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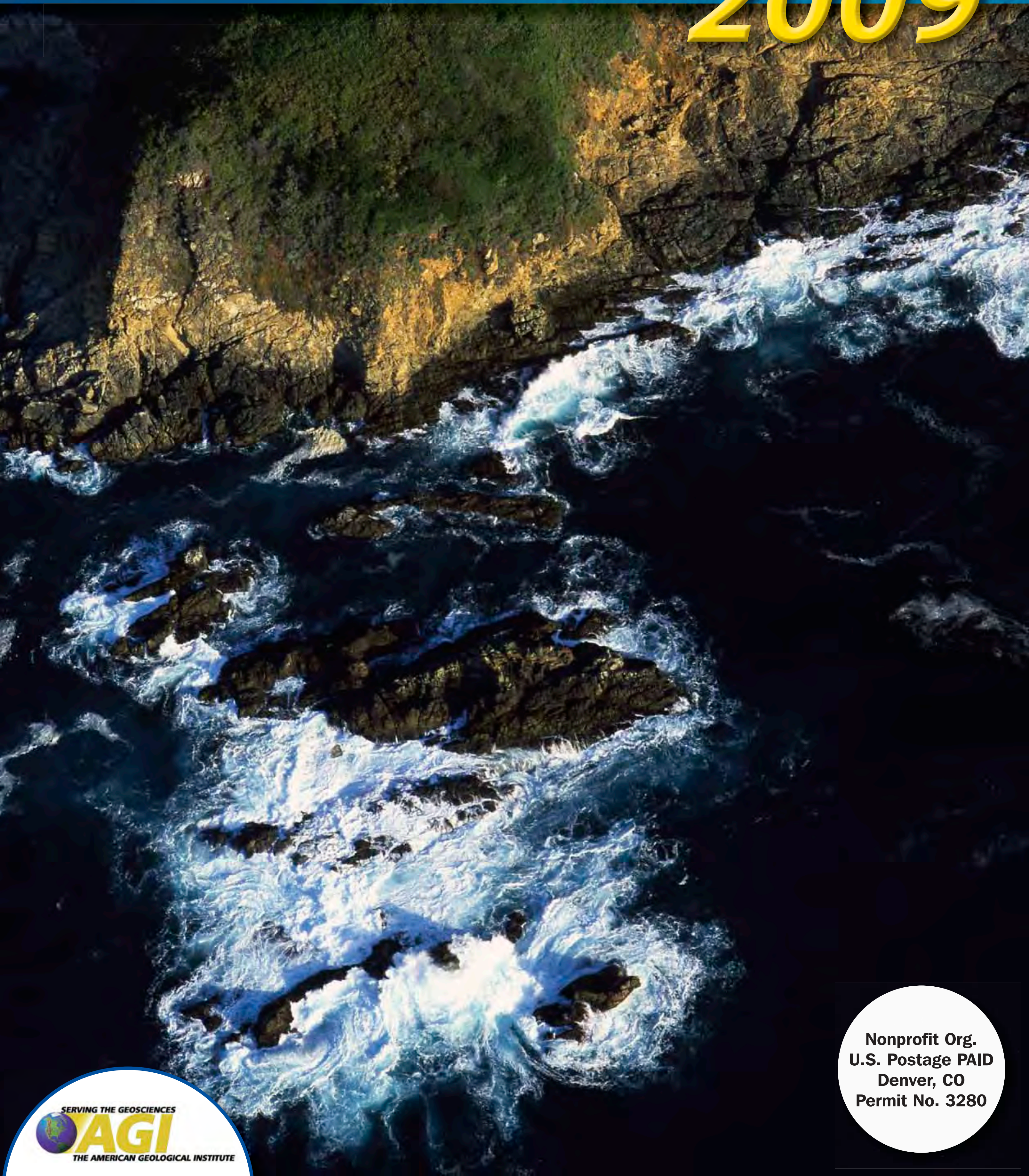

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Cover: Salmon Cone, one of the Santa Lucia Mountains in California's Big Sur country seems to rise up out of the Pacific Ocean. The waves however are constantly eroding the mountain's base. The waves here are in their final stages of creating a wave-cut or marine terrace. image # ivpzsh. This photo: Dunes near Hasbidito Creek on the Navajo Reservation in Arizona. Photo # iejkzy. Both photos Copyright © Michael Collier. From the Earth Science World Image Bank www.earthscienceworld.org/images — see page 22.

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We invite you to look inside the catalog for the informative publications, programs, software and outreach services we provide. We are particularly proud of the evolution of our monthly magazine, Geotimes, which is now EARTH magazine. There is information on our various member societies and their programs, as well.

Turn the catalog over and you will find the great earth science and GIS software from GeoSoft, a generous sponsor of this catalog – www.geosoft.com.

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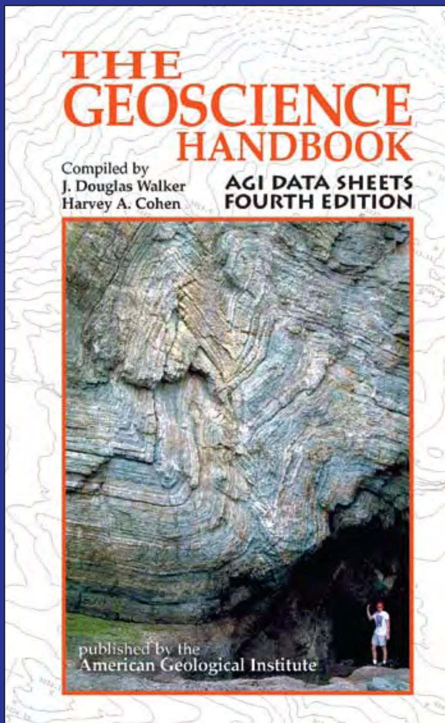

The Geoscience Handbook: AGI Data Sheets Fourth Edition

Compiled by J. Douglas Walker and Harvey A. Cohen

The essential reference for geoscientists in the field, office, or lab, *The Geoscience Handbook* provides a quick reference for the key metrics and concepts, as well as short tutorials on subjects that may not be familiar to all geoscientists. The handbook covers diverse subjects, from geophysics to geologic map symbols to GPS usage, and everything in between! Newly updated for 2007, *The Geoscience Handbook* is now a larger, but still portable, format for easier reading. Also now in full color, the *Handbook* uses color photos when possible to better illustrate geology in the real world. Each book comes with a handy fieldwork ruler and a grain-size scale, both supplied courtesy of the Society for Sedimentary Geology (SEPM.)

ISBN 0-922152-75-6. Spiral bound, 5"x8" 314 pages. $49.95 (*AGI Member Society price $39.95); 1 lbs.

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Copyright © Marli Miller, University of Oregon. Calcite slickenlines on a fault surface. Slickensides are a polished and striated surface that forms along a rock surface as a result of friction along a fault plane. Image # hfyw5t from the Earth Science World Image Bank www.earthscienceworld.org/images.

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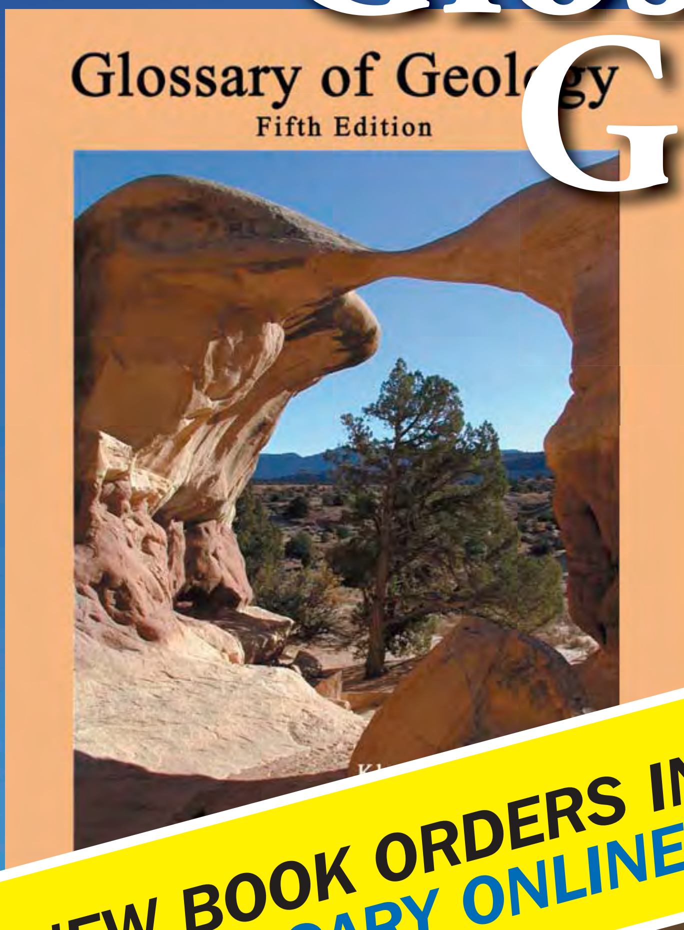
Fifth Edition

Klaus K.E. Neuendorf
James P. Mehl, Jr.
Julia A. Jackson



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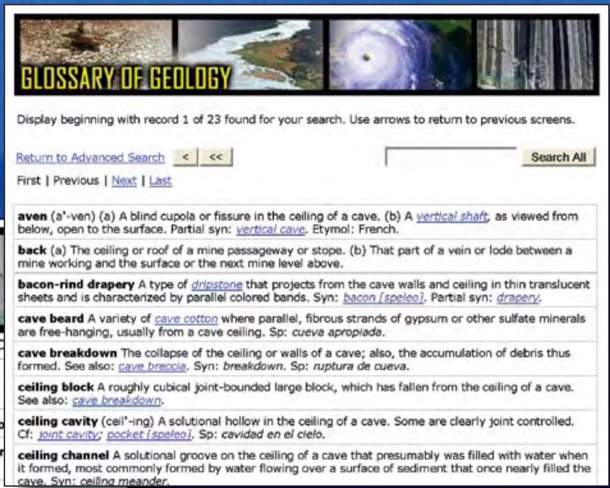

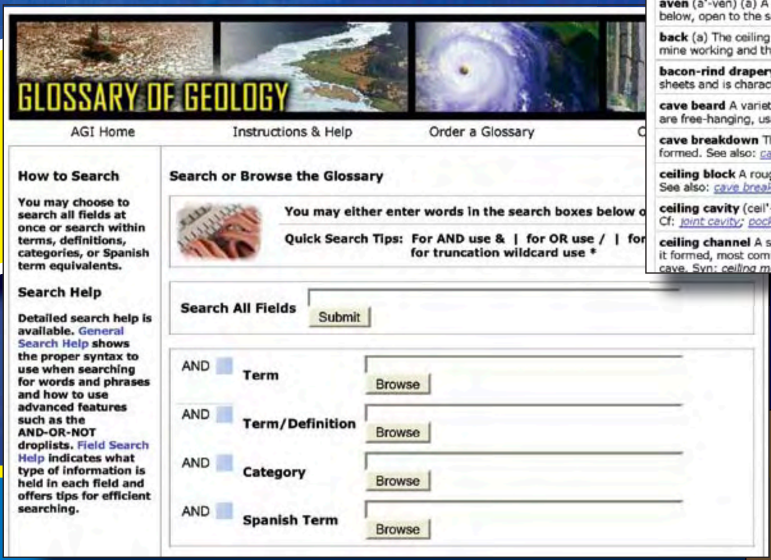

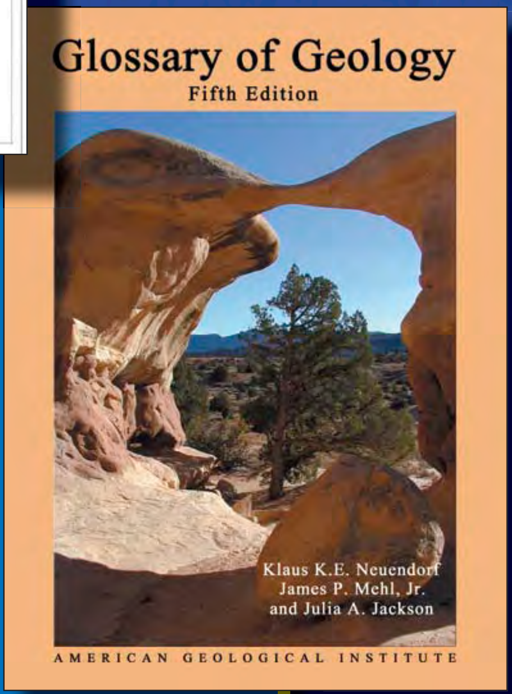

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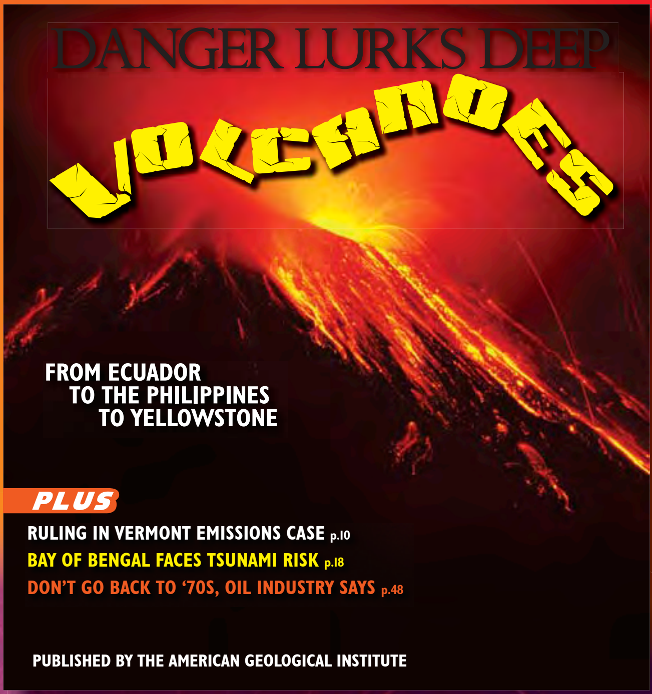

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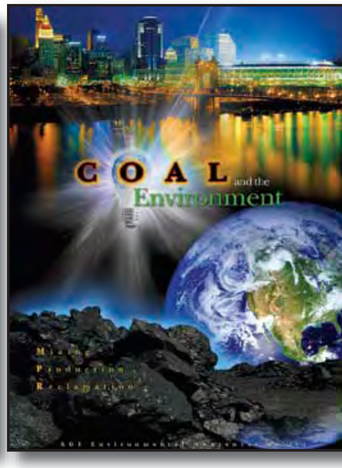

Soils, Society, and the Environment

Thomas E. Loynachan, Kirk W. Brown, Terence H. Cooper, John M. Kimble, Murray H. Milford, David B. Smith

Soil is a fragile, finite resource. How societies manage their soils can directly impact their environments and may even be a determining factor in a society's long-term success or failure. President Franklin D. Roosevelt eloquently stated the significance of soils to the global community when he said, "A nation that destroys its soils destroys itself".

Soils, Society and the Environment, produced in cooperation with the Soil Science Society of America, the USDA Natural Resources Service and the U.S. Geological Survey, focuses mainly on soil as society's primary source of food and fiber (such as cotton and wood). Growing plants in soil is the only known way to produce large quantities of these necessities, and the implications of that fact are profound. Includes a full-color poster with an investigative activity for students on back

ISBN 0-922152-74-8. Item #603604. Full-color paperback, 8.5"x11" 64 pp. 1 lb. $9.95 (*$7.96 for members of AGI Member Societies.)

Coal and the Environment

S. F. Greb, C. F. Eble, D. C. Peters, A. R. Papp

Coal is the world's most abundant fossil (hydrocarbon) fuel, occurring in 37 of the 50 U.S. states. Today, 90 percent of the 1.1 billion short tons of coal produced in the United States each year are used for electricity generation; contributing 51 percent of U.S. electrical energy needs. Coal resources are also essential in the production of steel and other heavy industrial processes, such as the production of cement.

The United States has more coal reserves than any other country, about 30 percent of the world's total known coal reserves. U.S. reserve estimates exceed 500 billion tons of which 275 billion tons are economically recoverable using existing technologies. The demand for coal resources is growing, and U.S. coal consumption is expected to increase from 1.1 billion tons per year in 2000 to 1.5 billion tons in 2020.

Coal and the Environment explains the uses and importance of coal, the environmental concerns associated with its mining and use, and how technological advances are making coal an environmentally cleaner fuel. Because coal is such an abundant, low-cost source of needed energy, developing even more environmentally sound ways to use coal in the future is very important. Includes a full-color poster with an investigative activity for students on back

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Environmental Awareness Series books are also available at www.amazon.com

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Water and the Environment

Stephen J. Vandas, Thomas C. Winter, and William A. Battaglin

Produced in cooperation with the Bureau of Reclamation, National Park Service, U.S. Army Corps of Engineers, USDA Forest Service, and the U.S. Geological Survey.

