with variable effect to save the Earth from NEAs (near-Earth asteroids) using manned spacecraft, rock drills, and nuclear devices. In *Deep Impact*, Robert Duvall lands on an 11 km diameter body and blows it into two pieces, one of which lands in the Atlantic causing a dramatic mega-tsunami. In *Armageddon*, Bruce Willis lands on an asteroid and blows it up, this time showering Earth with exploding rocks. Lamentably, *Armageddon* is overblown and portrays science and scientists poorly, yet it did better at the box office. I confess: I saw both films. I saw *Armageddon* in Mammoth Lakes, California, inside the Long Valley caldera. In an amazing coincidence, a magnitude-5 earthquake rattled the theatre just as a meteorite (in the movie) was vaporizing Paris. There were no injuries (in the theater), but what great special effects!

More seriously, disastrous meteorite impacts are a continuing part of Earth history. The frequency is low and poorly understood, but the results can exceed even Hollywood’s lively imagination. Chelyabinsk (2013) and Tunguska (1908) were dramatic, but they were relatively small events. Some impacts recorded in the rock record were far larger, but are only known from geophysical evidence, thin spherule layers, or detrital shocked minerals. Others caused large craters or mass extinctions. Clearly, the study of past impacts



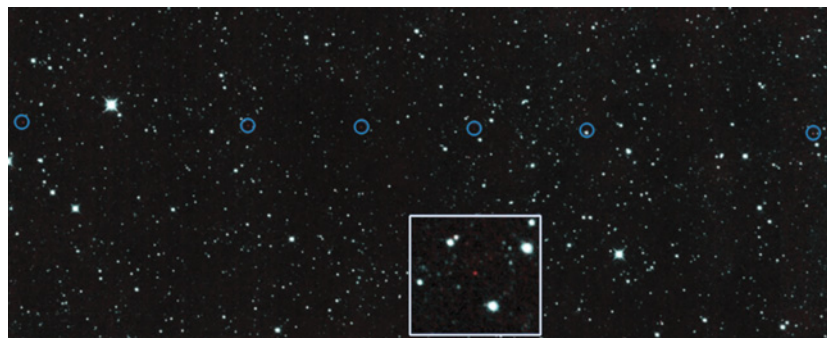
Fictional meteorite striking Paris from the 1998 movie *Armageddon*

and the prediction of those in the future are of more than academic interest, as is the study of asteroids themselves.

Many organizations are searching for NEAs from Earth-based observatories and more recently from space. There are 1450 potentially hazardous near-Earth objects known. The NASA spacecraft NEOWISE (Near-Earth-Object Wide-Field Infrared Survey Explorer) reported discovery of the newest potentially hazardous NEA on December 29, 2013. Using its 20 cm telescope and infrared cameras, it determined the size (650 m), albedo, thermal properties, and trajectory of YP139, which is currently 43 million kilometers from Earth but is predicted to eventually pass within 490,000 km, about the distance from Earth to the Moon. In 2010–2011, the spacecraft discovered 34,000 new asteroids, bringing the total identified by all researchers to about 600,000.

If you are curious about asteroids, read on in this issue of *Elements*. Six articles review the discovery and different types of asteroids, as well as current and future space missions to study or recover them. Asteroids are highly organized, but they do not occur in one homogeneous “belt.” How do they form? What causes a well-behaved body to become a rogue NEA? Three special asteroids are singled out. The former asteroid 2008 TC₃ became the Almahata Sitta meteorite after fragmenting above the Sudanese desert on October 7, 2008. The asteroid Itokawa was sampled by the JAXA mission Hayabusa, providing the only non-meteoritic samples of an asteroid. Vesta is the most-studied asteroid and the second most massive; it was visited by NASA’s Dawn mission and is interpreted to be the source of 100 known meteorites. Whether or not asteroids ever had a PR problem for you, I think you will find this a fascinating issue.

John Valley (valley@geology.wisc.edu)
Principal editor in charge of this issue



The 650 m diameter, potentially hazardous near-Earth asteroid YP139 (red dot in box) was discovered by NEOWISE on December 29, 2013. IMAGE FROM JPL