only to meet with an unexpected hiatus in the volcano's activity.

*Geothermal Energy*

In the Kuriles, Kamchatka, and Aleutians, efficient and reliable energy production is key to economic viability. Accordingly, there is growing interest in, and in some cases successful development of, geothermal systems associated with active volcanoes. A. Abdurakhmanov (IMGG, Sakhalin) and coworkers described the coupled magma/hydrothermal system on Kunashir Island, Kuriles where a small geothermal plant supplies a village with power; and Y. Kugaenko and V. Chebrov (KEMSD) discussed seismicity at the Mutnovsky, Kamchatka geothermal field, whose 60-MW capacity has relieved Petropavlovsk of frequent power blackouts. Finally, V. Droznin and coworkers (IVS, presented by A. Kiryukhin) argued that a substantial hydrothermal reservoir exists within Avachinsky Volcano, adjacent to Petropavlovsk, and called for exploratory drilling.

*The Future*

A closing half-day exchange on emerging and future collaborations stood in contrast to early meetings when there were only a few matters to discuss. This time, the entire workshop easily could have been occupied with such discussions.

A strong consensus emerged that there should be a joint expedition to the central Kurile Islands to instrument them for eruption monitoring and for subduction research. This should be coupled with geologic studies of their volcanic and tectonic history. The Kuriles remain the largest unmonitored gap beneath the heavily traveled air route between East Asia and North America. It is also a region of ignorance in subduction science, despite its attractive status as pure ocean-ocean convergence. Collaboration among Japanese, Russian, and American scientists should continue to be broadened and strengthened in monitoring, research, and education. Equally strong was the desire to meet again at the next stop, Sapporo, in 2006. The JKASP Consortium is open to all students and scientists with an interest in subduction processes, whether or not their interest is focused on the North Pacific.

Abstracts from the meeting and consortium news are available at www.avo.alaska.edu/kasp.

The 4th Biennial Workshop on Subduction Processes was held 21–27 August 2004, in Russia.

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# A Focus on Risk Science and Sustainable Development

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The world faces major threats resulting from the expansion of human activities, among them deterioration of the environment; biodiversity loss; depletion of natural resources through excessive consumption; and in certain regions, destabilization of economies and the social order. Long-term threats to the sustainability of our planet include droughts, degradation of water quality, global warming, nuclear waste disposal, nuclear plant side effects, and the manipulation of life itself. These threats are accompanied by the dangers of natural and human-made disasters at both microscale and macroscale.

How should we intensify our efforts to reduce the number and effects of geophysical, technological, and human-made disasters and to maintain sustainability over the next decades? A recent workshop on Risk Science, Society, and Sustainability, organized by the Commission of the International Union of Geodesy and Geophysics (IUGG) on Geophysical Risk and Sustainability and the European Association for Promotion of Science and Technology, tried to answer the question.

The major scientific goals of this workshop were (1) to provide insight into the relationship between risk science, society, and sustainable development; (2) to search for new possibilities in risk science that focus on the major responsibilities of the scientific community; and (3) to address the problem of implementation of scientific initiatives as elements of public policy.

The workshop focused on the question, Can sustainable development be successful without taking into account the risk of hazards and their impacts? To this end, the workshop brought together experts from the fields of geophysics and mathematics with experts in social science and law specifically to deal with problems of risk and sustainability.

The synergy between these fields of expertise has been successfully demonstrated in the past [e.g., *Beer and Ismail- Zadeh*, 2003], and this workshop explored further applications of such a joint approach. Discussions took place on the social dimensions of proposed scientific initiatives and their implementation at the level of public policy. The workshop discussed a range of topics as diverse as environmental and water risk management and sustainability; earthquake, landslide, and tsunami risks; natural and technological risk modeling; problems of megacities and megarisks; the relationship between problems of risk, sustainable development, and society; and social and legal aspects of risk and sustainability.