Water — not oil or minerals — is the most controlling resource on Earth. Its distribution, quantity, availability, and quality are the controls for the development of agriculture, industry, rural, urban, and municipal use. *Water and the Environment*, the fifth publication in the AGI Environmental Awareness Series, provides information about water and its importance; where water comes from; water-related environmental concerns; water protection, policies and regulations; and our future needs for water. This richly illustrated, non-technical publication is appropriate for the general public, educators, and policy-makers. Includes a full-color poster with an investigative activity for students on back

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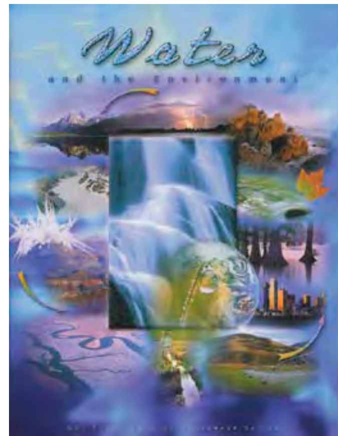

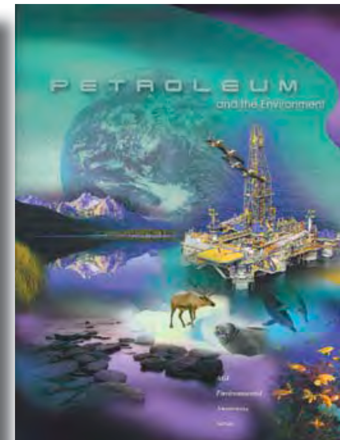

Petroleum and the Environment

William E. Harrison and Stephen M. Testa

Produced in cooperation with the American Association of Petroleum Geologists Foundation, Bureau of Land Management, Minerals Management Service, USDA Forest Service, U.S. Department of Energy, and the U.S. Geological Survey

Concerned citizens recognize the need to manage both our petroleum resources and natural environments wisely. This publication provides an introduction to the major environmental concerns and solutions associated with petroleum exploration, production, transportation, and use. Includes a full-color poster with an investigative activity for students on back

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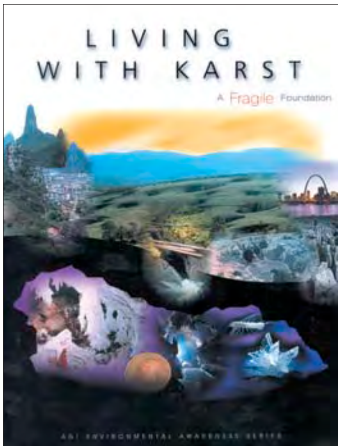

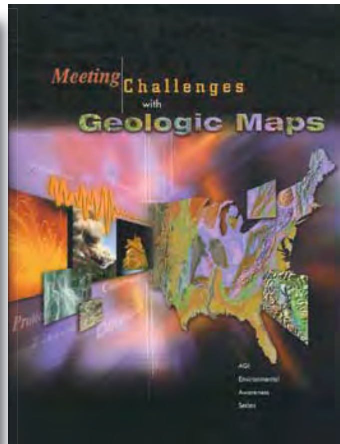

Living With Karst — A Fragile Foundation

George Veni, Harvey DuChene, Nicholas C. Crawford, Christopher G. Groves, George N. Huppert, Ernst H. Kastning, Rick Olson, Betty J. Wheeler.

Produced in cooperation with the National Speleological Society, American Cave Conservation Association, Bureau of Land Management, Illinois Basin consortium, National Park Service, USDA Forest Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey.

Although the term "karst" is not widely known, nearly 25% of the world's population lives in karst areas. *Living With Karst*, the fourth booklet in the AGI Environmental Awareness Series vividly illustrates what karst is and why karst areas are important. The booklet also discusses karst-related environmental and engineering concerns, guidelines for living with karst, and sources of additional information. Includes a full-color poster with an investigative activity for students on back

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Meeting Challenges with Geologic Maps

William A. Thomas

The first geologic map was prepared to solve a practical problem involving the distribution of different types of rocks at and near the Earth's surface, and that is still the reason geologic maps are made today. Geologic maps are our most important and complete compilation of information about the solid Earth we live on, and we cannot understand the Earth without them. We use geologic maps and the fundamental information they provide in many ways. *Meeting Challenges with Geologic Maps* presents 16 examples that show how geologic maps are helping to delineate fragile habitat and ecosystems, protect against natural hazards (earthquakes, volcanic eruptions, landslides, and sinkholes), and find needed resources (groundwater, metals, coal, and sand and gravel).

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Sustaining Our Soils & Society

Thomas E. Loynachan, Kirk W. Brown, Terence H. Cooper, and Murray H. Milford

The booklet, *Sustaining Our Soils and Society*, and the colorful poster, Soils Sustain Life, offer new tools for raising awareness and understanding of our soil resources. The soils booklet and poster can help you:

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- Provide a geoscience perspective on soils and the environment
- Improve Earth science literacy
- Increase student understandings of Earth materials and systems
- Achieve content objectives of the National Science Education Standards

Includes a full-color poster with an investigative activity for students on back

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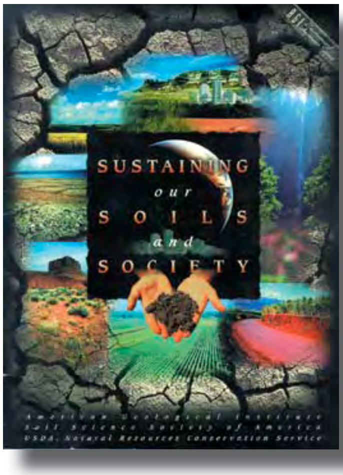

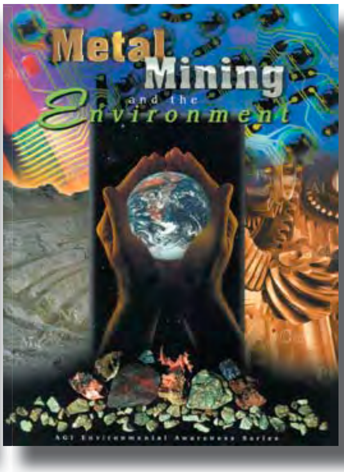

Metal Mining and the Environment

Travis Hudson

The booklet, *Metal Mining and the Environment*, offers new tools for raising awareness and understanding of the impact and issues surrounding metal mining and the environment. This booklet and poster can help you:

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- Provide a geoscience perspective on metal mining and the environment
- Improve Earth science literacy
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Includes a full-color poster with an investigative activity for students on back

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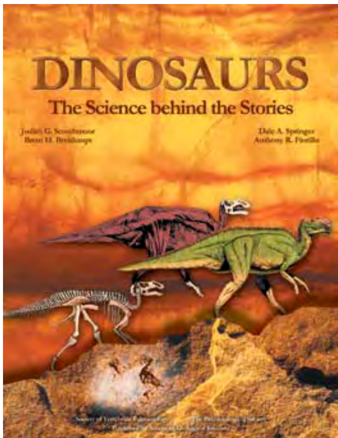

Dinosaurs: The Science Behind the Stories

Edited by Judith G. Scotchmoor, Dale A. Springer, Brent H. Breithaupt, and Anthony R. Fiorilloa

Using dinosaurs to illustrate the nature and methods of science, leading paleontologists relate how we know what we know. Follow their fascinating journey as they work through multiple lines of evidence that have led to new hypotheses, discoveries, and understandings of the history of life on Earth.

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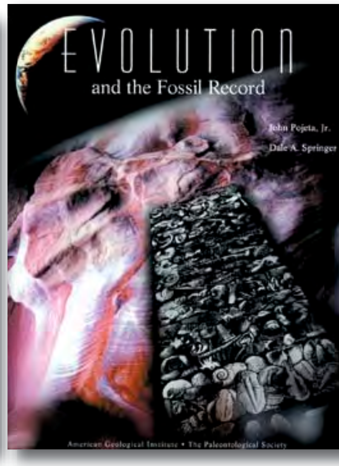

Evolution and the Fossil Record

John Pojeta, Jr. and Dale A. Springer

Evolution and the Fossil Record, an eye-catching booklet produced by the American Geological Institute in cooperation with the Paleontological Society, aims to help the general public gain a better understanding of one of the fundamental underlying concepts of modern science.

Colorful photos, drawings, and illustrations complement the authors' conversational style as they discuss geologic time; change through time; Darwin's theory of evolution; evolution as a mechanism for change; the nature of species; the nature of theory; paleontology, geology, and evolution; and determining the age of fossils and rocks. Four "case study" examples from the fossil record — evolution of vertebrate legs, evolution of birds, evolution of mammals, and evolution of whales — are presented to provide a time perspective for understanding the evolution of life on Earth. This non-technical introduction to evolution contains straightforward definitions as well as discussions of complex ideas.

ISBN 0-922152-57-8. Paperback, 8.5"x11" 32 pp. item #300113. $8.95 (*AGI Member Society price $7.16); 1 lb.

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Christopher M. Keane and Cynthia M. Martinez, Editors

The *Directory of Geoscience Departments 46th Edition* provides a state-sorted listing of 2,023 geoscience departments, research departments, institutes, and their faculty and staff. Also includes:

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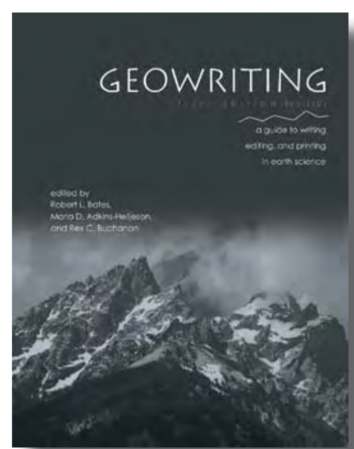
Departmental listings identify faculty by rank, highest degree, year and source of degree, and geologic specialty. A faculty index by last name shows individual faculty e-mail addresses and phone numbers. Other departmental information includes latest enrollments, degrees granted, and field-camps offered. The DGD also lists research institutes, selected natural-history museums, state geological surveys, federal agencies and national laboratories.

ISBN 0-922152-80-2, ISSN 0364-7811, paperback, 6”x9” 415 pp. item #300349. 2 lbs.

Geowriting: Fifth Edition, Revised

Edited by Robert L. Bates, Marla D. Adkins-Heljeson, and Rex C. Buchanan



This introduction to writing, editing, and printing will help students and scientists cope with a process that many dread — writing something for publication. Although *Geowriting* has been prepared especially for authors and editors working in the earth and environmental sciences, the publication provides useful information for any writer or editor. This how-to manual will encourage you to write, edit, and package your ideas for publication.

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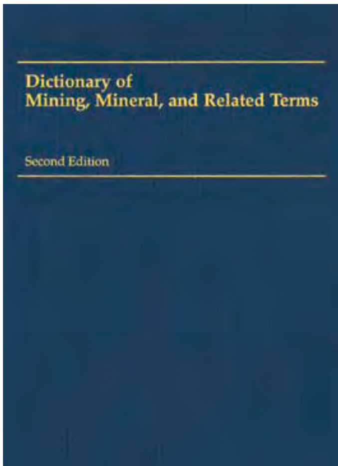

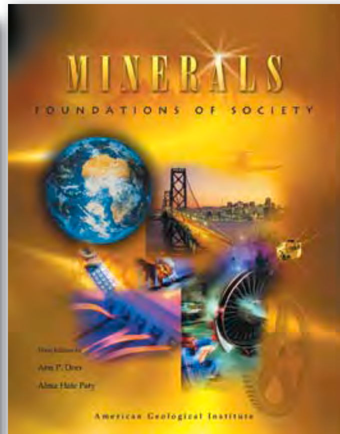

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Ann P. Dorr and Alma Hale Paty

In this richly illustrated 96-page volume, the authors provide an objective overview of non-fuel minerals and the critical role they play in societies throughout the world. Written in a reader-friendly style, *Minerals — Foundations of Society* describes the significance, origin, and distribution of minerals as well as the economic, political and social issues affecting the development and use of mineral resources. The third edition includes a dramatic poster with an educational activity for students.

ISBN 0-922152-60-8. Paperback, 8.5”x11” 96 pp. item #300109.
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Dictionary of Mining, Mineral, and Related Terms Second Edition

Compiled by the American Geological Institute for the U.S. Bureau of Mines

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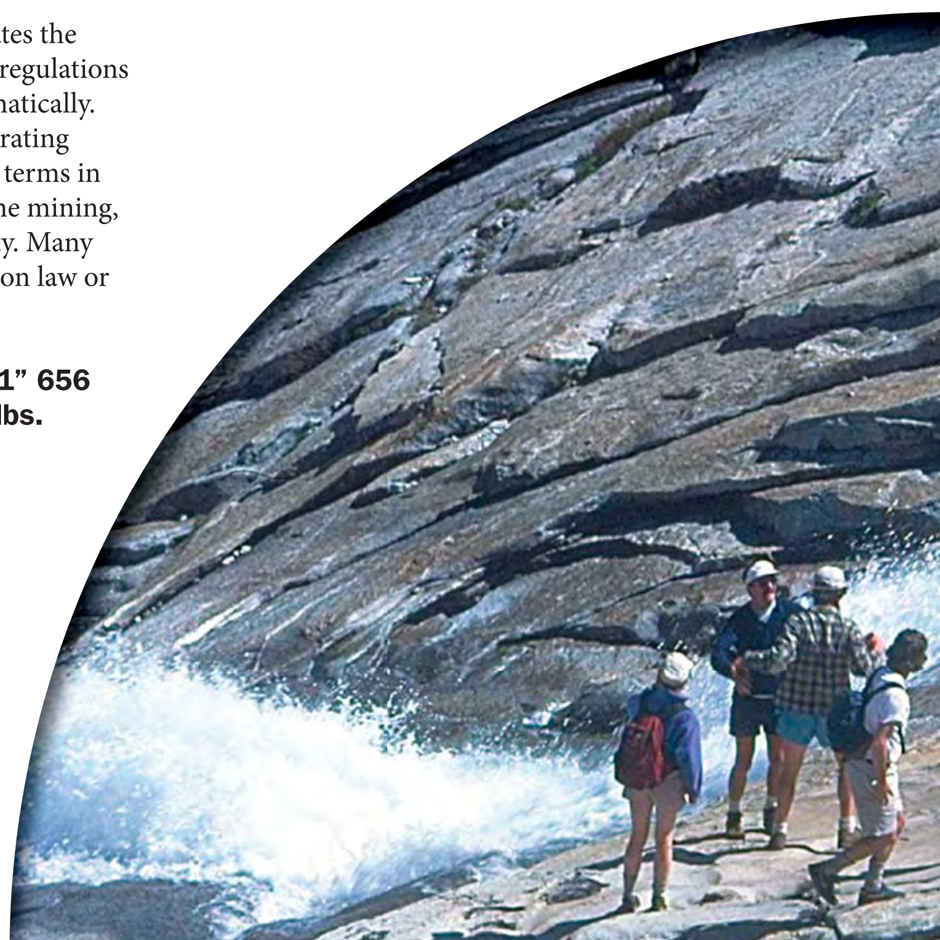

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Dictionary of Geological Terms Third Edition

Edited by Robert L. Bates and Julia A. Jackson

Contains 8,000 terms and definitions that cover the core vocabulary of the earth sciences. This edition includes more than 1,000 new terms; accurate definitions without technical jargon; hyphenation and pronunciation guide; commonly used abbreviations; and a geologic time and life chart. The definitions in this book are drawn largely from the authoritative 37,000-term *Glossary of Geology*, third edition, to which nearly 150 specialists from all fields of the geosciences contributed. Ideal for high-school and college students, science teachers, and rockhounds!

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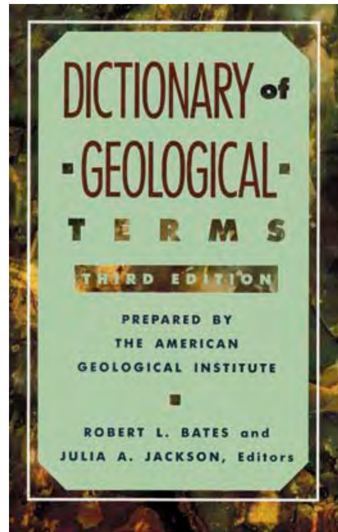

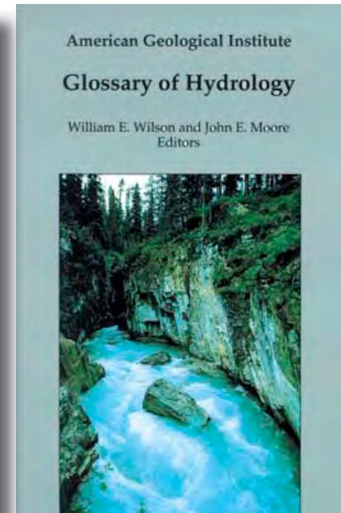

Glossary of Hydrology

Edited by William E. Wilson and John E. Moore

This glossary is perfect for anyone who must think and write concisely about hydrology. Hydrologists, environmentalists, or any professional geoscientists, engineer, or student can use it to define their research in current terminology. With more than 4,000 terms, many with background information, the *Glossary of Hydrology* will be an invaluable addition to your reference library. Selected terms include: hydrogeology, surface water hydrology, hydrochemistry, meteorology, oceanography, engineering geology, environmental geology, soils, and other related fields.

