El Reventador Erupts in Ecuador

True to its name - "The Exploder" - El Reventador erupted with a 16-km high plume of volcanic ash on November 3, 2002, blanketing Quito, 130 km away, with 1-2 cm of ash. One of the eight most active volcanoes in the Ecuadorian Andes, El Reventador rises to a summit elevation of 3562 m, emerging as a rocky cone in the midst of an older amphitheatre covered in equatorial rainforest. It has been largely dormant since its last significant eruption in 1974.

While investigating current volcanic hazards, such as the new debris avalanche that flowed across the Quito-Nueva Loja highway, DINAGE scientists collected volcanic specimens of both previous lavas and newly-erupted rock. Two samples (M-5 and M-2, respectively) were sent to MAP:GAC administration in Canada for petrological evaluation. Geochemical results (see table) and petrographic descriptions indicate that both lavas are andesitic, although the freshly crystallized rock is darker, rougher, and more scoriaceous than the older grey porphyry.

This recent eruption of El Reventador, typical of andesitic stratovolcanoes, and its damaging effects on local communities as well as international air travel, underscore the importance of ongoing volcanic hazard studies such as those of the MAP:GAC project.

Dr. Jennifer Getsinger

El Reventador erupts in Ecuador.

Chemistry & Petrology

El Reventador	M-2 Nov03	M-5 Older
Major Oxides	%	%
SiO_2	59.4	60.35
Al_2O_3	17.44	17.56
Fe_2O_3	6.42	5.9
CaO	5.73	5.37
MgO	3.02	2.28
Na_2O	4.42	4.65
K_2O	2.29	2.08
Cr_2O_3	0.01	<0.01
TiO_2	0.66	0.56
MnO	0.09	0.1
P_2O_5	0.35	0.32
SrO	0.1	0.11
BaO	0.13	0.12
LOI	0.11	0.12
Total	100.15	99.51

GeoSemantica: The Database Concept

We think of databases as large vaults that hold vast amounts of "data" that can easily be accessed by typing a key word. Back in the 1980s the main task of a database was to capture, store, and retrieve "data". Through time databases have evolved and are now doing more and more sophisticated work. By the 1990s, Database Management Systems (DBMS) were developed in which relational databases were able to compile meaningful data from several databases or vaults rather than just one. The database soon proved itself a valuable tool for marketing. Corporations developed DBMS's to help identify patterns in their customers' purchasing habits. Department stores captured and evaluated every item purchased not only to control their inventory and accounting systems, but also to use the information for analyzing the purchasing habits according to climate, geographic location, culture, etc. DBMS's became the tool to stay ahead of the competition, and the more data corporations captured the more accurate forecasts they were able to make.

Due to the increasing need for corporations to stay ahead of the competition, DBMS's soon grew in size and complexity. These "legacy" systems not only required large amounts of data for these valuable predictions, but also required the data to be organized and formatted in a special way.

In today's Internet environment the DBMS's face a new challenge. It is common knowledge that the Internet holds a large amount of data. The value of these data would increase substantially if one were able to format it, organize it, and also weed out useless data from relevant data. Legacy DBM systems cannot handle this task. The DBMS's of the future need to have the ability to search, identify and register data efficiently.

Imagine a multitude of virtual librarians that live in the Internet and that understand which data is new, relevant and of value. These are called "Intelligent Agents", and they are capable of handling large quantities of "data". They do this not by storing the data but rather by registering when and where it is available in the Internet. MAP: GAC plans to use "Intelligent Agents" that specialize in Geoscience data for the creation of GeoSemantica.

One of the objectives of the MAP:GAC project will be to develop "GeoSemantica" a DBMS that will specialize in capturing, registering and evaluating geoscientific data generated by integrating all the databases of the member countries. The development of the "Intelligent Agents" will provide a valuable tool for all geologists in the project. We envision a future where the geologist who goes to the field will carry a PDA (Personal Digital Assistance) or laptop with satellite internet access. One will have available at their fingertips a DBMS that will provide them with the most complete and relevant information available for the area of study. More importantly, the geologist's knowledge and assessment of the area of study will also be available for others to see almost instantaneously.