Sustainable management of water resource systems may be measured according to many dimensions, risk being among the most important; other dimensions include integrity of the resource in quantity and quality, technological and economic affordability, and institutional and political viability. Measures of risk are difficult to define and even more difficult to estimate. U. Shamir (Technion, Haifa, Israel) presented several approaches to integrating risk considerations into sustainable management of water resources.

The problems of environmental risk management were discussed by T. Beer (CSIRO Environmental Risk Network, Aspendale, Australia) using an Australian case study of emissions from biofuels. The concerns relate to the environmental, economic, and social appropriateness of a political commitment to producing 350 ML of biofuels by 2010. The consequences examined were economic, environmental (greenhouse gases and air pollution), and social (health effects from air pollution, and regional employment). The environmental and social risks were quantified by generating probability distributions of the quantified health benefits associated with the use of the biofuels.

Large seismic events, earthquake-induced landslides, other ground failures, as well as tsunamis were the main components of seismic hazards discussed by G. Papadopoulos (National Observatory of Athens, Greece) in his Rammal Award lecture. Large shallow and intermediate-depth earthquakes and strong tsunamis may have a large area of impact that exceeds national borders. Frequently the extent of destruction creates urgent needs for international mobilization to support rescue operations and provide humanitarian help.

The traditional ways of evaluating risks of earthquakes and tsunamis are often not comprehensive enough, and thus may result in estimates lower than the actual risks of these hazards. For example, earthquakes with a magnitude below 3 are not considered dangerous, because they do not cause significant damage. Meanwhile, such small earthquakes (or even industrial noise) can cause a destructive landslide that may generate a significant destructive tsunami. E. Kontar (Russian Academy of Sciences, Moscow) presented a new approach to risk evaluation of submarine contaminated groundwater discharge, saltwater intrusion, coastal zone earthquakes, landslides, and tsunamis. It combines microseismic zoning using ocean-bottom and onshore sensible portable seismographs, landslide zoning, analysis of the slope stability, and numerical modeling to evaluate a potential tsunami.

As the global population continues to increase, our vulnerability to natural and human-made hazards is magnified with each passing year, undermining our ability to maintain a sustainable and productive world into the 21st century and beyond. Many of the world's megacities are subject to the combined threats of natural, technological, and social risks. F. Wenzel (Karlsruhe University, Germany) discussed various factors which contribute to the increase of megacities' vulnerability, among them high population exposure; dependence of population welfare on proper functionality of transportation, power, water, and communication;

lack of robustness of critical facilities such as public health, public safety, and educational facilities; and weaknesses of preparedness programs and response and relief capabilities. Because of the speed of change in large cities, the key challenge for risk reduction is a dynamic approach that takes temporal changes of hazards, vulnerability, and exposure appropriately into account.

The concept of sustainable development [e.g., *Agenda 21*, 1992] is still descriptive with no strict formalization. One of the attempts to formalize this concept was discussed by A. Makarenko of the National Technical University (Kiev, Ukraine). He presented a new methodology for the evaluation of sustainability and risks in large heterogeneous systems, which incorporate natural, technological, biological, and social components. This methodology is based on cybernetics and synergetic and mathematical modeling and considers a human factor in decision-making, which assists in developing various scenarios of critical events and sustainable development.

One of the key foundations of sustainable development is the precautionary principle, a concept that has given rise to a considerable amount of controversy. For some, it is a barrier to technological progress, for others a means of preventing potentially harmful applications of science. What does this principle actually mean? What is its contribution to sustainable development? How should it be applied? J. Paterson (University of Westminster, London) examined the questions as well as the relationship between risk, sustainability, science, and law.

Risk management and sustainable development are two strategic frameworks currently utilized for studying and managing the environmental consequences of human actions. Are there similarities in these two frameworks? P. Wiedemann (MUT Research Center, Juelich, Germany) believes so, and considers that the risk management and the promotion of sustainable development include a series of comparable tasks: to identify hazards, to quantify the potential losses, to develop criteria for what is meant by "safe enough" or sustainable, and to communicate this to the public or other users of information.