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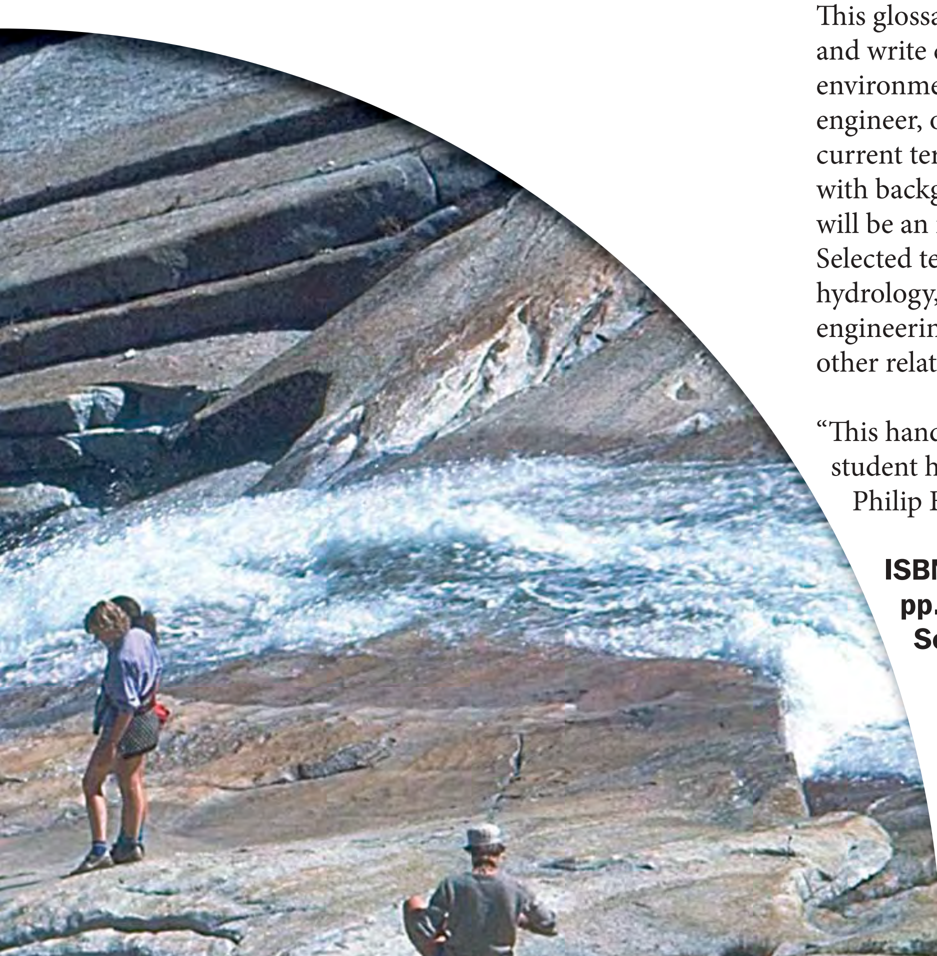

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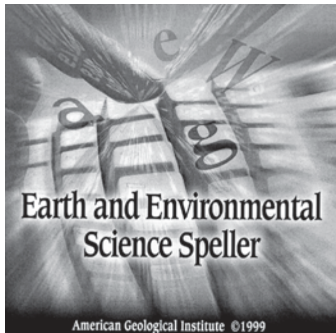

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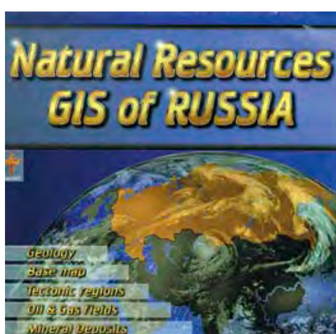

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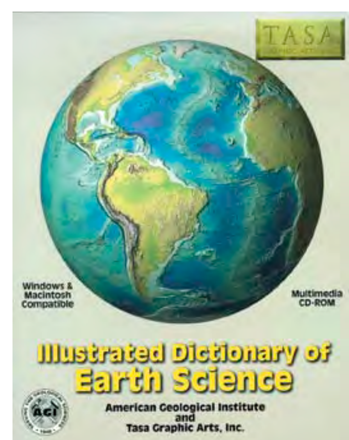

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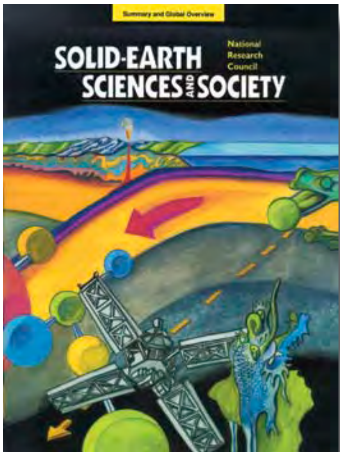

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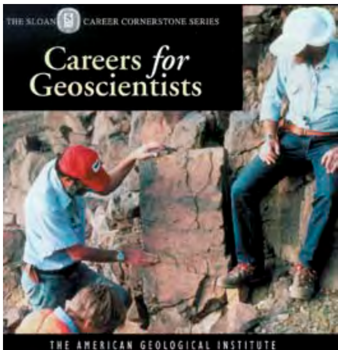

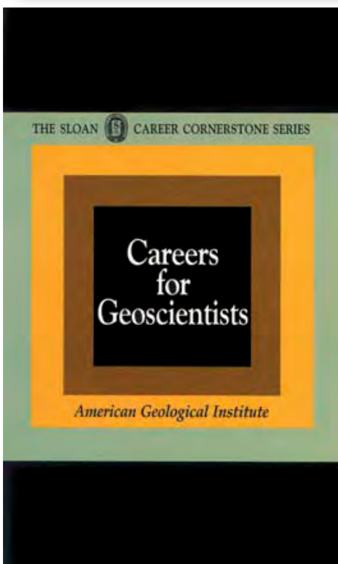

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Courtesy National Oceanic and Atmospheric Administration. This image shows paleoclimatologists extracting a core with a hydraulic drill on a Porites lobata colony, Clipperton Atoll. The drilling is completed and the core segment is removed from the hole. The drill goes all the way into the coral. Next, the scientists carefully extract the core pieces, label them, and box them for safe shipment home. Back in the laboratory, the field work will be followed by new discoveries and new insights into our planet's past. Image # h2a882 from the Earth Science World Image Bank www.earthscienceworld.org/images.

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P. Hearn, Jr., T. Hare, P. Schruben, D. Sherrill, C. LaMar, P. Tsushima

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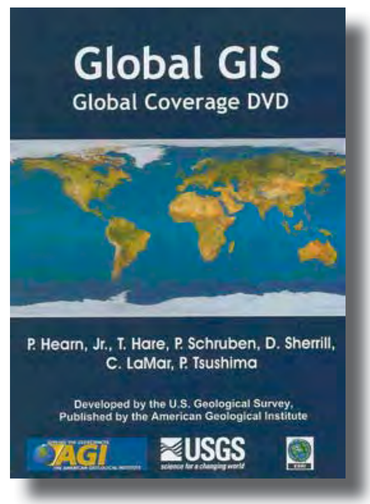

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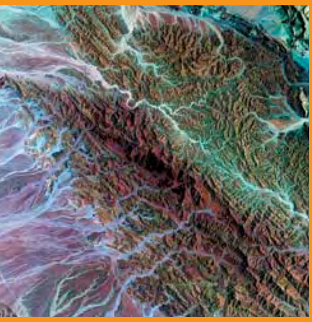

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Earth From Space

Andrew Johnston
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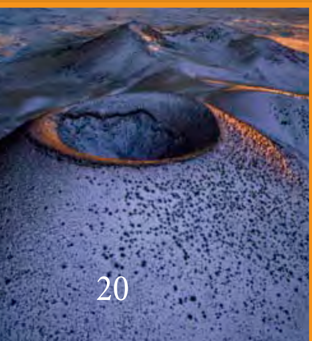

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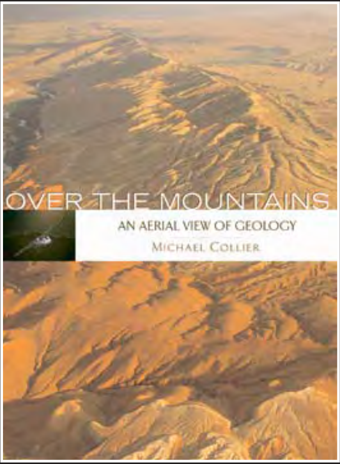

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Michael Collier, Mikaya Press, 2007

ISBN 1-9314-1418-1. Hardback, 9.5"x12.5" 128 pp. item #300347. $29.95; 3 lbs. (No discount price available.)

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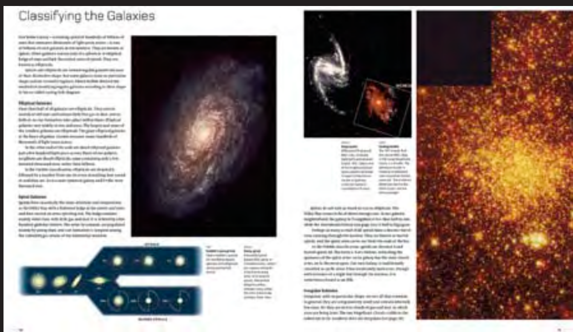

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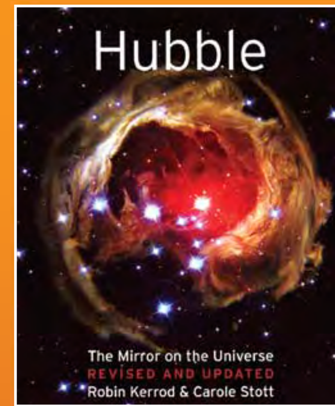

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Robin Kerrod and Carole Stott
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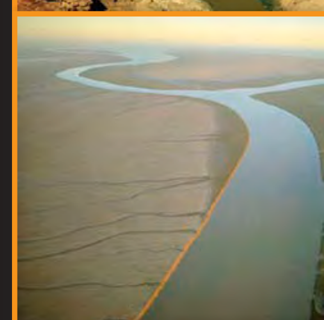

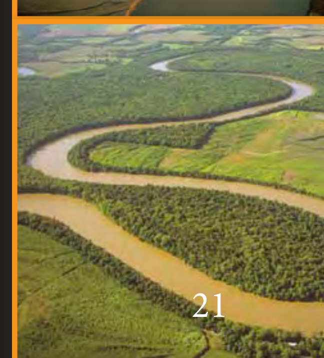

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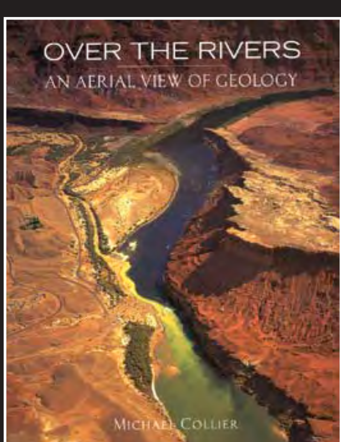

Over the Rivers inspires as it informs, and dazzles as it enlightens.

Over the Rivers

Michael Collier, Mikaya Press, 2008

ISBN: 1-9314-1421-1. Hardback, 9"x12" 128 pp. item #300350. $34.95; 3 lbs. (No discount price available.)

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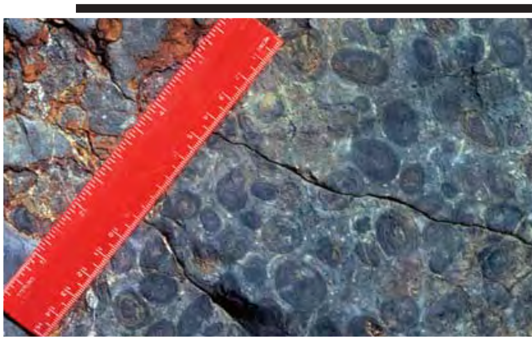

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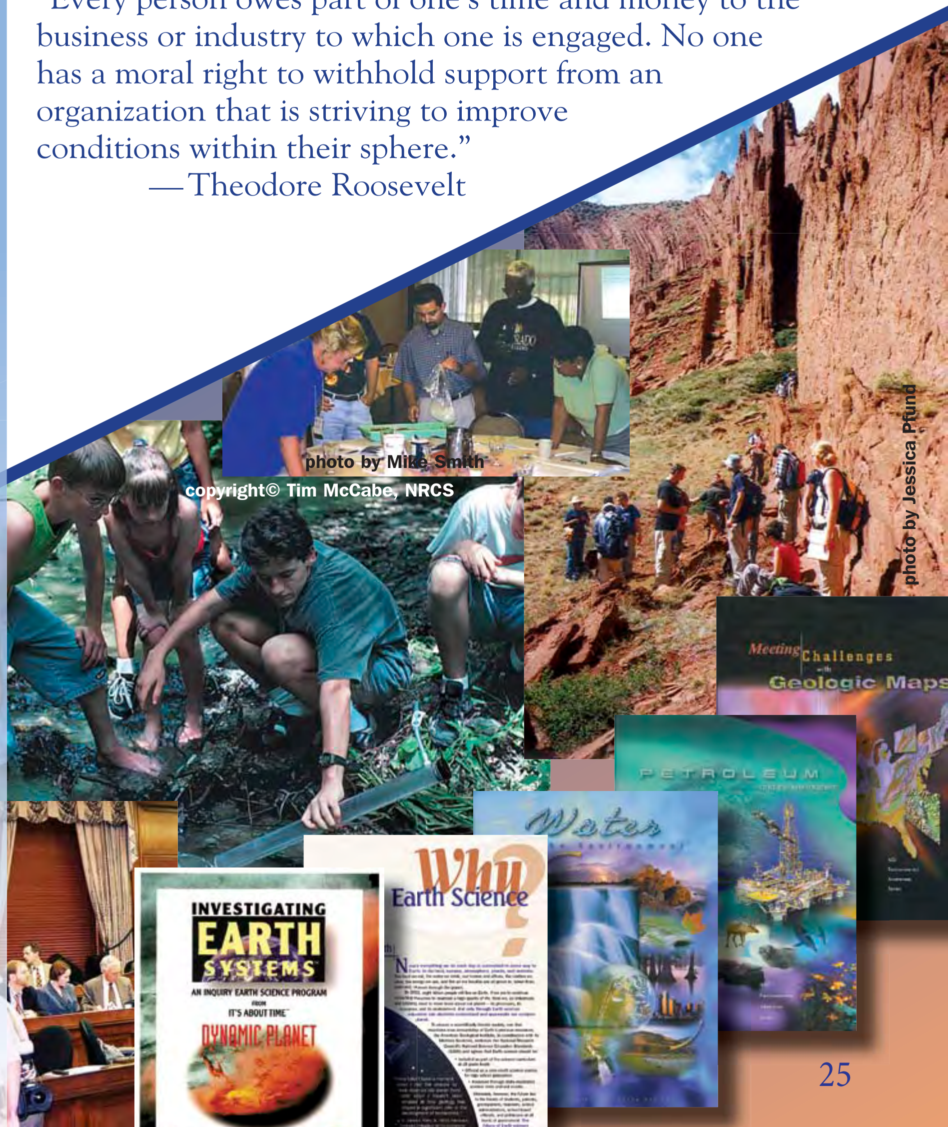

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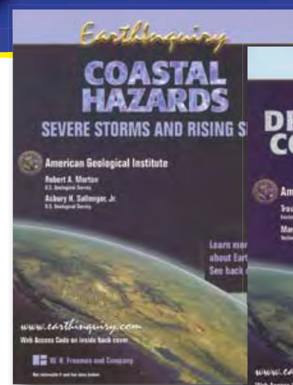

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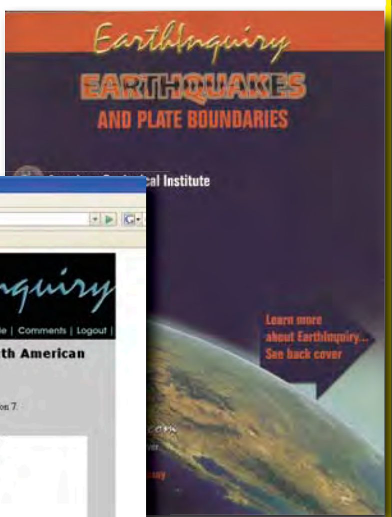

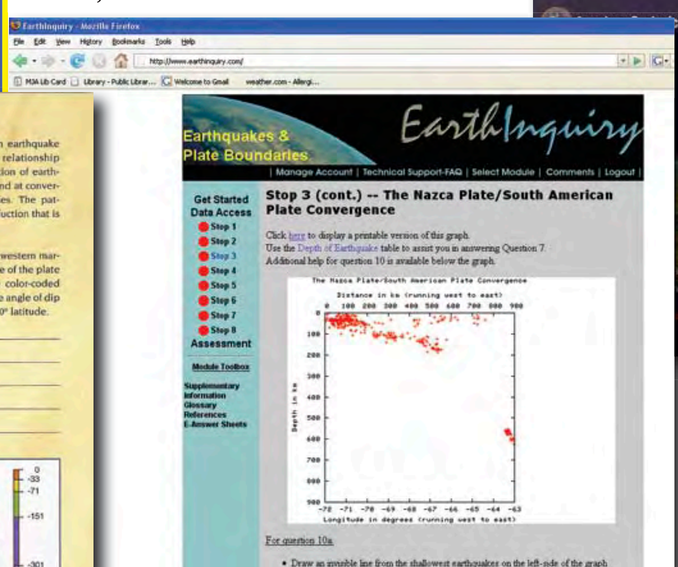

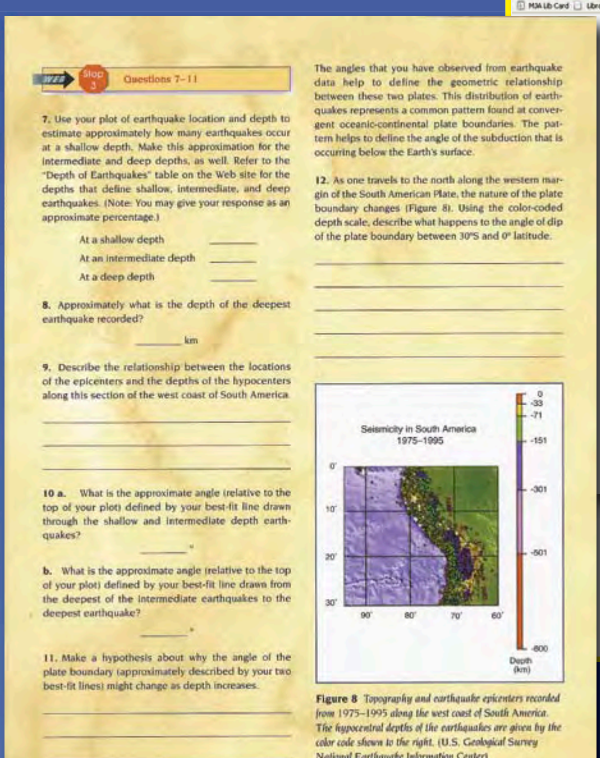

Stop 3 Questions 7–11

7. Use your plot of earthquake location and depth to estimate approximately how many earthquakes occur at a shallow depth. Make this approximation for the intermediate and deep depths, as well. Refer to the "Depth of Earthquakes" table on the Web site for the depths that define shallow, intermediate, and deep earthquakes. (Note: You may give your response as an approximate percentage.)

At a shallow depth ______

At an intermediate depth ______

At a deep depth ______

8. Approximately what is the depth of the deepest earthquake recorded?

______ km

9. Describe the relationship between the locations of the epicenters and the depths of the hypocenters along this section of the west coast of South America.

10 a. What is the approximate angle (relative to the top of your plot) defined by your best-fit line drawn through the shallow and intermediate depth earthquakes?

