## XII Latin American Geological Congress

Conference inauguration.

Keynote speaker, Dr. Tomas Feininger of Laval University, Quebec, Canada.

Iberoamerican Geological and Mining Survey Association (ASGMI) meeting.

Conference closing ceremony.

Quito, the capital of Ecuador, welcomed more than five hundred representatives of the national and international scientific communities for the XII Latin American Geological Congress; the IX Ecuadorian Congress of Geology, Mines, Petroleum, and the Environment; and the I Ecuadorian Congress of Hydrogeology from May 3 to 6, 2005. The objective of the meetings was to reposition society's view of earth sciences as a priority human concern.

With its international significance, the XII Latin American Geological Congress was well-received and provided a venue for the exposure of the work of national and international experts in research related to economic geology, petroleum, environmental geology, geological hazards, geological engineering, and hydrogeology.

Several keynote speeches were presented by such internationally recognized experts as Thomas Feininger of Canada; Dieter Schumacher of the United States of America; Víctor Ramos of Argentina; Michel Hermelín of Colombia; Joseph Mata and Emilio Custodio of Spain; Jorge Oyarzún of Chile; Rafael Guardado of Cuba; Alberto Riccardi of Argentina; Massimo Chiaradia of Switzerland; and Rómulo Mucho of Peru.

Rómulo Mucho presented the objectives, scope, and advances of MAP:GAC to the international community, emphasizing the work of the Community Communications Sub-project.

Within the framework of the event were the parallel meetings of:

- The Latin American and Caribbean Network of Faculties and Departments of Geosciences (GEOLAC)
- The Association of Iberoamerican Geological and Mining Surveys (ASGMI)
- The Commission of the Geological Map of the World, Sub-commission for South America
- The MAP:GAC continued work on the Binational Geological Map of the frontier between Ecuador and Peru
- The Ecuador representatives of the International Association of Hydrogeologists (GECAIH)

Currently the presidency of ASGMI is held by DINAGE and it was announced that the XIII Latin American Geological Congress will be held in Peru in 2008.

Mr. Elías Ibadango

### Word of the Month

The word of the month features definitions that are part of a standardized glossary compiled by MAP:GAC's GEMMA group and, in most cases, adapted from the book Living with Risk. In this issue, we feature the definition of 'capacity'.

**Capacity**

*(From Living with Risk: A global review of disaster reduction initiatives (UN/ISDR))*

A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster.

*Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.*

Ms. Malaika Ulmi

Capacity Capacity Capacity Capacity Capacity


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## From the Manager's Desk

*June 2005*

May has been a busy month for the MAP:GAC group here in Vancouver, and for the remote sensing specialists in each of the countries. Three weeks of multinational remote sensing short courses held in Santiago, Chile, finished on May 14th. Ms. Malaika Ulmi shepherded the participants through the courses, ensuring smooth facilitation. See p.2 for article. From course conclusions and feedback we received, the experience was fruitful for all, and most importantly, participants ended up learning (in some cases the hard way), what is actually required to create DEMs from real data, and conduct interferometry studies. The importance of cooperation and coordination between geological staff and remote sensing personnel was probably the best lesson everyone learned. Remote sensing requires teamwork, and to be successful everyone has to participate. Participants felt confident at the end of the sessions that they now had the skill and tools necessary to create their own DEMs, and could work constructively with their geologists to gather specific information required for the creation of DEMs. They also came to the realization that interferometry is still a developing tool for hazard studies, and can't yet be routinely applied.

The Latin American Congress was successfully held in Quito, Ecuador, May 4–6, 2005, and attended by over five hundred geologists and hydrologists (see p.4 for article). MAP:GAC supported a number of scientists to attend the meeting and some excellent presentations were made. INGEMMET sent a large contingent, and is to be congratulated for supporting the attendance of several young scientists. These types of meetings are great learning opportunities in how to present scientifically significant, relevant, and timely talks.

May is also Volcano Awareness month in the state of Washington, USA, and this year marks the 25th anniversary of the catastrophic May 18, 1980 eruption of Mt. St. Helens. The eruption makes an excellent focal point for reminding people of the devastating impact a volcanic eruption (or any major natural disaster), can have on people and the environment. During my work regarding the Indian Ocean tsunami, one of the things I recommended to governments was that they should create remembrance ceremonies so that the lessons learned are not lost through the years and generations. Institutionalizing remembrance of a significant event is one way to ensure that we continue to remember the horrific death toll natural disasters have taken through the ages.