Mr. Otto Krauth

For further MAP:GAC information please consult the project Web page at **http://www.pma-map.com/gac/**

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MAP GAC

Internal Newsletter of the Multinational Andean Project: Geoscience for Andean Communities

http://www.pma-map.com/gac/

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From the Manager's Desk - December 2002

Firstly, I and all the members of the MAP:GAC team here in Vancouver would like to wish all of you happiness for Christmas, the holiday season and the New Year. We know that this can be a busy and stressful time of year, but we hope you are able to be with those you love. We wish all of us peace, tranquility and prosperity in the New Year.

November has been a very busy month as the management team scrambled to complete the required reports for CIDA. A few adjustments to the new administrative system (MAPAS), the complexity of the system, the large numbers of reports required by CIDA, and the steep learning curve for those of us who were inputting information delayed completion of the first Quarterly Report (for the 2nd quarter of the fiscal year July 1 to September 30). The report was completed Nov. 13 and couriered to CIDA Nov. 15 and to the participating countries Nov. 20. Included with the Quarterly Report are the Spanish minutes from the Executive Council, and the updated English version of the Implementation Report. This is the final version of the Implementation Report reflecting all the changes made to the Spanish version in Lima, Peru. The English now matches the Spanish. The production of this report has helped shake the knots out of MAPAS and we expect the next quarterly report will go much more smoothly and be on time!

The MAP:GAC team here in Vancouver is making a commitment to get the Newsletters out in a more timely fashion. The Editorial team (Hickson, Mr. Mike Ellerbeck, Dr. Mark Stasiuk, Mr. Otto Krauth, Dr. Jennifer Getsinger, and Ms. Loretta Wong) plan to have the Newsletter ready for printing the first Monday of each month and ready for mailing immediately afterwards. We are requesting your input, both for comments on the format and on the content. Stasiuk will be soliciting articles on geoscience and Krauth articles on aspects of information technology. Please help us develop a better and more useful newsletter!

In November, MAP:GAC had a one day visit from an auditor who reviewed our financial systems to ensure compliance with CIDA's rules and regulations as set out in the Executing Agency agreement between the GSC and CIDA.

Dr. Catherine Hickson

Emergency Management

Emergency management expert Mr. Roberto Gonzalez of the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) completed a tour of visits to the MAP:GAC countries during the final week of November 2002. On the trip Gonzalez visited Venezuela, Bolivia, and Argentina. While in Bolivia SERGEOMIN took advantage of the visit to organize the first symposium on disaster emergency management and to sign a variety of significant memoranda of understanding related to the organization's role in supporting emergency management in Bolivia.

Currently Colombia and Chile are the only two countries that he has not visited. Mr. Gonzalez has been meeting with the emergency management organizations of each country in order to assess the relations that exist between these organizations and the national geoscience agencies of the countries. He will make a presentation on his findings, along with recommendations, to the MAP:GAC Executive Council at the next meeting of the group in Toronto in March 2003.

Mr. Mike Ellerbeck

MAP:GAC Puerto Varas Hazard Workshop

Participants on break at the Puerto Varas Symposium.

The first MAP:GAC organized and sponsored workshop, "Introduction to Hazard Mapping for Landslides and volcanoes", was delivered during the "International Symposium on Environmental Geology for Land Use Planning" in Puerto Varas, Chile on Thursday, November 7, 2002. Canadian landslide expert Dr. Matthias Jakob of Kerr Wood Leidal Associates Limited was contracted by MAP:GAC to deliver the landslide section of the course and Jose Antonio Naranjo and Hugo Moreno of SERNAGEOMIN delivered the Volcanology section of the course which was prepared along with GSC Pacific's Dr. Mark Stasiuk.

Approximately 80 people attended including scientists from every MAP: GAC participant country. There have been many positive comments on the workshop which provided the first opportunity for MAP:GAC scientists to meet and work together in a scientific context.

Mr. Mike Ellerbeck

Geohazard Series No.1

Introduction to The Geohazard Series

To facilitate scientific discussion, MAP:GAC News will now include a regular feature focused on natural hazards: The Geohazard Series. Dr. Mark Stasiuk will be the editor. A number of people have been invited to contribute, and others are encouraged to contribute articles, comments, and suggestions. Those interested should make contact Dr. Stasiuk (mstasiuk@nrcan.gc.ca). The project website will be used for any supplementary material.