______°

b. What is the approximate angle (relative to the top of your plot) defined by your best-fit line drawn from the deepest of the intermediate earthquakes to the deepest earthquake?

______°

11. Make a hypothesis about why the angle of the plate boundary (approximately described by your two best-fit lines) might change as depth increases.

The angles that you have observed from earthquake data help to define the geometric relationship between these two plates. This distribution of earthquakes represents a common pattern found at convergent oceanic-continental plate boundaries. The pattern helps to define the angle of the subduction that is occurring below the Earth's surface.

12. As one travels to the north along the western margin of the South American Plate, the nature of the plate boundary changes (Figure 8). Using the color-coded depth scale, describe what happens to the angle of dip of the plate boundary between 30°S and 0° latitude.

Seismicity in South America 1975–1995

Figure 8 *Topography and earthquake epicenters recorded from 1975–1995 along the west coast of South America. The hypocentral depths of the earthquakes are given by the color code shown to the right. (U.S. Geological Survey National Earthquake Information Center)*

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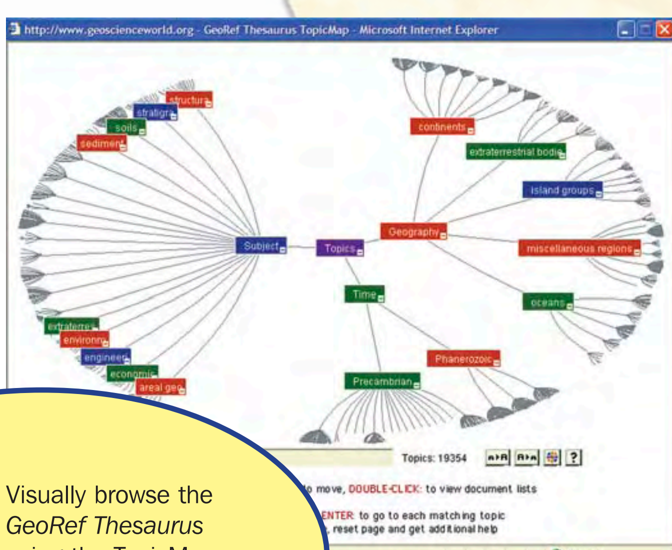

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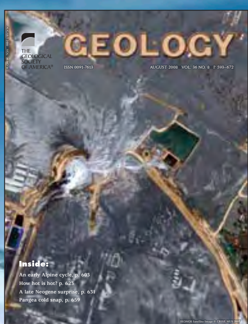

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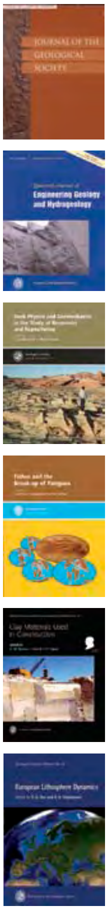

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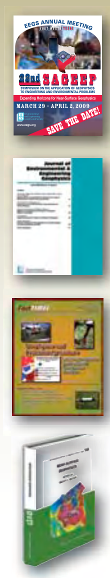

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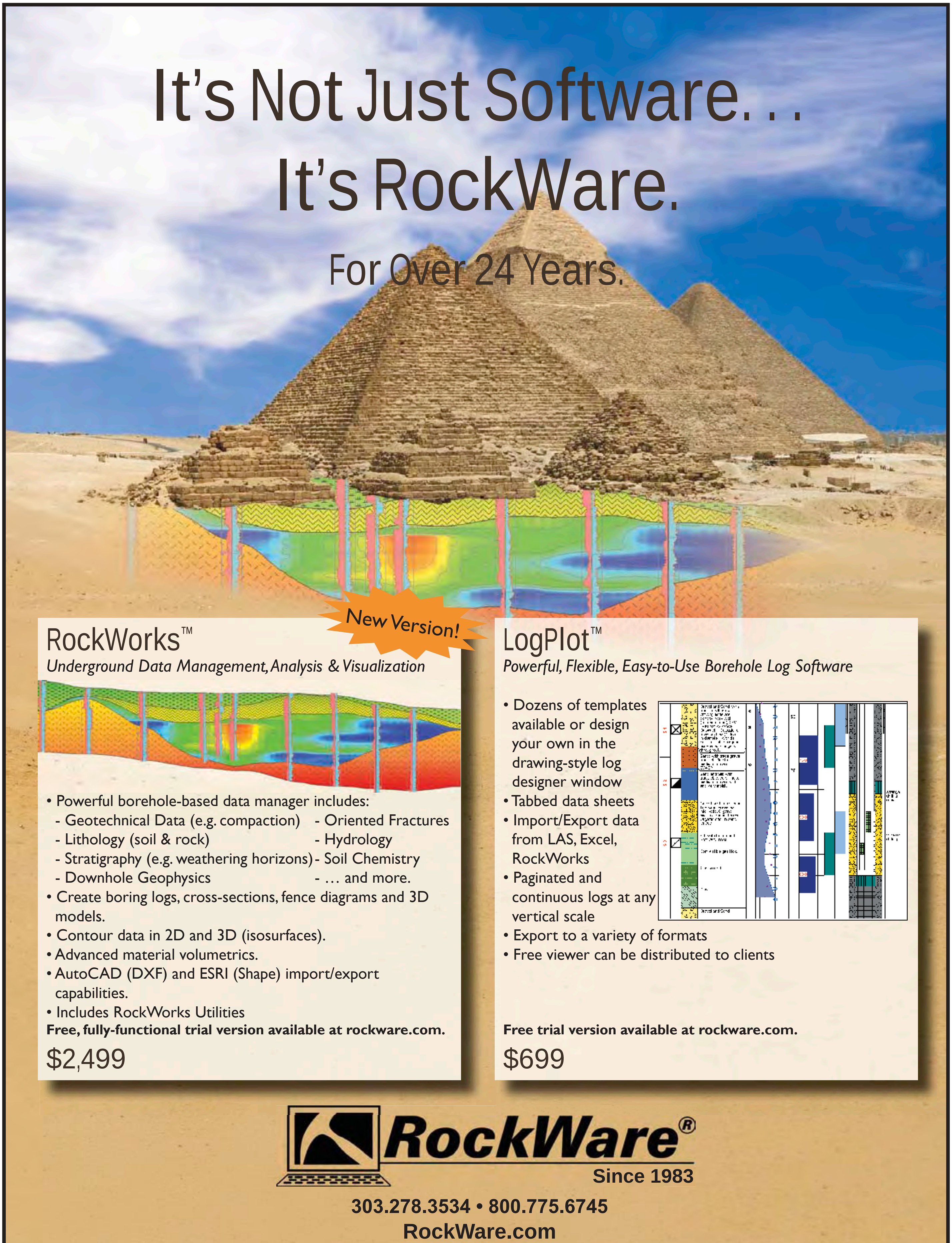
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In this Annual issue of Earth Explorer we report on the resurgence of gravity and magnetic methods in Oil exploration, and new Volcanogenic Massive Sulphide (VMS) exploration that is uncovering missed ore deposits in old mining camps.

Our article on Oklahoma State University looks at their integrated approach for preparing a new generation of geoscientists that will have to hit the ground running. And in our Rock Science article, we visit inside Brazil's Museum of Earth Sciences which is celebrating its 100th anniversary.

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Ice cave at the terminus of the Theil Glacier, SE Alaska: Chip Kalvin

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THE NEW FRONTIER:

Exploring for oil with gravity and magnetics

Mark Wolfe

Advancements in earth mapping technologies, coupled with the industry's emerging need to characterize sub-surface systems, have led to a resurgence of interest in using gravity and magnetic methods in Oil and Gas exploration and development.

With global fuel shortages and oil prices at record levels, Oil and Gas explorers are looking at deeper and more expensive targets. Proven, low-cost techniques like gravity and magnetic are being brought in earlier in the project cycle to minimize the risk of more costly seismic investigations.

Gravity and magnetic (or potential field) methods have a long history of use in the oil and gas industry dating back to the 1920s, but the petroleum industry lost interest in these techniques in the early '90's due to the rapid advances in seismic techniques.

Faced with the challenge of meeting growing global demand for gas supply, the industry has been steadily expanding exploration efforts into frontier and seismicly challenging areas. Both are environments ideally suited to gravity and magnetic techniques.

"Potential fields are typically used in frontier areas to do reconnaissance exploration, to look for new basins, and to investigate large areas that might be prospective for doing more detailed and expensive seismic work," says Gerry Connard, Petroleum Industry Market Manager with Geosoft Inc., a Canada-based exploration software company.

Although seismic visualization technology still remains the powerhouse of oil and gas exploration, the industry now has the tools and the knowledge to integrate the best of this technology with gravity and magnetic methods. By combining technologies, the industry has added a robust new dimension that is enabling explorers to look more quickly and efficiently into the uncharted frontier, while reducing the risks associated with technically challenging exploration.

Exploration in the new frontier areas can be an order of magnitude more costly using seismic visualization when compared to the less expensive potential field methods. Economics aside, Connard says that gravity and magnetic methods are commonly used in areas where seismic work is difficult or impossible. He notes as an example instances where you are trying to gather images beneath basalt-covered areas that have high-velocity rocks near the surface or exploring sub-salt plays. "When visualizing salt structures, seismic technology is very effective for imaging top of salt but has difficulty imaging below the salt because of the high velocity of salt," Connard says. "Gravity and magnetics have been used extensively in sub-salt exploration to integrate with the seismic data and image the base of the salt, or to assist in the processing of the seismic data."

EXPLORATION SUCCESS IN SOUTH AMERICA

Brazilian-based Petrobras has experienced major success using gravity and magnetic methods with the discovery of a major natural gas and condensate field in the pre-salt layer, at a depth of 5,000 meters, in the Santos Basin located in the southeastern part of the country. The field, named Jupiter, may have the same dimensions as Tupi, a newly-discovered field believed to be Brazil's biggest oil-bearing area. The Jupiter well is 290 kilometres off the Rio de Janeiro state coast and 37 kilometres east of the Tupi area.

The Petrobras discovery reinforces the notion that there is decreased exploration risk in the pre-salt layer. In their announcement of the discovery, Guilherme Estrella, Petrobras Exploration and Production Director is quoted as saying, "All of the pre-salt blocks achieved exploratory success, something that confirms the region's high prospectivity."

In the Santos Basin alone, the company has stakes in 13 blocks in initial exploratory phase in the pre-salt layer. The Tupi field discovery was considered a new frontier for the industry. The state-run oil firm reported last year that production tests confirmed the existence of a "significant volume" of 30 degrees API crude oil. The field is located more than 7,000 metres below the ocean's surface.

Gravity and magnetic methods are also starting to be used by junior companies engaged in frontier exploration. "There's been an explosion of smaller oil companies starting up and getting into exploration in the last several years. These companies are really flying under the radar and are having great success," Connard says. "Many of them are starting to use gravity and magnetics in their exploration particularly in the frontier areas that have not been explored extensively in the past."

Land gravity measurement with differential GPS positioning.

TECHNOLOGY ADVANTAGE

Advances in software that provide the ability to effectively display, rapidly assess, and dynamically experiment with multiple datasets have helped to reduce risk and increase prospecting capabilities in exploration. These technological innovations have helped to make the use of gravity and magnetic methods in the oil and gas industry more effective.

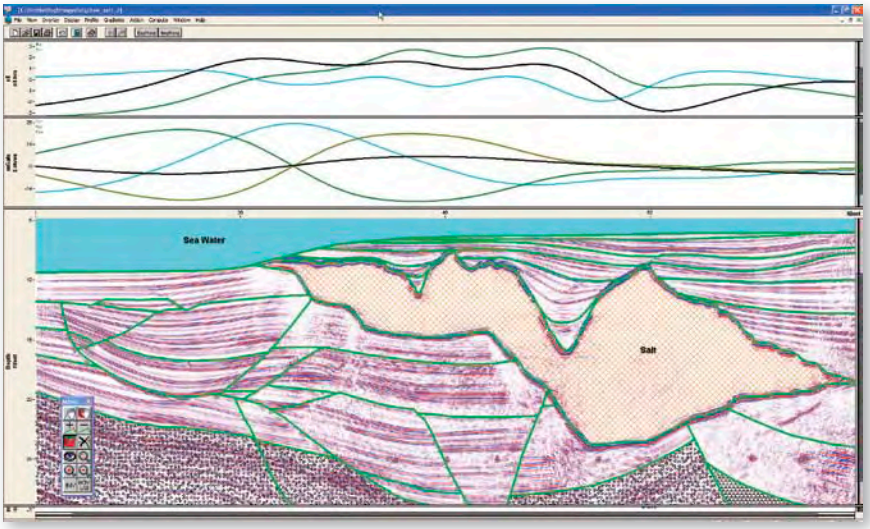
"From the interpretation side, there is better software available to integrate the gravity and magnetics with the seismic and other geophysical and geological data," Connard says. "This kind of technological integration has been key."

Utilizing today's visualization tools, geoscientists are able to reduce risk and increase their understanding by looking at as much different data as they can, in as many different ways as they can, within compressed project time frames.

Despite the fact that exploration companies are leaner, with fewer people and shorter project time frames, Dr. Michal Ruder, Consulting Geophysicist and Principal of U.S.-based Wintermoon Geotechnologies Inc., has seen exponential improvements in productivity and data quality as a result of new software for mapping and visualization.

For Dr. Ruder, whose livelihood depends upon delivering accurate, up-to-date maps to clients in the oil and gas sector, recent advancements in integrated exploration tools mean smoother workflow and higher productivity in both two-dimensional and three-dimensional environments.

Where it used to take weeks to process and interpret geoscience datasets, today it's not uncommon for geoscientists to address the salient issues of interpretations in the course of one or two days. Increasingly, what's required for exploration is software



Geosoft GM-SYS™ Profile model of salt structure integrating seismic reflection, FTG gravity, and magnetic data. Seismic image courtesy of Parallel Geoscience Corp.

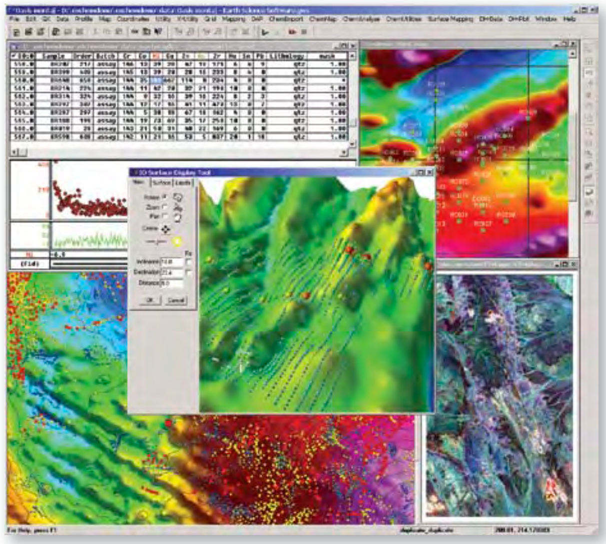
that can handle large volumes of data and multiple data sources and data types, such as geophysical data, geochemical data, drillhole data, satellite imagery and GIS data within one single environment or transparently linked environments.

"I can remember doing batch maps, in paper copies, back in the 1980's," Dr. Ruder says. "Since then, the ability to image geoscientific datasets on a computer screen in real-time, and continual improvements in visualization software, has had an amazing impact on what we can do, as geoscientists, and how quickly we can do it."

Interpretation results are also more accurate because geoscientists have the tools to view the quality of the data in every single phase, from initial data processing and quality control through to visualization, integration, and the final interpretations.

DYNAMIC AND INTEGRATED VISUALIZATION

Equipped with her laptop and mapping software, including ArcGIS and Geosoft's Oasis montaj mapping and processing software, it's not uncommon for Dr. Ruder to do on-the-spot interpretations in collaborative meetings with her major oil and gas customers.



Integrated mapping environment: Powerful exploration mapping systems such as Geosoft's Oasis montaj enable the integration and visualization of many types of data at once. From raw survey data to 3D models, you can process, interpret and analyze geology, geophysics, drillhole, GIS, and remote sensing data in a single environment.

"I can do a lot of work in my clients' offices on my laptop," she says. "My mapping software offers a lot of interactivity, and testing of their hypothesis, and I can show customers results in real time."

There are efficiency and quality advantages to being able to dynamically pull customer data in, and immediately look at it as part of the interpretation whether it's well data, satellite imagery, or other types of data. The dynamic linking of multiple views of imagery, maps, profiles, plots and data in Oasis montaj also provides an easier point of reference for visually linking common features or areas of interest.

This type of rapid assessment and dynamic experimentation depends on the ability to interactively display, and enhance, different attributes in different ways, whether through contrast enhancement, shaded relief, angle illumination, or two-dimensional or three-dimensional displays.

Speed in creating and recreating visualizations, or refreshment time, is also an important consideration, especially when dealing with large datasets.

THREE-DIMENSIONAL MODELING

The use of specialized three-dimensional modeling software for prospect modeling of salt bodies can

Technology for Team-based Exploration

Exploration software has adapted to meet the needs of today's multidisciplinary and team-based exploration. As teams of structural geologists, petroleum technicians, seismologists and geophysicists work together to develop Oil and Gas exploration projects, maps and results need to be quickly and easily shared across different software platforms.

With the gridding, filtering, modeling, depth-to-basement, and other capabilities of Geosoft's Oasis montaj and GM-SYS software, explorers can optimize their analysis and visualization of gravity and magnetic data and integrate this information with interpretations derived from geologic, seismic and other data.

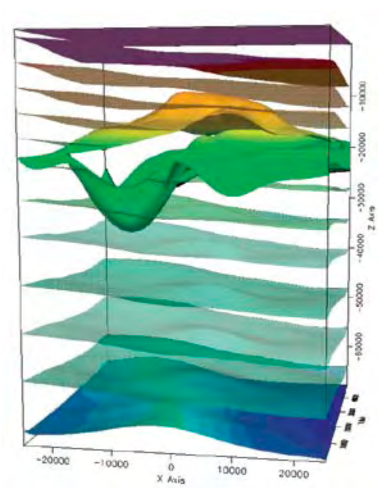
As a result, they can maximize the accuracy of their final interpretations and optimize the more expensive aspects of their exploration program such as seismic reflection or drilling.