Dr. Catherine Hickson

## Community Communications

Presentation of the results of the technical and social studies done on the case study area of Nidia in Cucuta, Colombia. Attended by local organizations involved in the MAP:GAC Community Communications sub-project.

The new 2005–06 Community Communications Sub-project work plan was reviewed and approved during the February Executive Council Meetings in Caracas. Since its beginning in July 2003 the Community Communications Sub-project of MAP:GAC has faced great challenges and made significant advances. Sub-project Coordinator Mr. Mike Ellerbeck and hazard communications expert Dr. Fernando Muñoz Carmona have visited each of the seven participant countries twice to work with the national geoscience agencies and other partner organizations in selecting a case study area in each member country. As a team, they have presented workshops to government and non-government organizations, the private sector, and academic institutions in the case study areas. Currently, each member geoscience agency is working in its respective case study area, and in some places significant advances have been made sooner than expected in the application of geoscience knowledge to land-use planning and emergency management.

Following the progress of the first two years, the next year will focus on uniting representatives from the various partner organizations and the geoscience agencies to develop products synthesizing information on the geological, social, economic, and historical conditions in the case study area, such as posters, maps, pamphlets, and other forms of communicating scientific information to a community. In many instances this will represent the first time such organizations have collaborated on the creation of such products aimed at benefiting their communities.

The results of this effort will be presented at a special invitational workshop to be held following the Cities on Volcanoes Conference in Quito, Ecuador, January 23-27, 2006.

During the next seven months, Muñoz Carmona, Ellerbeck, and information technology expert Mr. Otto Krauth will be visiting each case study area and working in collaboration with communities and partner organizations on the collaborative information products.

Mr. Mike Ellerbeck

## Remote Sensing Workshops, Chile

The Remote Sensing Group in Vina del Mar on a day trip between classes.

Dr. Vern Singhroy teaching basic remote sensing.

Mr. Carlos Pattillo instructing the group in the use of EV-InSAR software for interferometry.

MAP:GAC's Remote Sensing Group met for a series of short courses hosted by SERNAGEOMIN in Santiago, Chile, from April 28 to May 14, 2005. The courses were aimed at arming participants with skills to create digital elevation models (DEMs) and work with radar imagery in interferometry. This set of workshops built on the foundation of previous courses held in the past few years within the framework of the Project.

Dr. Vern Singhroy, a world-renowned expert from Natural Resources Canada, Earth Science Sector's Centre for Remote Sensing, initiated the less-experienced members of the group in the basics of remote sensing, and updated everyone on the latest techniques. Singhroy raised the awareness of the group regarding a number of valuable resources on remote sensing available on the internet. One such resource is a program called GlobeSAR 2 which is aimed at increasing the capacity of South American institutions in radar technology**.** The Multinational Andean Project: Geology in Support of Sustainable Development (http://www.pma-map.com/en/map/index.html), a predecessor project to MAP:GAC, was a partner in this program.

The second course, *Geomatica Focused in the Generation of Digital Elevation Models*, was taught by Ms. Sandra Maigler of PCI Geomatics. She led the group through DEM extraction with PCI software using aerial photos, ASTER, EROS pairs, and Quickbird imagery. Everyone discovered the combination of accuracy, resolution, and ground control points necessary to generate a DEM with each type of imagery. Maigler's thorough training left the group ready to process any medium available to create a DEM.

Maigler joined the group for a day trip to Viña del Mar and Valparaiso on the Sunday between courses. Everyone enjoyed a vineyard tour, the colourful sites of Valparaiso and its busy docks, the polished town of Viña del Mar, and a stop at the beach.

The third course was led by Mr. Carlos Pattillo, a Chilean expert and head of the Centre for Remote Sensing and GIS Studies in Santiago. Patillo and his colleague Ms. Maria Elena Pezoa began with a summary of theory, and then led the group through hands-on processing of radar images with Earth View InSAR software creating interferograms, interpreting the results, generating DEMs, and using radar data for differential use in monitoring motion. The potential of this developing technology was evident, as was its sensitivity and complexity. Use of the European Space Agency's radar image archive database was introduced, as this imagery will be available to the Project.

