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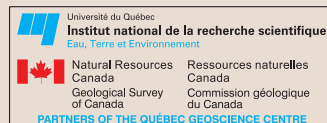
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BREAKING BOUNDARIES



Georges Calas

Fifteen months have passed since a gigantic earthquake and resulting tsunami hit the Japanese islands on March 11, 2011, resulting in some 20,000 people killed or missing. Subsequent flooding of the Fukushima Daiichi nuclear power plant led to a major crisis, with radioactive contamination developing in the ensuing days and creating public fear and confusion. As observed in many countries, this accident may have superseded concerns of how Japan had been severely affected by the megatsunami and, to a lesser extent, the earthquake of March 11. The nuclear side of these catastrophic events is the subject of this issue of *Elements*, which is unusual in its presentation due to the topic treated. With six review articles, and also the *Triple Point* and *Perspectives* sections, this *Elements* issue presents a large variety of factual descriptions and opinions. Indeed, it is expected that the Fukushima Daiichi accident will not only severely affect the continental and coastal environment of this part of Japan, it will also have consequences for future technological choices worldwide. As expressed by Koji Omi in *Science* on March 9, 2012, "There are important lessons to be learned as Japan faces critical decisions not only about rebuilding but also in planning for the nation's future energy needs—lessons that are also relevant to many other countries." Among these lessons, the contribution of nuclear energy to the global energy supply mix is now under reevaluation in some countries, despite the fact that nuclear energy contributes to limiting greenhouse gas emissions and mitigating global climate change.

Nuclear energy-related topics are familiar to *Elements* readers: the December 2006 issue, edited by Rod Ewing, was devoted to the environmental aspects of the nuclear fuel cycle, and this topic was also included in the June 2007 issue on energy. Also, *American Mineralogist* has a virtual special issue on the topic "Mineralogy and the Nuclear Industry." Nuclear energy-related activities may be accidentally impacting our environment at various stages of the nuclear fuel cycle, and we must develop robust, scientifically based predictive models to properly react to unusual situations. Geoscientists bring a unique point of view to this effort, using their expertise on how complex biogeochemical systems interact with external forces and their ability to model and anticipate long-term effects. Issues raised by uranium exploration and exploitation and by the management of nuclear waste, including its disposal in geological repositories, are the main domains of the nuclear cycle in which mineralogists and geochemists are usually involved. Many research activities are then shared between geo-

logical/environmental science and materials science, as both domains become more and more interlinked on topics of mutual interest. The successful "Scientific Basis for Nuclear Waste Management" symposia and proceedings of the Materials Research Society have, for the past 35 years, been a forum involving mineralogists and geochemists, together with materials scientists, and have resulted in original contributions to this area of research. But breaking boundaries between mineralogy and materials science and sharing time and effort between both fields is sometimes not easy, as is often the case in multidisciplinary science. In fact, the extraordinary effort required to do research across disciplinary boundaries may have the effect of making mineralogy seem less relevant, because little credit is given for this effort as soon as it leaves the Earth science sphere. Ironically, the broader application of mineralogy and geochemistry to societal problems may have planted the seeds for their demise in some traditional Earth science departments.

Breaking the "boundary" between "applied" and "fundamental" science is also needed: on which side of the boundary are topics such as

radiation-induced damage in minerals and materials, the thermodynamic properties of actinide systems, or the trapping of fission products and actinides at mineral-water interfaces? Perhaps there will be a proper answer in the time we have left to answer this question: the longer the time left to research, the more the fundamental aspects may be explored. But the Fukushima Daiichi accident reminds us that expertise is sometimes needed on a very short timescale for decisions to be taken in a few days and for a technological solution to be immediately made available.

Facing the consequences of a major nuclear disaster is clearly a global issue, despite the fact that the management of a nuclear reactor is local. This is evident because the terrestrial fluid envelopes—the atmosphere and ocean—are stirred by global circulation and so have worldwide effects. International cooperation needs to be exemplary in urgent situations, and here too it is a matter of breaking boundaries to provide the most useful expertise from all nations. Many countries have been and still are currently involved with damage evaluation in Fukushima, decontamination procedures, and engineering assessment, and many of us have colleagues involved in this activity. A direct result of this work will be learning the response of these environments to such extreme forcing conditions. This will help us to design efficient remediation and reclamation procedures.

This issue of *Elements* has been organized and edited by Takashi Murakami and Rod Ewing in an unusually short time, due to the urgency of the events. We expect it will provide a large audience with advanced scientific information on this "hot" topic. Indeed, technical, political, and

We must develop robust, scientifically based predictive models to properly react to unusual situations.

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THIS ISSUE

A little more than one year after the Fukushima tragedy, this issue of *Elements* provides a summary of the nuclear accident as it has been reconstructed and the lessons that other facilities can take from it, and it gives an overview of the resulting contamination in the air, soils, and ocean. The Perspectives section provides six different points of view on the future of nuclear power in the aftermath of Fukushima. And Travelogue offers an account of a scientist's visit to the evacuation zone. These articles reveal that behind the human tragedy, a large number of scientists are working hard to provide the data necessary to understand the accident and find solutions.