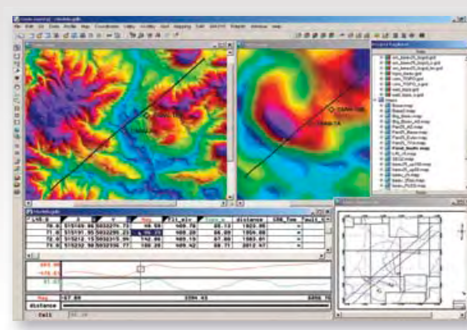
Explorers can easily work with all their data formats, 3D surfaces, 3D grids, and 3D models, within Geosoft's integrated exploration platform. They can generate advanced gravity and magnetic interpretations and easily share their Geosoft maps and interpretations across their Seismic or ArcGIS systems, so that other team members can work with them and continue to add value. Geosoft recently added ARC connectivity to its already strong data support capabilities.

Integrated Solution for Gravity and Magnetics

Geosoft's Oasis montaj earth mapping platform combined with its gravity and magnetic modeling software, GMSYS, creates an integrated visualization and modeling solution for Oil and Gas explorers identifying and characterizing potential reservoirs.

The Oasis montaj platform provides an optimal environment for integrating, viewing and comparing large-volume geophysical, geochemical and geological data. It accelerates data analysis to support effective interpretation and target selection in daily decision making.



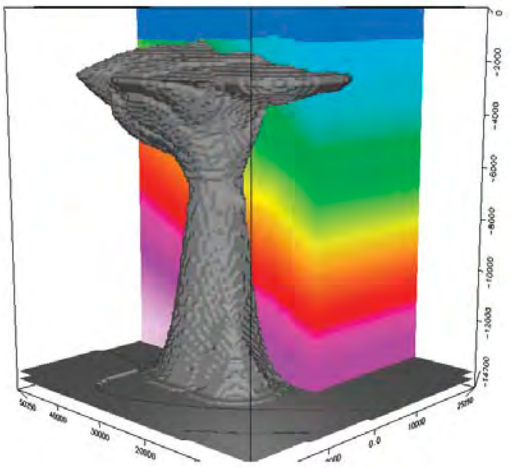


Geosoft's advanced projection engine provides on-the-fly projection, and can handle over 2000 datums and projections.

Geosoft's GM-SYS profile modeling and GMSYS-3D modeling extensions, add powerful gravity and magnetics visualization and specialized data modeling, compilation and interpretation functionality to the Oasis montaj environment.

GM-SYS Profile Modeling is an interactive gravity and magnetic profile modeling program that enables users to create a geologic model of the subsurface and compare the model's gravity and magnetic response to observed gravity and magnetic measurements.

GMSYS-3D is an interactive 3D gravity and magnetic modeling software program that enables users to design three dimensional models to accurately depict subsurface structures, and calculate their gravity and magnetic responses.



Geosoft GMSYS-3D model of a salt body embedded in a 3D density volume.

help to further reduce risk in areas such as potential field exploration.

"It's very prudent to do three-dimensional modeling for prospect modeling of salt bodies when you're considering a very expensive well in deep water," Dr. Ruder says.

Geosoft's GMSYS 3D application is integrated with, and fully exploits, the three-dimensional visualization capabilities of Oasis montaj.

Geoscientists can use the software to plot three-dimensional displays of the entire model in one simple step, while retaining control over each element in the three-dimensional visualization. The three-dimensional visualizations update automatically during inversion and structure editing. Geosocientists can also add wells, seismic sections, or other vector or raster information to their three-dimensional model visualizations.

"We've been using 3D seismic volumes, and approximations of a 3D velocity volume in our interpretations for some time," Dr. Ruder says. "With modeling software such as GMSYS 3D, we can convert that to depth, and ensure that it makes sense with the observed gravity and magnetic data."

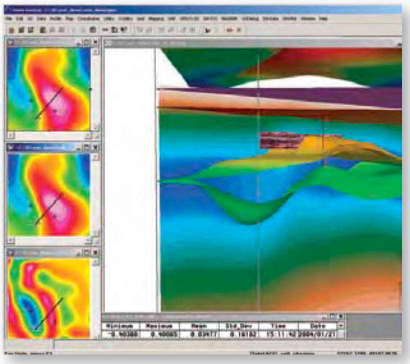
SOFTWARE AND DATA INTEGRATION

Today's visualization software is required to enable and support the easy integration of different types of datasets, including geoscientific data, satellite imagery, and other GIS data into the mapping environment. Working in multiple software environments is a reality for geoscience consultants like Dr. Ruder who need to meet their needs, as well as the needs of customers with a variety of software preferences.

"In general, I find that the software tools I use work well together," she says. "I also welcome the ability to distribute datasets and grids back and forth between my GIS and mapping software, with programs like Geosoft's Target for ArcGIS."

While geoscientists recognize that there's a lot to gain by looking at different types of data, Dr. Ruder admits that there is still a tendency, within each discipline, to use the data that they understand the best.

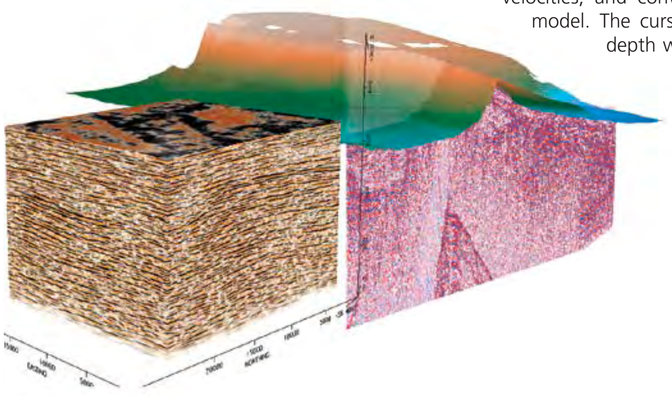
"I think people don't realize how easy it is to integrate all of their datasets, whether it's seismic and non-seismic, raster and vector," she says. "GIS software and Oasis montaj provide some great tools for that." ❑



Geosoft GMSYS 3D model. The three flat maps along the left side of the workspace show Observed Gravity, Calculated Gravity, and the Difference. The black line marks the location of the seismic section shown in the 3D visualization on the right. The "+" symbol in the flat maps tracks the location of the 3D cursor in the 3D visualization (the long vertical line at the end of the seismic section). The other vertical plane in the 3D visualization is the sub-surface gravity response.

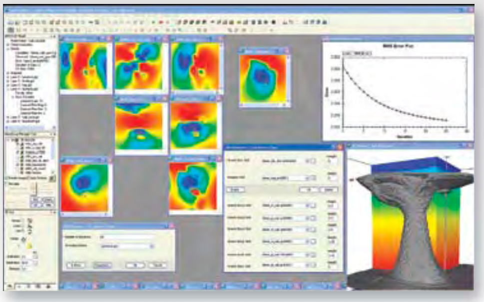
Seismic Data Integration

A built in SEG-Y Reader enables the integration of seismic data in SEG-Y format with Oasis montaj geospatial data and GM-SYS Profile and GMSYS-3D gravity and magnetic models. The SEG-Y Reader converts 2D SEG-Y data into bitmaps, Oasis montaj grids or databases and 3D SEG-Y data into 3D Grids or databases. Explorers can insert the bitmaps and 2D or 3D Grids into GM-SYS Profile Modeling, GMSYS-3D Modeling, and Oasis montaj. They can view and override nonstandard fields. In addition, the SEG-Y Reader can accept trace coordinates from either a trace header or a separate navigation file. When creating a seismic bitmap or grid, the 2D SEG-Y data may be automatically projected on to a vertical plane (e.g. GM-SYS cross section).



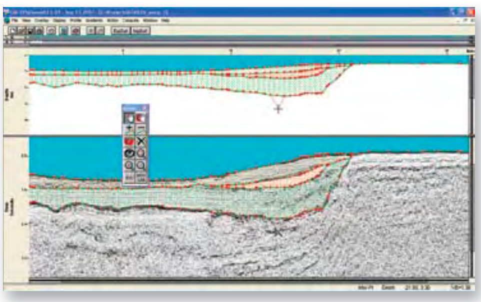
Joint Inversion

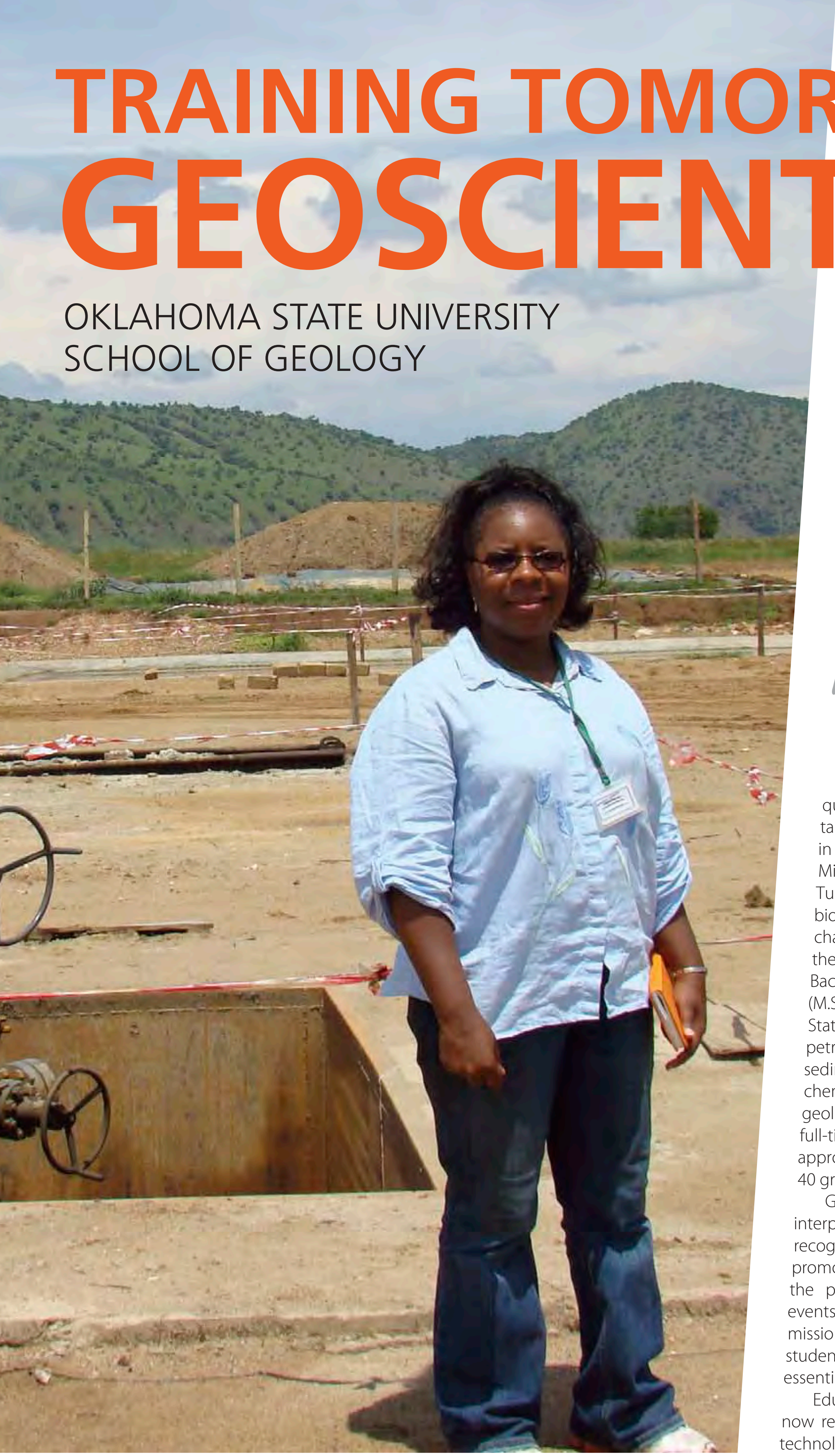
Explorers can better understand their subsurface geology with Full Tensor Gravity Gradient Joint Inversion. They can jointly use any combination of the gravity gradient ten¬sor components plus magnetic and normal gravity to constrain the inversion. Explorers can specify weighting factors for each of the eight possible data constraints. The RMS mis-fit is displayed at each step so that users can monitor the progress of the inversion and stop it at any time.



Time to Depth

Explorers can load seismic time sec¬tions, build models in time using all of the GMSYS tools, assign velocities, and convert the time model to a depth model. The cursor tracks between the time and depth windows so that changes made in one window are im¬mediately reflected in the other window.





TRAINING TOMORROW'S GEOSCIENTISTS

OKLAHOMA STATE UNIVERSITY SCHOOL OF GEOLOGY

Heather Adams

The Boone Pickens School of Geology at Oklahoma State University excels in geological research whether students are interested in unconventional hydrocarbon plays or water quality issues of Oklahoma, incipient continental rifting in Africa, geomorphological changes in Antarctica, dolomitization of the Irish Midlands, extensional tectonics in Western Turkey, structural studies in Death Valley, biostratigraphy in Pakistan, Holocene seal level changes in the Gulf of Mexico, or geology of the Himalayas. They offer programs leading to Bachelor of Science (B.S.), Master of Science (M.S.) and Ph.D. degrees in Geology. Oklahoma State University (OSU) offers special emphasis in petroleum geology, exploration geophysics, sedimentary geology, hydrogeology, geochemistry, paleontology, and environmental geology. The Department presently includes 10 full-time tenure track faculty members, approximately 100 undergraduate students and 40 graduate students.

Geology is a discipline that involves interpreting the history of earth; discovering, recognizing and using natural resources to promote the quality of human life; and occupying the planet more safely through awareness of events that continue to shape its surface. The mission of the OSU School of Geology is to provide students with a broad perspective of the skills essential for discovery of geologic knowledge.

Educating the next generation of geo-physicists now requires training students to be proficient in technologically advanced software tools. For Estella

> In the working world, theory is second to knowing how to process and interpret data.
>
> *-Estella Atekwana*

ABOVE: Demand is growing for geoscientists skilled in magnetic and gravity geophysical methods.
LEFT PAGE: Professor Estella Atekwana teaches Potential Field Methods at Oklahoma State University.

Atekwana, Ph.D, Professor and Sun Chair at Oklahoma State University's Boone Pickens School of Geology, the tool of choice is Geosoft's Education Program – a kit that enables her students to easily process, analyze and interpret magnetic and gravitational data.

"I've used a Geosoft Research License, since I first started teaching 18 years ago," says Atekwana. "Now with the Education Kit, we have 10 licenses, so that more students have access to the software. It's also very easy to use, which means that students can focus on the task at hand, rather than how to use the software."

Geosoft's Education License Kits are available in two configurations. For multi-disciplinary geoscience teaching, the kit includes Oasis montaj™ plus extension for: Geophysics, Geochemistry, Magmap, Drill Hole Plotting and a GM-SYS Lab Kit. The Education Kit for GIS configuration includes 10 subsurface geology software licenses of Target for ArcGIS.

Professor Atekwana purchased the Kit a year ago, when Geosoft first introduced the teaching kit to the geoscience market. The software has become integral in supporting the curriculum of both her undergrad and graduate classes.

"My teaching style is to give students a strong theoretical background, and then a lot of hands-on experience," Atekwana says. "In the working world, theory is second to knowing how to process and interpret data."

Students of Atekwana's Potential Field Methods course use Oasis montaj in learning gravity and magnetic exploration methods. Homework assignments and projects include processing, modelling data, and then interpreting the data. Students also expected to make a PowerPoint presentation.

First, Atekwana has students write simple programs to calculate x, y, and z derivates or upward and downward continuation, so that they understand the process. Then, they use Oasis montaj to process larger data sets and to visualize the data through the software's enhanced graphics.

"Students gain experience processing vast data sets, which is a skill that they'll need as working geoscientists," Atekwana says. "The software also enables them to enhance certain features, such as shallow subsurface structures."

According to Atekwana, there is a strong demand in today's geoscience industry for geoscientists who are skilled in magnetic and gravity geophysical methods. Historically, geophysicists have been experts in seismic and electrical methods, for resource exploration projects and for locating contaminants in environmental investigations. With today's increased oil prices, the oil and gas sector is looking for expertise not only in the seismic methods but also in magnetic and gravity techniques which, when compared with seismic methods, are significantly cheaper (especially in the preliminary stages of exploration).

"With the recent hike in oil prices, there is a push for exploration and geoscientists that have experience in magnetic and gravitational geophysics," Atekwana says. "Exploration companies want to know where sedimentary basins are and the thickness of the sedimentary package. With Geosoft's software, you can process magnetic and gravity data follow up with seismic data and then verify seismic findings.

"My students are trained in these techniques and so, are highly in demand. In fact, two of my students landed jobs working with oil companies last summer."

For Atekwana, Geosoft's software is an important geophysical instrument that helps prepare students for their chosen profession as leading geoscientists, who deliver a higher level of accuracy in their interpretations. "We are trying to take physics and math and make sense of the geology," she says. "Geophysical tools help minimize uncertainty, so that we can make more accurate interpretations of the subsurface." ❑

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VMS exploration: NEW LIFE FOR OLD

Virginia Heffernan

FAR LEFT: Geotech's airborne VTEM technology provides high definition, deep penetrating magnetic and electro-magnetic measurements of the underlying rock. LEFT: Surface crew conducts deep-penetrating TDEM survey over the Lalor Lake discovery. BOTTOM LEFT: Lynda Bloom, President and CEO of Halo Resources Ltd., oversees 28,000 m drilling program at the Sherridon VMS Property in Manitoba.

With a tendency to be small, zinc-rich and sometimes difficult to process, Volcanogenic Massive Sulphide (VMS) deposits fell out of favour in the low metal price environment that characterized the late 1990s and early 2000s. But with increasing demand for base metals – including zinc, an early laggard in the metals revival – explorers are returning to some of the old Canadian mining camps known for their VMS production to see if they can find ore deposits missed by their predecessors.