The Geohazard Series starts with a set of articles focused on a review of geophysical techniques useful in natural hazards work. This information is needed because the project participants are heading toward the second year of work plan design and most are planning geophysical measurements.

Geophysical Measurements in Natural Hazards: Overview

1. Monitoring versus Measurement

Geophysical measurements form at least half the foundation for determining the level of natural hazards in any particular area – the other half are geological observations characterizing past hazardous behaviours. Quantitative measurements have the great advantage of being objective and can reveal subtle changes with time. However, there is a range of conditions under which geophysical measurements can be performed, from one-off or very rarely for static conditions to continuous real-time measurements during periods of rapid change. Measurements become monitoring once they are done regularly and used to make decisions, for example to detect changes signalling a need for more frequent measurements or elevated alert levels. Measurements that are done once or rarely can be important as they may guide monitoring efforts or provide critical information. An example of this is the application of Interferometric Synthetic Aperture Radar (InSAR), which can map out surface deformations and perhaps trigger additional types of measurement. Monitoring feeds directly into emergency management by providing a basis for forecasts. However, monitoring programs, particularly those involving 24-hour, real-time surveillance and hazard alert systems, are challenging and expensive to initiate and maintain. They also carry very real and very significant direct public responsibilities that are best taken on carefully. For these reasons, in the MAP:GAC we will focus on building the capacity of existing monitoring efforts. Where new capacities are created the emphasis will be on background, non-real-time measurements with good potential for application to a variety of hazard problems, high likelihood to complement existing monitoring efforts, and the potential for use in crisis conditions. In all cases the methods proposed will be completely or nearly "self-contained". This means that, after initial expense and training, they can be performed by the national geoscience agency and not require significant externally-provided services. This is a necessity in order for any acquired methods to continue to be applied after the MAP:GAC.

It is beyond the scope of this project to bring multiple new techniques to all project participants, and it is beyond the abilities of most institutions to absorb multiple new techniques in a short time. As a result, new techniques will be strategically distributed to the participating countries, with the intention that resources will be shared through collaboration.

The sections below are a brief discussion of the main issues and preferred measurement methods. Supplementary material will be placed on the project website, including author information, photographs, and a list of techniques and upcoming articles.

2. Measure What, Where and How?

There is a seemingly endless list of measurement methods. In addition, field measurement is an active area of technology development, and so there are always new techniques on offer. Additional techniques provide additional information, but the backbone of a monitoring effort must include established, affordable techniques that produce interpretable results "on demand". Fortunately there are just a few techniques that fit this description. The preferred techniques below reflect the personal research experience of the project management team, and are open to additional discussion.

> *The backbone of a monitoring effort must include established, affordable techniques that produce interpretable results "on demand".*
> Dr. Mark Stasiuk

Digital Elevation Models (DEM)

Most primary and secondary hazards from volcanoes and landslides are directly influenced, or even controlled, by topography. The need for high resolution DEMs is becoming ever more important for accurate calculation of slope stability, flow process modelling, and even basic visualization purposes. DEM creation will be the focus of the next article in this series. (January 2003)

Precise differential GPS (Global Positioning System) survey in progress in Canada. The technique has sufficient precision and flexibility to be used for a variety of hazards studies and likely will be taken on by the countries in MAP.

The topography of large areas can be determined in many ways, from traditional photogrammetry and surveying, to spaceborne remote stereo imaging and airborne LIDAR (light detection and ranging). However, there are significant variations in the precision, time to produce results, personnel requirements, and direct cost. Spaceborne methods have large coverage but the affordable methods are generally too low resolution for hazards purposes, typically producing DEM data with spatial resolutions in the range of 5 – 20 metres. For hazards work, DEMs are typically needed with resolutions of 1-5 metres. LIDAR is more precise than needed (less than 1 metre), and expensive. The emphasis in the project will be on computer-automated extraction of high resolution topography from air photographs, a method which balances cost, productivity, manpower and precision. This technique has the great advantage that it can be performed "in-house". It also illustrates the common inter-relationship of techniques: In order for software to generate a DEM, ground control points are needed. These can be supplied using differential GPS. The DEM, as one of its many uses, can then be used in InSAR analysis.