The workshop participants supported the Budapest Manifesto [*Beer and Ismail-Zadeh*, 2003; pp. xv- xvi] (www.iugg.org/budapest.pdf), a guide for scientists who deal with risk and sustainability, which aimed to reinforce the social and vital link between the scientific community and the public. A consensus was reached among the participants that consisted of the following:

1. In the connected world of today, there are new kinds of risks that are not relevant to national sovereignty or, indeed, to regional decision-making, but require a global approach.
2. Risk evaluation must rely heavily, but not exclusively, on modeling and visualization of physical, biological, and social processes and their effects. The results need to be easily grasped by emergency planners, the insurance industry, policy makers, and the public.
3. Scientists and their institutions have an obligation to work with the public to earn their trust and understanding.
4. Ongoing communication between the various groups needs to integrate the social and cognitive dimensions. Scientific knowledge can be useful as a basis for public policy when it is acceptable to society from moral and ethical points of view.
5. Where there are threats of serious or irreversible natural, technological, or social hazard, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Careful evaluation and an assessment of the risk-weighted consequences of various options should guide the application of the precautionary principle.

The workshop participants considered that further progress in hazard and risk reduction requires answers to four key questions:

1. How have humans altered the geosphere, the biosphere, and the landscape, thereby promoting and/or triggering certain hazards and increasing societal vulnerability to such hazards?
2. What technologies and methodologies are required to assess the vulnerability of people and places to hazards, and how might these be used at a variety of spatial scales?
3. How do hazards compare relative to each other regarding current capabilities for monitoring, prediction, and mitigation, and what methodologies and new technologies can improve such capabilities to help civil protection at local and global scales?
4. What are the barriers to the utilization of risk and vulnerability information by governments (and other entities) for risk and vulnerability reduction policies and planning (including mitigation) from various hazards?

There are many existing programs and organizations presently working to seek answers to these questions. The geosciences community is best placed to tackle question 2 but will need to interact with social scientists to determine the best measures to use for vulnerability.

The Workshop on Risk Science, Society, and Sustainability was held 27–28 August 2004, in Stockholm, Sweden.

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*References*

Agenda 21 (1992), Results of the 1992 Earth Summit, United Nations, New York. (Available at http://www.un.org/esa/sustdev/agenda21.htm.)

Beer, T., and A. Ismail-Zadeh (Eds.) (2003), *Risk Science and Sustainability*, 256 pp., Kluwer Acad., Norwell, Mass.

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# BOOK REVIEWS

## Morphotectonics

**ADRIAN E. SCHEIDEGGER**

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Significant advances have been made in the fields of tectono-geomorphology and neotectonics in recent years. The development of satellite geodesy and improvements in geophysical tools for dating Quaternary materials combined with the widespread availability of high-resolution digital topography have improved our ability to resolve the impacts of active tectonics and surface process on sculpting Earth's surface. In recent years, many Earth science departments have shifted emphasis from classical geologic, structural, and tectonic investigations to investigations of neotectonics and landscape evolution, further accelerating our understanding of surface kinematics and the consequent surficial change expressed as the land surface morphology.

The principles of "morphotectonics" as proposed in this book take the unorthodox view that most or all of the preferred orientations of principal landscape features have resulted from weathering of bedrock joints, regardless of their age or origin. The author continues with a somewhat less than orthodox view that it is unimportant to distinguish between brittle fractures without evident slip (the currently held definition of a joint by the fracture mechanics community) and those with small amount of slip (generally recognized as faults). Lastly, the author dismisses the theory of plate tectonics and continental drift as problematic and wrought with inconsistencies and thus of minimal significance to landscape evolution studies.

Some general principles of geomorphology including the principles of antagonism, instability, catena, and selection are reviewed in the short introduction, followed by a discussion of the origin of joints, faults, and wiggly lines, and methods of measuring them in the field. The second chapter, the greater part of the book, is devoted to a craton-by-craton morphotectonic analysis, which consists of comparing joint orientations to local or regional stream and valley segment orientations. The results, documented primarily by the author and collaborators with nominal reference to other structural studies, show agreement between the two features with