This time, they come armed with powerful exploration tools that can see deep into the subsurface, can detect subtle geochemical signatures and/or are capable of integrating multiple historical datasets with more recent information to generate new targets.

From Matagami, Quebec to Flin Flon, Manitoba, they are succeeding. This year alone, several new VMS deposits have been found in mining camps that were thought to have had their day. And in most cases, explorers are crediting improved technology with their success.

VMS deposits are significant sources of copper, zinc and, sometimes, precious metals (e.g. Eskay Creek in British Columbia). The model for VMS deposits, which form on the ocean floor and are one of the few deposit types to have active, modern analogues, is constantly evolving as are the exploration methods to find them.

Take Lalor Lake, a discovery in the Flin Flon – Snow Lake greenstone belt of northwestern Manitoba. The new discovery is showing potential to be a relatively large VMS deposit that could reach production as early as 2010 if ongoing drilling continues to intersect ore-grade mineralization.

Winnipeg-based HudBay Minerals had identified the Chisel Lake Basin where Lalor Lake occurs as prospective, but it was an experimental deep penetrating TDEM (time domain electromagnetic) survey incorporating proprietary "innovative techniques" that identified a large bull's eye anomaly, according to project geophysicist Alan Vowles.

Using 3-D computer modeling software, HudBay geophysicists defined the

Alan Vowles, Project Geophysicist for Hudson Bay Exploration,and Dave Koop, President of Koop Geotechnical Services Inc., at the discovery hole

conductor as a flat-lying, tabular body within favourable stratigraphy at a depth of 800 m. They plotted it using Geosoft software, and this year, won approval from management to test it with drilling. The company hit 45 m of high-grade zinc and copper in the first hole and sees the potential to develop an 18-20 million tonne deposit grading about 8% zinc and 0.8% copper.

"We believe we have in hand one of the most significant zinc discoveries in Canada in recent years and, of course, we are now fast-tracking that opportunity," Peter Jones, president and CEO of HudBay told mining analysts in a conference call.

Though relatively deep, Lalor Lake has the advantage of occurring within an established mining belt. The deposit lies within 15 km of the company's Snow Lake concentrator and just 3 km from a haulage road and power line, so the cost of developing the project would be considerably less than if it were a greenfields discovery.

Inspired by HudBay's success, other companies in the area are using a combination of geophysics and geochemistry to find similar pockets of mineralization within the Flin Flon- Snow Lake belt, which contains 20 known VMS deposits with an average size of five million tonnes. The belt is covered by Paleozoic limestone sediments, making airborne and ground geophysical tools that can see through the cover particularly useful.

Igneous geochemistry of the mafic and felsic rocks associated with VMS deposits has also been refined to better delineate prospective ground for VMS mineralization. The two rock types can be used in tandem to identify key ingredients required to form VMS deposits – rifting and high-temperature magnetism – according to S.J. Piercey of Laurentian University in a paper presented at Exploration '07, a once-a-decade event that covers recent advances in exploration technology.

It was geochemistry that lead VMS Ventures Inc., the second largest landholder in the Flin Flon-Snow Lake belt, to the Reed Lake project southwest of Snow Lake, though geophysics that confirmed its potential.

Past drilling campaigns had identified altered rhyolites with geochemical signatures typical of the alteration halo around VMS deposits in the belt, prompting the junior to acquire Reed Lake. A subsequent airborne VTEM (Versatile Time-Domain Electromagnetic) survey identified an 800-metre-long southwest-trending anomaly and follow-up drilling hit the jackpot – 10.5 m grading 11.2% copper at a depth of 270 m.

VTEM is a leading airborne geophysical survey system capable of providing high definition, deep penetrating magnetic and electro-magnetic measurements of the underlying rock. The system, produced by Geotech Ltd., is particularly good at detecting copper-zinc massive sulphide deposits.

"We've primarily relied on geophysics to guide our drilling," concurs Lynda Bloom, president of Halo Resources, which is also using VTEM technology to identify mineralization within favourable stratigraphy at the contact between felsic and mafic volcanics in the Sherridon camp in northwest Manitoba, about 70 km northeast of HudBay's mining and metallurgical complex in Flin Flon and just north of Reed Lake.

The Sherridon property , which contains the past-producing Sherritt Gordon mine, has only recently been considered a VMS target. New thinking is that the felsic gneisses on the property may be equivalent to the suite of rocks that hosts the VMS mineralization in the Flin Flon and Snow Lake camps.

Last year, Halo identified 122 new targets with an airborne survey and, in combination with alteration mapping, prioritized new areas of VMS mineralization for drilling.

An ongoing 30,000 m drill program has intersected moderate widths of copper-zinc mineralization including 1.2% copper and 6.3% zinc over 6.5 m and 1.6% copper and 4.9% zinc over 5.1 m.

Because VMS deposits often occur as a series of lenses, down-hole magnetic and EM surveys to detect conductive sulphide bodies near the borehole are also becoming an increasingly powerful tool for VMS exploration as modeling software improves, says Marc Boivin of MB Geosolutions in a paper presented at Exploration '07.

Partners Alexis Minerals Corporation and Xstrata Zinc Canada, for instance, used a combination of magnetic and EM borehole surveys to detect buried VMS occurrences on the Ansil West property in the Rouyn-Noranda camp of northern Quebec. He team used the magnetic data from a borehole orientation probe to optimise EM interpretation and drilling locations.

Xstrata inherited West Anvil and other properties from its predecessor Noranda, which revived exploration in the Noranda camp five years ago with the objective of finding more ore in the vicinity of its Horne smelter by using new exploration technologies.

The prolific camp is one of the most studied VMS camps in the world and literally hundreds of companies have scoured its ground over the years since the Horne deposit was discovered in 1923, leaving behind not only truckloads of data but the impression that there was nothing left to find.

Xstrata's toolbox included MegaTEM and VTEM, both airborne EM systems, as well as Titan24 for deep penetration from the surface and advanced borehole survey systems. An integral part of the program was the use of 3-D earth modelling technology, particularly 3-D GIS systems, to integrate and interpret the vast amounts of multidisciplinary historical data with new data.

By developing a series of quantitative queries from conceptual geological models (e.g. proximity queries to select cells within 150 m of typical VMS associations, including hydrothermal alteration and exhalites), the partners were able to use a process of elimination to highlight prospective areas.

The resulting West Anvil discovery hole assayed 3.6% copper over a core length of 53 m, representing the first major base metal discovery in the 17 km^2 central area of the camp in 25 years, according to a paper given to Exploration '07 by the Xstrata team.

Xstrata, along with partner Donner Metals Ltd., is also using a combination of 3D data integration, advanced technologies, new concepts and diamond drilling to find ore in the Matagami camp about 300 km north of Noranda. Matagami contains 18 known VMS deposits.

The use of advanced technology to find hidden orebodies in the camp has been ongoing since 1999, when a new EM system survey led to the discovery of the Perseverance deposits containing a resource of 5.1 million tonnes grading 15.8% zinc, 1.24% copper, 29 gpt silver and 0.38 gpt gold.

The main productive horizon in the Matagami camp is a "Key Tuffite" at the top of the felsic volcanics, but earlier this year, Donner made a significant discovery in mafic volcanics about 220 m statigraphically above the Key Tuffite zone. This initial discovery, and subsequent others, demonstrates the potential for stacked mineralization in the Matagami camp.

The drilling success also validates the multidisciplinary approach the partners have used on the project. In recognition, the Québec Mineral Exploration Association (l'Association de l'Exploration Minière du Québec) awarded the 2007 Prospector of the Year Award to the Xstrata/Donner exploration team.

What lies ahead for VMS exploration in Canada after the significant successes of the past couple of years?

Laurentian's Piercey says future geochemical research will focus on distinguishing productive from non-productive volcanoes within rifts. This will require a combination of field methods, new analytical techniques and thermodynamic modeling to better understand the way tectonic, igneous and hydrothermal processes interact.

In the geophysics field, Boivin says further improvements in depth penetration of geophysical tools will be the key to discovering more deep orebodies that can contribute to the next generation of base metal production in Canada.

And finally, 3-D mapping and modeling software and GIS systems continue to evolve. Exploration software companies, like Geosoft, are giving companies more powerful tools to visualize, integrate and interpret both historical and new data. The end result is new techniques and better tools for accessing and working with their data – whether geophysics, geochemistry, drilling or 3D models.

Bring on the old mining camps. ❑

Exploration and GIS:

Closing the Productivity

Virginia Heffernan

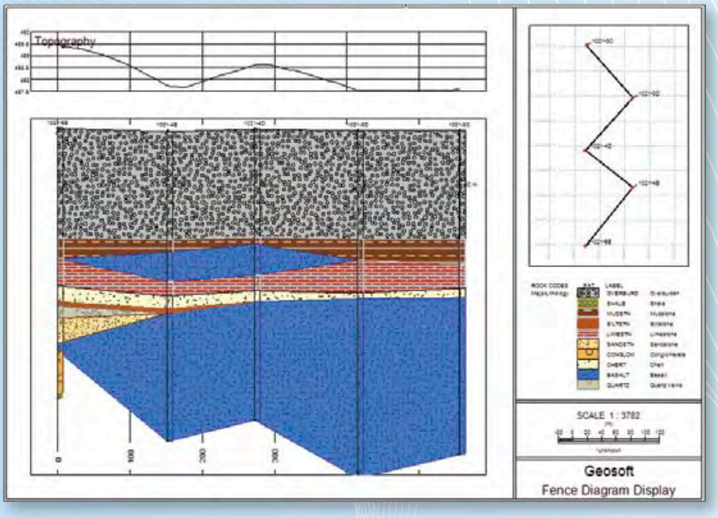
Exploration software and Geographic Information Systems (GIS) are essential for geologists searching for petroleum and mineral deposits. With discoveries harder to find, geoscientists are collecting more data than ever before and examining their findings with greater scrutiny.

The key to keeping the whole process efficient and focused is technology.

GIS and exploration software has come a long way in the past 10 years, especially visualization and 3-D modeling. But, until recently, the inability to work and share data between earth mapping software like Geosoft and ESRI's ArcGIS application environments has left a gap for explorers.

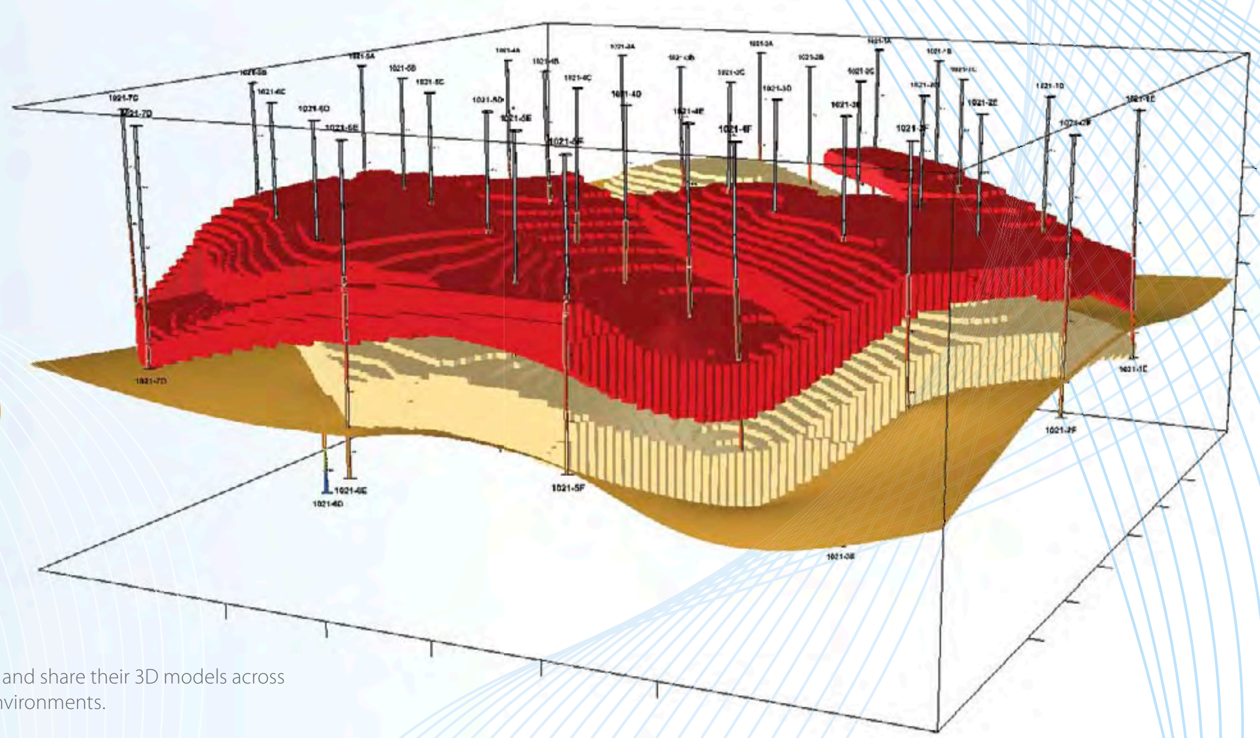
As software developers on both sides of the gap begin to collaborate, technology and solutions are now evolving to allow geoscientists to share data easily between their mapping and GIS environments.

Geographic information systems have been used for 2-D mapping for decades; however, the limited ability of GIS to visualize below the earth's surface means exploration companies have had to resort to work-arounds. As a result, geoscientists tend to store their geological, geophysical and geochemical information in one



Fence diagram generated using Geosoft's Target for ArcGIS extension software.

Gap



Geologists can now create and share their 3D models across Geosoft and ESRI ArcGIS environments.

database, and their surface spatial (GIS) data in another, with no efficient way of merging the two.

Although geoscientific data can be moved in and out of a GIS environment, doing so is time-consuming and can result in lost, changed or corrupted data.

For consulting geophysicists like Michal Ruder, whose livelihood depends on delivering accurate, up-to-date maps to clients in the oil and gas sector, recent advances in integrated GIS exploration tools mean smoother workflow and higher productivity in both 2D and 3D environments.

"Most of the time I work with gridded data, and I can manipulate it with ease using Geosoft exploration software, Oasis montaj and Target," says Ruder, who is principal of Denver-based Wintermoon Geotechnologies. "That's not the whole solution, though, because after I've processed the gridded data, I need to integrate it with vector data. That means putting my magnetic and gravity data into the geographic context of my exploration problem."

After moving the data into ESRI's ArcGIS, Ruder uses Geosoft extension software, Target for ArcGIS, to see geographic and other associations. She then searches for patterns in the Geosoft grids and ArcGIS vector data.

Geosoft is working to close the exploration GIS gap entirely with its recent introduction of earth mapping software that has ArcGIS Engine technologies built in. The new generation of Geosoft Target and Oasis montaj software allows geoscientists to work seamlessly between their Geosoft and ESRI environments using ESRI technology to display Arc.mxd and .lyr files without leaving the Geosoft environment.

The breakthrough is expected to boost productivity and result in smoother workflows for geoscientists in both the private and public sectors. It will also prevent data from being changed or lost.

"With this software, geoscientists have greater flexibility and control in achieving the results they need," says Louis Racic, Director of Product Management for Geosoft Inc.

Closing the gap between GIS and geoscience also benefits large companies with multiple users and data sets. The more integrated their exploration software is, the less likelihood of costly mistakes or missed opportunities for discovery.

> "Using Target for ArcGIS, our geoscientists can work with their geophysical, geochemical and geological data within the ArcGIS environment much more quickly and effectively."
>
> *-Ana Maria Gonçalves*
> *Information Manager, Vale*

There is better access to exploration tools, such as this 3D lithology selector, within ArcGIS.

Ana Maria Gonçalves is information manager for the exploration and project development division of Brazil-based Companhia Vale do Rio Doce (Vale), one of the largest mining companies in the world with 14 regional exploration offices. "As we become more global, being able to share information and expertise with other regions is increasingly important," says Gonçalves. "In the past, our exploration applications didn't connect with our GIS. We had to make all sorts of conversions, and with data sets such as geophysical grids, you can lose important information when you try to convert the data to other formats."

Adopting Geosoft Target for ArcGIS has done away with the need for data conversion, says Gonçalves. "Using Target for ArcGIS, our geoscientists can work with their geophysical, geochemical and geological data within the ArcGIS environment much more quickly and effectively."