Ground Surface Deformation

The gradual deformation of the ground surface over time is a fundamental premonitory feature of seismic, volcanic and landslide processes, and will form the topic of a future article. For landslides, surface deformation may be the only simple feature indicating the state of unstable slopes. For volcanoes, deformation measurement supplements seismic monitoring by mapping stress accumulation related to magma intrusion. For regional seismology, measurement of strain accumulation and release is an emergent area promising a forecasting capability.

In most cases the deformation is too small to be detected by the techniques used for creating DEMs. There are many techniques for measuring ground deformation, from labour/time intensive but extremely precise methods (e.g., precise levelling) through to real-time, remote instruments (e.g., tiltmeters). The application of two techniques: InSAR and differential GPS is encouraged as they are complementary and each can guide the other's application. The InSAR technique, although currently fashionable and able to map large areas of surface deformation, can be expensive and is neither "on demand" nor fully reliable – it should be regarded as a one-off type measurement. Once the equipment is acquired, differential GPS is cheap and fully "on demand", precise, reliable, portable, and can be performed in real-time or near real-time. However it can be labour intensive and produces only point data.

Seismic Monitoring

Earthquake monitoring is fundamental both for seismic and volcanic hazards, and will be the focus of a separate article in this series. The existing regional networks in South America are typically not managed by national geoscience agencies, hence any work done in this area should be in collaboration with the currently responsible groups.

For regional seismic hazards, monitoring is done to determine regional magnitude-frequency relationships, understand seismic source zones, determine the frequency content of regional earthquakes, and ultimately to create hazard maps. There are always areas where networks should be expanded or densified to improve knowledge. In addition, the sensitivity of strong ground motion to local, shallow geology has led to important efforts to map out small areas of hazard variations, or hazard microzones. This is typically done using arrays of strong motion seismographs or accelerographs. The placement of new instruments should be strongly influenced by the geology, and hence geologists and seismologists should work collaboratively. In addition, because volcanoes and earthquakes often occur in the same or at least nearby areas, it is worth considering instrument locations with dual purpose. It is critical at this stage to appreciate that seismic monitoring is perhaps the most costly of all monitoring methods, in money and personnel. Increasing the capacity for seismic monitoring is best done by adding to an existing capacity rather than creating a new one.

Other Measurements

There are many other methods and measurements, many of which are described on the project website. Most are too expensive, labour-intensive, difficult to interpret, overly-specific in their application, or unreliable to be taken on as monitoring methods in MAP:GAC. Some of these are worth considering for specific, one-off applications to provide additional data or an independent, confirming measurement. The application of multiple independent methods can greatly clarify monitoring results and, if selected carefully, can be cheap. However, such measurements should happen later in the project. We encourage project leaders and involved geologists to contribute suggestions, questions and comments on the issue of geophysical measurements in order that informed decisions by the group can be made.

Dr. Mark Stasiuk
(author info: see www.pma-map.com)

Upcoming Event of Interest

MAP:GAC members and colleagues who want more practical experience in how to measure volcanic gases as part of their natural hazard management programs might want to look into the 8th Field Workshop on Volcanic Gases (Nicaragua and Costa Rica), sponsored by the IAVCEI Commission on the Chemistry of Volcanic Gases (CCVG) and the National Science Foundation, to be held on March 26 to April 1, 2003. For more information, see the web site: http://volcgas.unm.edu/nextworkshop.htm

Researchers from a range of backgrounds are invited to participate, not only to exchange ideas, but also to compare actual field measurements for purposes of more accurate international cross-calibration of volcanic gas studies.

Dr. John Stix

Executive Council Meeting, Toronto.

The next meeting of the MAP:GAC Executive Council will be held in Toronto, Ontario, Canada during the Prospectors and Developers Association of Canada (PDAC) annual convention (March 9 – 12, 2003). It is anticipated that 3 full days will be required for the meetings.

Prior to the meetings and no later than February 15, 2003, MAP:GAC management requires the work plans from each country for the 2003/04 fiscal year (April 1, 2003 to March 31, 2004).

Mr. Mike Ellerbeck