Kudos to guest editors Takashi Murakami and Rod Ewing who accepted the challenge of assembling this issue of *Elements* under a much accelerated schedule: the first invitations to authors were sent out at the end of August 2011. Our gratitude also goes to the authors, who accepted the challenge of writing review articles while so much data are still being amassed—like trying to hit a moving target.

At Goldschmidt 2010, I was impressed by the argument Tennessee Senator Lamar Alexander made in favor of nuclear power as the energy of the future. In his keynote presentation, he reviewed all the energy sources in terms of the land used to produce the energy. For example, the land occupied by one nuclear plant producing enough power for 90,000 homes is one square mile. To produce the same amount of energy, solar power requires 15 square miles, petroleum 18. But the Fukushima Daiichi nuclear power plant accident reminds us that when something goes wrong in this industry, a huge territory can be impacted and the economic costs of bringing an accident under control are staggering. This does not include the suffering of people who have been displaced from their homes and face an uncertain future. About 90,000 persons who lived in the evacuation zone near the plant have not been able to return to their homes. We dedicate this issue to them, and also to the 20,000 persons who died in the aftermath of the earthquake and tsunami.

Earth scientists are providing the scientific basis for addressing critical questions, such as when it will be safe to return to the contaminated areas. This requires multidisciplinary teams that need to avoid being made irrelevant by answering, "We need to do more work." Answers are needed now and have to be clearly communicated to decision makers.

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societal aspects are interlinked in nuclear activities, due to a general attitude of fear towards nuclear power. Better relations between technology and society rely on improved and deepened scientific knowledge and on complete disclosure of the available data. The Fukushima disaster illustrated public suspicion towards the various authorities and company representatives, and even towards the technological and scientific information provided by the organizations and institutions working on the site. Scientists must regain public confidence by clearly communicating in-depth and rigorous studies of the impacts of radioactivity on the various environments and ecosystems. An optimistic vision is that by improving the information available to the public, we will reinforce the need for our authorities to explain the scientific grounds for their political decisions, helping balanced choices to be made.

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UPCOMING EDITOR

We are delighted that Patricia (Trish) Dove of Virginia Tech has accepted our invitation to join the editorial team. She will replace Tim Drever, whose term ends in December 2012. We will formally introduce Trish in the first issue of 2013.

ABOUT DUPLICATE COPIES – PART 2

From time to time, we receive inquiries regarding the management of subscriptions, such as these: "I joined society X and am also member of society Y but I am still receiving only one copy of *Elements*. I would like this second copy to be shipped to a colleague in Estonia!" "I would be happy to only have online access to *Elements* and save you the mailing costs." "My husband and I both receive *Elements*. We only need one copy; please eliminate mine."

As explained in the April issue (8: 84), *Elements'* financial model requires that we eliminate duplicate mailings. This reduces printing and mailing costs, and these savings are passed on to the participating societies in the form of lower subscription rates. So even if you belong to more than one society, you should only receive one copy of *Elements*. We ask our readers to encourage colleagues who are interested in receiving *Elements* to join one of the participating societies.

Although granting requests like online access only might seem like a good idea, it could end up being expensive, as managing these requests would be very time consuming and might necessitate the hiring of a subscription manager, thus erasing any saving and probably increasing costs, which would then have to be passed on to the societies. Put your unneeded paper copy of *Elements* to good use: depending on the topic, send it to your dean, give it to a student, a colleague, or a neighbor.

Pierrette Tremblay, Managing Editor

Elements makes a splash in *Natural History*

With its timely and societally relevant topics, *Elements* has effectively permeated the mineralogy, geochemistry, and petrology community and has even reached other interested scientists and administrators. When geoscientists have the chance to reach out to the general public, it is important that they make the effort to do so. Such an opportunity occurred recently when the editor-in-chief of *Natural History* magazine, Vittorio Maestro, contacted Barb Dutrow and Darrell Henry, guest editors of the October 2011 *Elements* issue on tourmaline, about writing an article for his magazine. Associated with the American Museum of Natural History, *Natural History's* mission is to promote public understanding and appreciation of nature and science. Maestro had read the Tourmaline issue and felt it would draw the interest of his readers. Not since a 2004 article on zircon had *Natural History* focused an article exclusively on a mineral. Working with Vittorio Maestro, Barb and Darrell reconfigured and condensed the six papers from the *Elements* issue into a single article that is visually exciting, scientifically correct, and accessible to the curious public. The article entitled "The Tourmaline Diaries: An Eye-Catching Mineral and Its Many Facets" appeared in the March 2012 issue of *Natural History*. *Natural History* has a circulation of about 50,000, with 1900 libraries and an audience of nearly 200,000.

Barb Dutrow, Louisiana State University