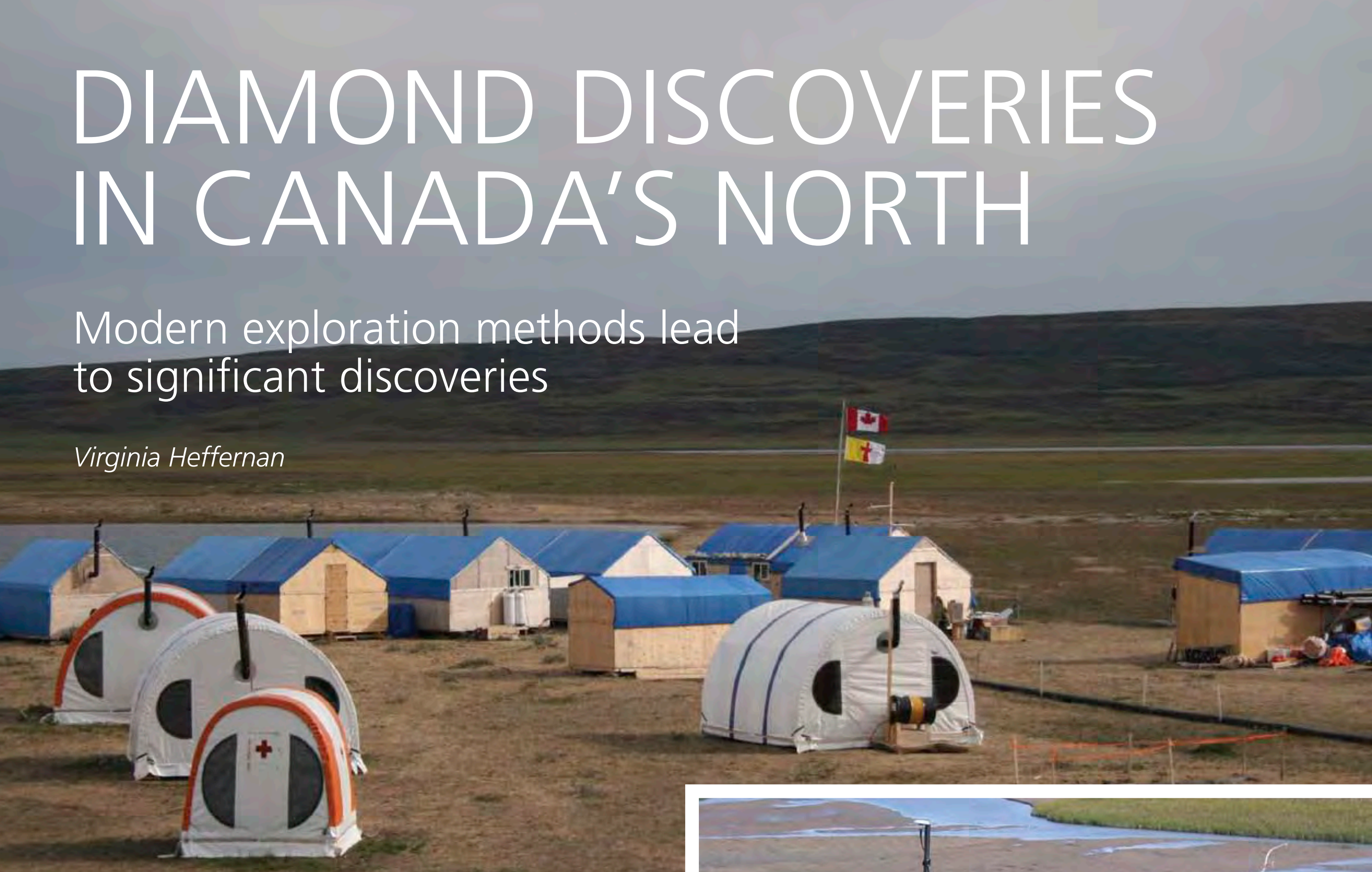
On a broader scale, trends in mineral exploration show there's a need for better integration of GIS and geosciences. Most ore deposits with a surface expression have already been found, so 3-D information from the subsurface – particularly geophysical data – is becoming the main pathfinder to discoveries.

Taking a tool known for excellent spatial analysis on a 2-D plane and integrating it with software that can handle multiple 3-D data sets from the subsurface makes the search for these deposits a whole lot easier. It's a development whose time has come. ❑

DIAMOND DISCOVERIES IN CANADA'S NORTH

Modern exploration methods lead to significant discoveries

Virginia Heffernan



Diamond exploration and discovery is undergoing a renaissance in Canada's north that rivals the first wave of successful exploration in the early nineties, though the activity is going largely unrecognized.

The Ekati and Diavik mines, products of the original rush and investor frenzy that followed the discovery of diamonds near Lac de Gras, NWT in 1991, continue to churn out billions of dollars worth of diamonds each year and a third mine, Snap Lake, is gearing up for full production in mid-2008.

Meanwhile, mining companies are spending more than ever on diamond exploration in Canada and using modern exploration techniques to get some spectacular results. Last year more than $50 million was spent in Nunavut alone on 41 different projects, though few – even within the mining industry – are aware of the scope of the activity.

"There are some very high grade discoveries going under the radar screen," Pamela Strand, president and CEO of Edmonton-based Shear Minerals, told members of the Canadian Institute of Mining (CIM) and Women in Mining (WIM) at a joint luncheon in Toronto.

Some companies are investigating areas that have never been explored for diamonds before but show potential for the diamond host rock, kimberlite, while others are re-evaluating old prospects by revisiting data with faster and more sophisticated processing techniques.

GEOCHEMISTRY

In both cases, modern exploration methods, especially improvements in the ability to trace and analyze kimberlite indicator minerals such as pyrope garnet, chromite and chrome-diopside, have led to significant discoveries.

TOP: Diamonds North Amaruk Camp in Nunavut. ABOVE: Ground Geophysics on the Amaruk Project.

The main reason Canada attracts more diamond exploration spending than any other part of the world is because the county is blessed with large cratons, ancient stable parts of the earth's crust that are prospective for kimberlites. Exploration over the years has confirmed that many of these cratons have indicator mineral chemistry in the diamond stability field.

In northern Canada, it takes a combination of mineral chemistry, knowledge of regional ice advance and retreat patterns, and geophysical sleuthing to find potentially diamond-bearing kimberlites. The process is slow, pain-staking and expensive because in the early days, prospective areas can span hundreds of millions of acres.

Take Vancouver-based Diamonds North, for instance, one of the most active diamond explorers in Nunavut and the Northwest Territories. In 2002 the company identified more than 300 million acres that were prospective for diamonds and spent $9 million on till sampling over the ensuing years. Based on the resulting mineral geochemistry, the junior narrowed its focus to eight million acres encompassing four district-scale projects, including the flagship Amaruk project in eastern Nunavut.

"A lot of the previous exploration was on the Slave craton so we stepped out of that area into another area we thought would have the old Archean signature," says Mark Kolebaba, president of Diamonds North. "One of the early samples had 1,400 indicator minerals and that's what kicked off the staking rush."

The next step was to combine the anomalous mineral chemistry with coincident geophysical targets. As a result of that work, the Amaruk project alone has produced 500 drill targets, 22 kimberlites (90% of which are diamondiferous) to date, and some promising diamond counts. By comparison, the Ekati field contains 160 known kimberlites, including eight in the mine plan.

Earlier this year, an 82 kg sample from an Amaruk kimberlite returned 550 diamonds for an unusually high average of about seven diamonds per kilogram. Recent processing of a much larger sample produced similar grades, as well as the hoped for larger stones that were lacking in the first sample.

"At Amaruk, the chemistry is every bit as good as the Ekati area. If we have an economic deposit among our 500 targets, we'll find it. It becomes a prioritization game," says Kolebaba, who will test another 60 targets this year with a reverse circulation (RC) drill.

RC drilling is a unique aspect of the Diamonds North program that allows the company to move a drill rig by helicopter from site to site to test multiple targets much more quickly and cost-efficiently than using core drilling. The best targets are then earmarked for further drilling with a diamond rig.

Applying innovative exploration techniques is also paying off for Shear Minerals at its Churchill project in eastern Nunavut. Until recently, Shear and its partner Stornoway Diamonds Corporation were having a lot of luck finding kimberlite bodies using geophysics, but not much luck finding diamonds.

"It was like shooting fish in a barrel," says Strand of the geophysical target testing. But the diamond counts within the newly discovered kimberlites – if they carried diamonds at all – were discouragingly low.

A closer look at the chemistry of the indicator minerals explained why. Though the company was finding oodles of G10 garnets – the best indictor of diamonds – in the mineral trains at Churchill, further analysis revealed that the garnets were created at temperatures and pressures that were not conducive to diamond preservation.

Armed with these results, Shear determined that there are two distinctly different types of kimberlite co-existing on the Churchill project.

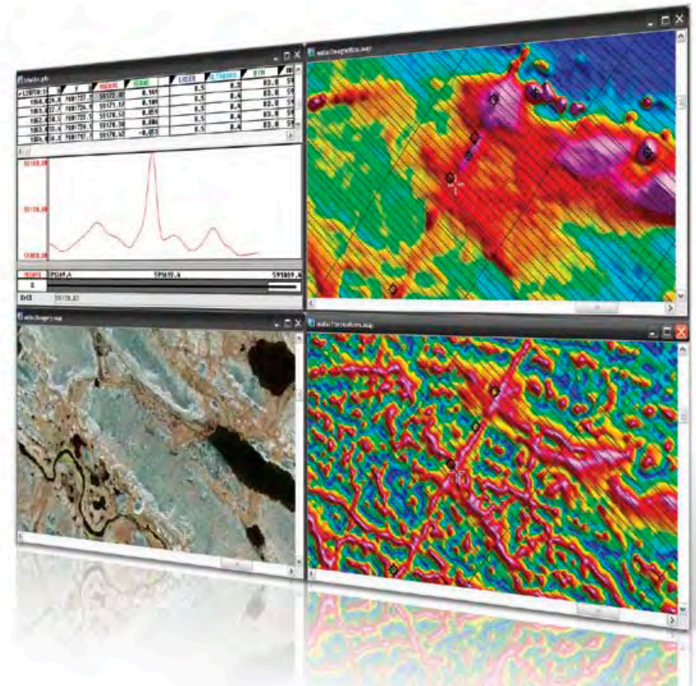
The first type – what the company was finding in the early years of exploration - is strongly magnetic with low indicator mineral counts, poor mineral chemistry and a warm geotherm indicating low diamond carrying capacity. The second type has a more subtle geophysical signature, a high abundance of indicator minerals, good mineral chemistry and a cold geotherm indicating moderate to higher diamond carrying capacity.

Partly as a result of this new thinking, the company has pinpointed four diamond-bearing kimberlite dykes that have returned grades in the range of 0.5-2.2 carats per tonne (cpt) in mini-bulk samples and is following up with much larger samples this year.

"The advanced filtering techniques have allowed us to focus our exploration," says Strand.

AGE DATING

Age dating is another method that Shear uses to determine the diamond potential of its kimberlites. The oldest kimberlites at Churchill (approximately 240 million years) have the most diamonds. As volcanism waned, so did the tendency for the kimberlites to bear diamonds.



Interpretation of Airborne Geophysical Data for Shear Mineral's Churchill Diamond Project in Nunavut. Created in Geosoft Oasis montaj.

Age also determines the economic viability of pipes at Ekati, the richest of which erupted during a relatively short geological time window 55-56 million years ago. "The diamond content of Ekati kimberlites apparently is related more to the age of eruption than to any other parameter investigated in this work," wrote Grant Lockhart, Herman Grütter and Jon Carlson in Temporal, Geomagnetic and Related Attributes of Kimberlite Magmatism at Ekati, Northwest Territories, Canada, a paper published in the September, 2004 edition of Lithos.

The authors suggest that magneto-stratigraphic correlation of kimbetlite pipes could provide a powerful exploration tool for further economic discoveries in the area because older kimberlites present as aeromagnetic low anomalies while the younger pipes are characterized as aeromagnetic highs.

GEOPHYSICS

Though the geophysical methods used to find diamonds have been refined since the early nineties, the basic techniques – airborne magnetics and electromagnetics and ground magnetic and horizontal loop electromagnetics – have not changed.

In recent years, however, capacitive coupled resistivity (CCR) and gravity have been added to the toolbox. CCR can be used as ground check for airborne resistivity values, while gravity helps delineate subtle density contrasts between kimberlites and the surrounding country rock.

The use of seismic methods to find kimberlites has also developed over the last decade. The method works because kimberlite is generally less dense and more porous than the rock that surrounds it. Seismics are particularly useful in finding kimberlite dykes in Canada's north, which tend to be gently dipping, because the sound waves can more easily delineate bodies that have shallow orientations.

REVISITING OLD DATA

Diamond prospects that were abandoned by previous explorers are also taking on new life as modern explorers revisit historical data. Vancouver-based Peregrine Diamond's WO property in the Northwest

Territories, for example, is benefiting from a re-evaluation of historical data combined with recent data to outline a significant diamond deposit.

The DO-27 kimberlite pipe on the property was discovered in 1993 and returned promising microdiamond results through core drilling, which encouraged Kennecott – the major partner in the project at the time – to proceed directly to an underground bulk sampling program. But the average grade in the bulk sample - 0.36 carats per tonne – proved disappointing and Kennecott subsequently dropped the property.

Peregrine returned to the WO property in 2005 to poke six reverse circulation drill holes into the vent. The resulting 151-tonne sample returned an average grade of 0.98 carats per tonne.

Since then, Peregrine has completed statistical modeling and normalization of the data and produced a 3-D density model that demonstrates grade consistency of about 0.91 cpt and diamond values ranging from US$43-70 per carat in the main vent, indicating the potential for an economic deposit.

"This is a good example of a kimberlite that has been reevaluated with modern exploration techniques,' says Strand.

Whether companies are investigating grassroots prospects or re-evaluating established diamond deposits, the ingredients are in place for another Ekati-like find in Canada's north. ❑

Percussion Drilling on the Diamonds North Amaruk Property in Nunavut.

This beautiful neoclassical building is home to Brazil's Museum of Earth Sciences in Rio de Janiero. Celebrating its 100th Anniversary, the museum features a huge collection of minerals, rocks and fossils, belonging to the Department of National Mineral Production (DNPM).

ROCK SCIENCE:

Brazil's Museum of Earth Sciences Celebrates its Centenary

Brazil has one of the most vibrant mineral markets in the world, producing over 70 mineral commodities, including metals, industrial and fuel minerals. The country is known for its large mineral reserves, and also for the quality and significance of its beautiful gemstones – aquamarine, tourmaline and citrine – produced in the colonial city of Ouro Preto, Minas Gerais.

Located in Rio de Janiero, on the path to the Sugar Loaf, the Museum of Earth Sciences is home to a permanent showcase of Brazil's minerals, rocks, fossils and meteorites. The valuable collection includes over 3,000 rocks and minerals, representing over 95% of minerals local to Brazil.

Celebrating its 100thth Anniversary, the Museum's collection is based on scientific knowledge that spans several generations of geoscientists. It was originally guided by the state Geological Service when it opened in 1907, and since 1969 has been overseen by the Department of National Mineral Production (DNPM).

As it marks 100 years of service, there are plans underway to rejuvenate the Museum, says Director Diogenes de Almeida Campos. The Museum is already a vital resource for school children learning about minerals – their names and properties such as density, color, magnetism, trace and inclusions. One goal of the restructuring will be to modernize the exhibit and make it more accessible and effective as a learning environment for researchers and students, of all ages.

"In Brazil, there's movement underway to advance the teaching of geological sciences, introducing it earlier in the primary grades," says Campos. "The Museum has an important role to play in making minerals, and the earth sciences associated with mineralogy, accessible for learning."

Insight into the history of mineralogy in Brazil is key to this learning experience, and a notable exhibit recently launched by DNPM showcases the African contribution to the

TOP RIGHT: Sugar Loaf Mountain, a granite peak overlooking Rio de Janeiro. BOTTOM RIGHT: Diogenes de Almeida Campos, Director of the Museum of Earth Sciences in Rio de Janeiro with a Quartz crystal specimen from Diamantina, Minas Gerais. Brazil is famous for the large and exceptional quartz it produces. The largest quartz crystal ever found in Brazil weighed nearly 90,000 lbs.

geosciences in Brazil. The exhibit sheds light on the important role of African slaves in the history of gold and diamond mining in Brazil. It includes a tribute to Brazilian mineralogist Jose Bonifacio de Andrada e Silva, who discovered the Afrizita (a variety of black tourmaline) and is said to have named it after his African slave Afrízio.

A naturalist and paleontologist committed to the conservation of fossiliferous sites at Crato and Santana do Cariri, State of Ceará, and at Uberaba, State of Minas Gerais, Campos has also helped to establish one of the most significant Brazilian fossil collections at the Museum. The Dinosaur Age exhibit features a collection of vertebrate fossils that lived in Brazil during the Era Mesozóica. In celebration of its centenary, the Museum recently added an exhibition on the life of Llewellyn Ivor Price, one of the greatest Brazilian paleontologists. Price collected the Staurikosaurus, the first discovered dinosaur of Brazil.

Minerals, and the earth sciences are integrated in all aspects of life in Brazil – contributing to the country's economy, unique landscapes and architecture. Rio's famous Sugar Loaf, with its massive gneiss dome, is perhaps one of the most spectacular granite landscapes in the world.

"Brazil has a rich history in mineralogy, and an active scientific community," says Campos. "The Museum is dedicated to capturing, preserving and showcasing Brazil's wealth of knowledge and discovery in the earth sciences." ❑

① **Aphrizite tourmaline specimen from Cantagalo, Rio de Janeiro.** A donation from the collection of Eugenio Bourdot Dutra. The Aphrizite (a variety of black tourmaline) is among the new species of minerals discovered by Brazilian statesman and mineralogist José Bonifácio de Andrada e Silva. It is believed that he named the Aphrizite in honor of his African slave Afrizio. In their natural state tourmalines are characterized by parallel ridges (or striations) which run the length of the crystal.

② **Imperial Topaz specimen from Ouro Preto, Minas Gerais.** Imperial Topaz is perhaps the rarest variety of topaz, primarily found in the Ouro Preto mines of Minas Gerais, Brazil. The Imperial Topaz was named in honor of the Brazilian monarchy who prized its luxurious golden-sherry hues.

③ **Rose Quartz specimen from Corcunda, Brazil.** Rose quartz is one of the most desirable varieties of quartz. The pink to rose red color is unique and unlike any other pink mineral species. The color is caused by iron and titanium impurities. Brazil is the only source of true well formed crystals of rose quartz. So amazing are the rose quartz crystals that the first ones discovered were dismissed as fakes by mineralogists from around the world.

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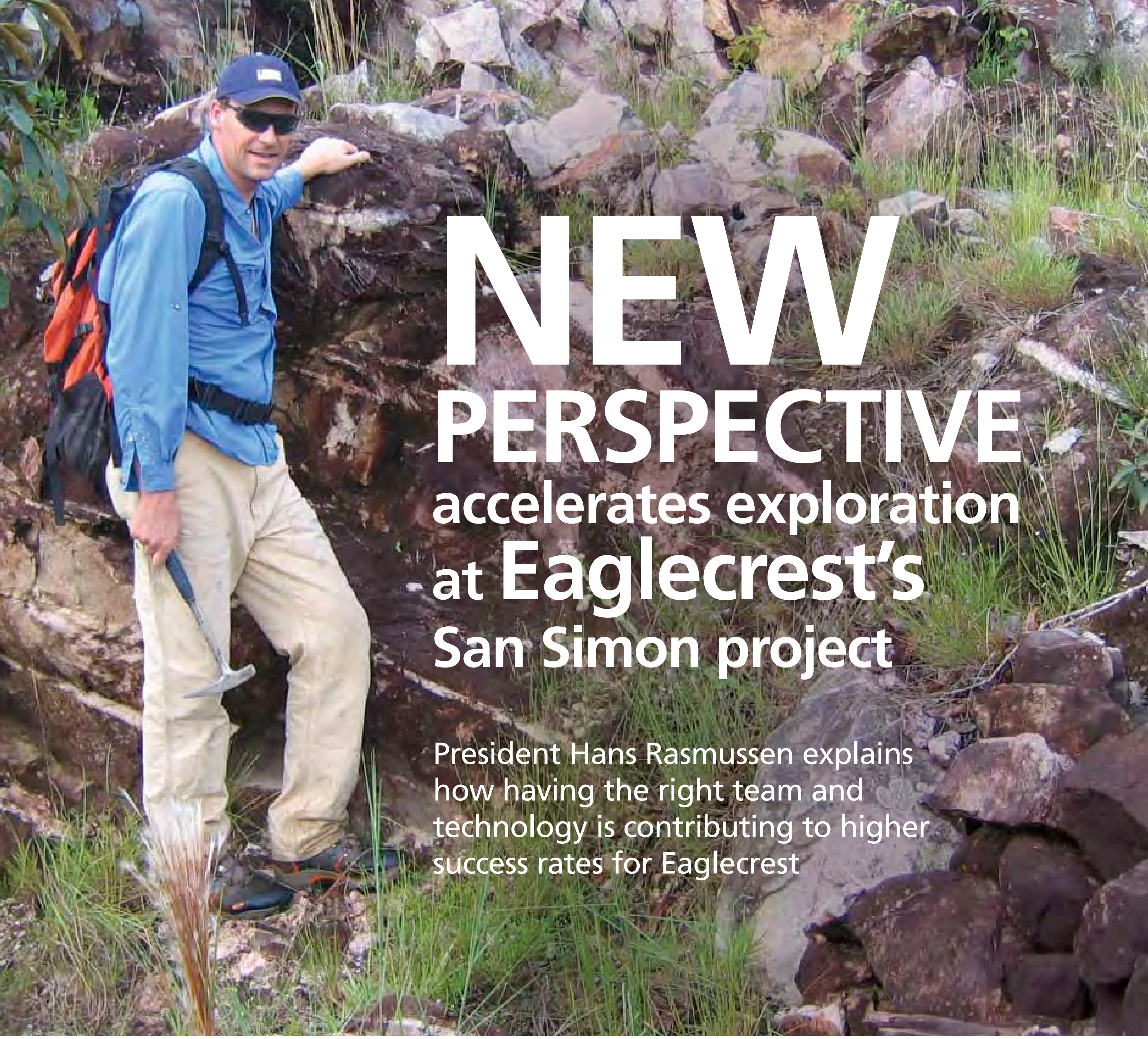


NEW PERSPECTIVE accelerates exploration at Eaglecrest's San Simon project

President Hans Rasmussen explains how having the right team and technology is contributing to higher success rates for Eaglecrest

Sometimes, simply viewing exploration results from a different perspective can highlight hidden details and change the whole direction of a project. That's what happened when Hans Rasmussen, a former senior geophysicist for Newmont and Rio Tinto, took the helm at Eaglecrest Explorations Ltd. and brought his appreciation for having the right team, approach and technology to explore projects to the fullest.

Rasmussen's first priority as President of Eaglecrest was to assemble a first-class team, both on the executive and on the ground, to lead and develop the company's advanced gold exploration projects. And his first observation on the ground was that the company needed to update the archaic software being used on drill projects, and bring in technology that enabled deeper, three dimensional insight.

Although Eaglecrest had been exploring the San Simon gold project in northeastern Bolivia for more than a decade, it wasn't until last year, when Rasmussen's team used the Geosoft exploration platform, and specifically their Target exploration geology application, to produce a 3-D model of previous drill sections, that Eaglecrest noticed something it hadn't seen before: the gold was concentrated in vertically-oriented high-grade gold shoots.

Rasmussen immediately revised the drill program to reflect this new understanding of gold distribution and since then, at least a third of the holes on the main ore shoot have hit grades of better than 10 grams gold per tonne. As the company progresses towards establishing an underground resource for San Simon, the original Target model is continuously being updated and used to illustrate drill results to shareholders.

“From a business perspective, this kind of technology is helping tremendously,” says Rasmussen, president and COO of Eaglecrest. “There is no question of the impact a three dimensional presentation makes on the average investor.”

And no question that during this period of accelerated worldwide exploration, explorers that can manage different data sets quickly and effectively, then convey the results to investors in a manner that is easy to visualize and understand, will have a competitive advantage over those who can't.

The record of the past two decades shows that mineral discovery rates have fallen even as the level of investment in exploration has risen to an all-time high. Companies are spending more than ever, but discovering less. To improve their hit rates, they need a means to manage their bourgeoning data.

Having one platform for working with exploration data and GIS data in three dimensions is where Rasmussen sees greatest advantage. “We can incorporate GIS data and exploration data – from technical information to topographic data – and view it all in three dimensions within our Geosoft platform,” says Rasmussen. “That's a core strength for our advanced exploration.”

In the earlier phases of exploration, when acquiring prospective ground and selecting targets is important, software like Geosoft Target is able to maximize the value of all available data and enable focused perspective to support drill decisions.

Later, as the company grows and takes on more exploration projects or moves into advanced exploration, their Geosoft platform can grow with them, adapting to larger and more complex datasets as a project or company develops.

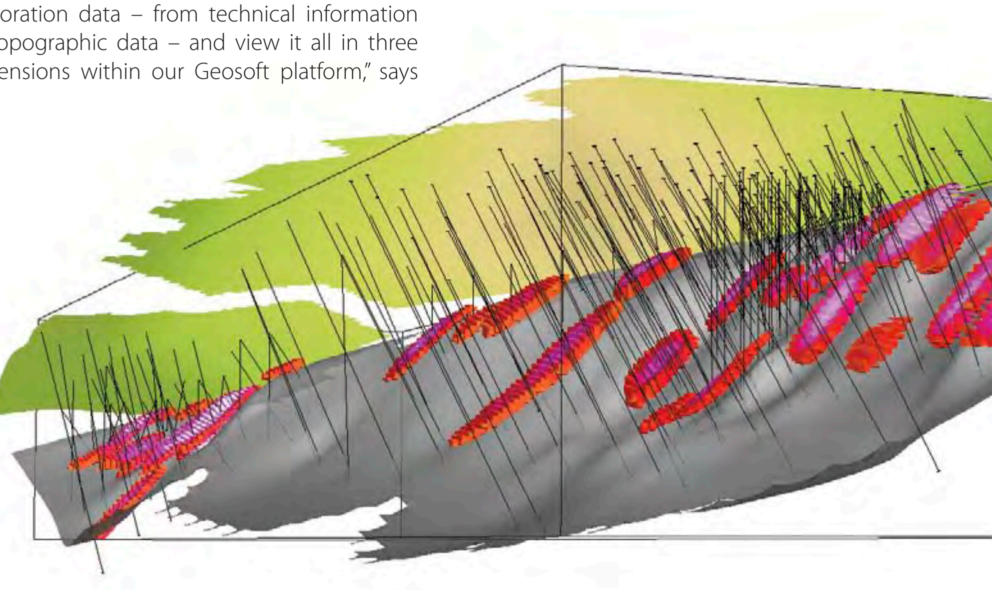
As Eaglecrest gathers the information required to produce a resource estimate for San Simon, Target continues to unlock the mysteries of the subsurface to ensure that the drilling is focused and effective. As testament to the value of the 3-D model, Eaglecrest has recently been intersecting some of the highest grades the San Simon property has ever produced.

There is also the opportunity to gather insight beyond their immediate drilling area. “Target is very good for cross-sections and it's good for planned view maps, so we've also been able to incorporate satellite images with surface geochemistry as a means of exploring our project outside of where we're drilling,” says Rasmussen.

“That's another capability that Target provides.”

“Exploration technology has made huge leaps in how you incorporate data, grid it, and then present it,” says Rasmussen. “The Geosoft platform and Target have worked out really well for us, meeting our technical requirements as well as our business need to effectively present our results to investors.” ❑

> “Exploration technology has made huge leaps in how you incorporate data, grid it, and then present it.
>
> -Hans Rasmussen



Three dimensional model of high grade gold shoots created in Geosoft Target.

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BOTTOM LEFT: Drill Rig at Eaglecrest's San Simon Project.
BOTTOM RIGHT: Core logging overseen by Walt Odie Edgar.

Next generation technology enhances data access and insight into the subsurface

Opal Aristizabal

To help focus their exploration, earth scientists and exploration companies need to fully leverage the value of all available data. Many Government Geological Surveys have deployed Geographic Information Systems (GIS) and are using ESRI's GIS platform to publish their geological data. Geophysical data released by Government Surveys is typically published in exploration formats like Geosoft format grd and gdb. The end result is that geoscientists are now working with and integrating both GIS and exploration datasets as part of their daily projects.

The latest software developments enable exploration teams to effectively utilize GIS data and tools, as an integrated part of their workflow. Continuing advances in Globe Explorer and three dimensional capabilities provide powerful new ways to find, view and integrate earth data and exploration information to make the best use of all the data you have available, and to interpret the data for maximum insight.

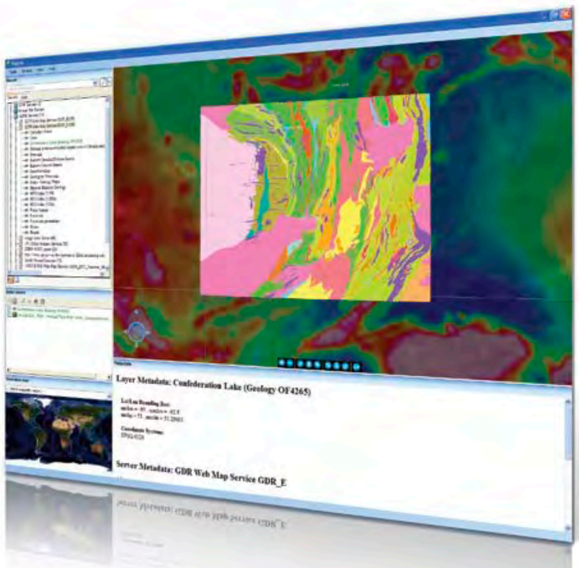
Single Environment for Working with GIS and Exploration Data

The latest release of Geosoft's earth mapping software now features ESRI's ArcEngine technology built-in. Designed to create a seamless connection between the geosciences and GIS for professional earth explorers, Geosoft now enables geoscientists to use ESRI tools to natively display Arc .mxd and .lyr files, without leaving the Geosoft environment. ArcGIS and Geosoft users can share their files seamlessly and spend more time collaborating in an increasingly integrated environment.

"We are excited that the solutions offered by Geosoft and ESRI are being so well received," says Geoff Wade, Natural Resource Industries Leader for ESRI. "Geosoft has done an excellent job of improving workflows and enhancing integration with ESRI software, to deliver value to the earth sciences community."

Additional features of the ESRI integration include cursor tracking and dynamic linking between MXDs and Geosoft Maps, and the ability to save MXD files as Geosoft Maps, or Geosoft Maps as MXD files. To make data sharing efficient, users can drag and drop layers between MXDs and Geosoft Map groups, and the redesigned Coordinate System tool supports ESRI projection files (PRJ).

Access More Data with Globe Explorer

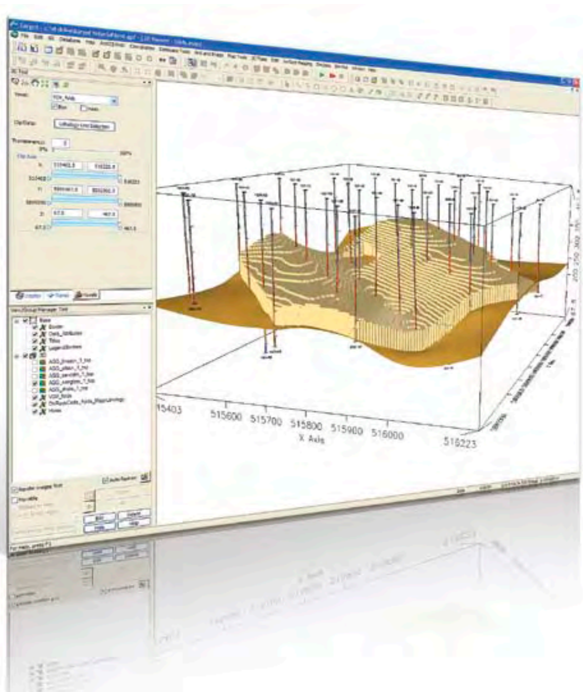


Geosoft has added the Dapple globe explorer as a core component of its software platform, enabling powerful access to a larger data universe. Geoscientists can find, view and extract data from a variety of data servers, including public DAP servers, WMS servers, ArcIMS servers, Tile Servers, and in-house data. They can search for data, and integrate it into their projects without leaving the Geosoft environment.

Along with enhanced Area-of-Interest searches using the globe explorer, new capabilities include a WEB spatial data search engine for locating available public data, and a text search to narrow searches to topics of interest.

Maximize Insight with Powerful 3D Views

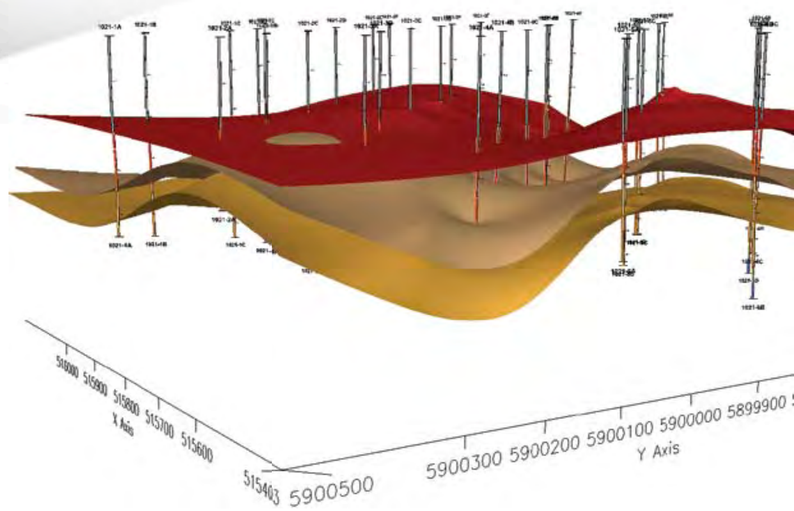
Geosoft has expanded and simplified its three dimensional capabilities, within its own software (Oasis montaj and Target) and also within its exploration geology extension software for ESRI's ArcGIS (Target for ArcGIS)



With the latest advances, Geosoft enables powerful integration and 3D views of subsurface geology, such as: fence diagrams, 3D geology voxels, and the automatic creation of 3D geological surfaces. These 3D capabilities enable geoscientists to integrate their data and enhance their view of the subsurface for more accurate results, greater insight and better decision-making.

3D GEOLOGY SURFACES. Create an elevation grid to represent the top or bottom surface of a lithology unit based on a lithology channel in a Geosoft Drillhole database.

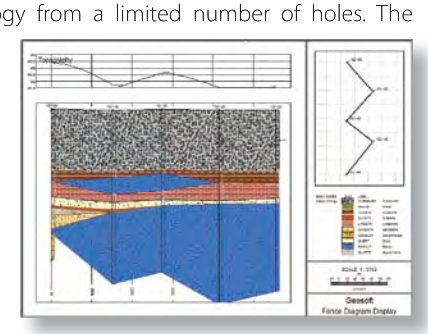
You can create a geology surface grid from any geologic attribute, such as rock type, alteration, or mineralization. You can also extract a profile of the 3D geology surface grid into a section view without digitizing.



3D LITHOLOGY MODELS FROM DRILLHOLE DATA. A geology 3D model can be created from any geologic attribute, such as rock type, alteration, or mineralization, enabling you to display only the rock unit of interest.

Once the 3D model is created, each individual rock unit in the model may be toggled on or off to be viewed separately or together.

PROFESSIONAL FENCE DIAGRAMS. Fence diagrams are useful when comparing down hole geology from a limited number of holes. The ability to create fence diagrams provides geologists with an additional mapping option for displaying and viewing drillhole data. There are many down hole data display options, including automatic creation of geology polygons between holes. ❑



2008 photo contest

Your image could make the cover of the Earth Explorer Magazine!

Explorers worldwide are invited to send their best shots that illustrate their freedom to explore.

PHOTO CONTEST CATEGORIES:

- In the field: real life earth explorers exploring
- Exploration technology: exploration field projects, technology, and equipment
- Exploration sites and landscapes

HOW TO PARTICIPATE:

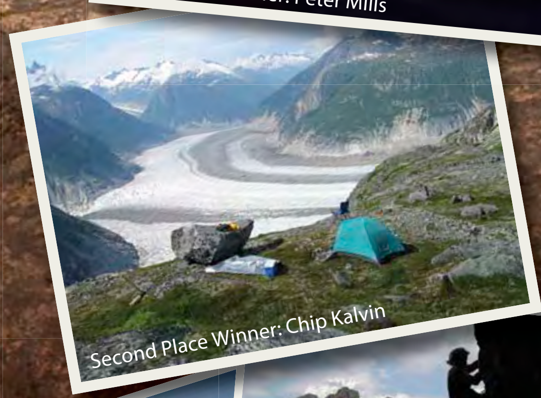
Submit your photos by completing the Earth Explorer 2008 Photo Contest form online at:
www.earthexplorer.com/photocontest

CONTEST DEADLINE: November 7, 2008

GRAND PRIZE:
Canon EOS Digital Rebel XTi

CATEGORY WINNERS: Geosoft Prize Pack


Grand Prize Winner: Peter Mills


Second Place Winner: Chip Kalvin


Finalist: Esmaeil Rameh


Finalist: Nathaniel Burgess


Finalist: Julio Aguilar


Finalist: El Goumi Najib

2007 Photo Contest Winners and Finalists

Earth Explorer

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