All participants left the courses with new knowledge and an ability to generate products using the software supported by the Project. Quality DEMs from each case study area are anticipated in the coming year. The group was reminded that PCI is offering a prize for the best product generated from their Geomatica software. The participants intend to maintain communication and cooperate regionally on any technical issues. As agreed at the Executive Council Meetings in Caracas, Venezuela, the attendees will deliver presentations to the geologists of their respective geoscience agencies, informing them of what is available within remote sensing, processing times, needs for various products, and necessary communication between geologists and remote sensing experts.

Ms. Malaika Ulmi

## Satellite Imagery for a World of Disasters: The International Charter "Space and Major Disasters" and UNOSAT

Two distinct international initiatives make satellite imagery available to those who need it most. The International Charter "Space and Major Disasters" is a multicountry-sponsored unified delivery system of satellite imagery for regions in the midst of a disaster; and UNOSAT is a United Nations team that provides low-cost satellite imagery and GIS services to the humanitarian, sustainable development, and disaster-reduction communities.

The International Charter is familiar territory to MAP:GAC, as it has been invoked by the project on behalf of Bolivia, and activated several times by Colombia and Venezuela. The Charter is an agreement among the European Space Agency (ESA), the Canadian Space Agency (CSA), France's Centre National d'Etudes Spatiales (CNES), the Indian Space Research Organization (ISRO), the American National Oceanographic and Atmospheric Administration (NOAA), Argentina's Comisión Nacional de Actividades Espaciales (CONAE), and the Japan Aerospace Exploration Agency (JAXA). The aim of the Charter is to help mitigate the effects of disasters on human life and property by creating a working relationship between space agencies and the civil protection community. Under the Charter, a single point of communication mobilizes a system of space data acquisition and delivery for those affected by natural or man-made disasters. The available data include SPOT, ERS, and RADARSAT imagery, and, when needed, image processing.

Only authorized users may invoke the Charter, and these include the civil protection, rescue, defense, or security bodies of a member country which have been given the activation phone number. When a call is received, it is verified and then information passed on to a designated Charter Project Manager who communicates with the member space agencies and has the appropriate satellites tasked. Once received, the data are then processed, interpreted, and passed on to the authorized user.

UNOSAT is a United Nations initiative designed to provide affordable satellite imagery and geographical information services to the humanitarian community. The UNOSAT team includes experts in remote sensing, GIS, programming, field, and communications to aid in the interpretation of the images. As the organization recognizes the value of remote sensing in the humanitarian and disaster management fields, they also offer training and technical assistance. The consortium is partnered with the United Nations Institute for Training and Research (UNITAR), the United Nations Office for Project Services (UNOPS), the European Organization for Nuclear Research (CERN), the Earth Observation User Liaison Office, the International Charter Space and Major Disasters, Respond, Global Monitoring for Security and Stability, Spot Image, Digitech International, GAMMA Remote Sensing, and Inta Space Turk. To qualify to order imagery through UNOSAT, organizations must register as members. For a group or government to meet the criteria to become a member, they must be involved in humanitarian and/or disaster relief work in line with the policies of the UN.

For more information, please visit www.unosat.org and www.disasterscharter.org.

Ms. Malaika Ulmi

## Airborne Gravity—An Emerging Tool For Hazard Studies

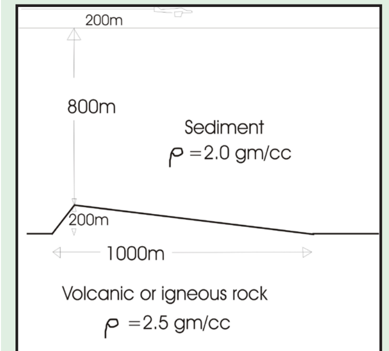


Fig. 1 Representation of a basement fault
ρ =density

### Introduction

Gravity was one of the earliest geophysical techniques for tectonic studies. As early as 1923, Vening Meinesz used a double pendulum apparatus mounted in a submarine to map gravity anomalies, now known to correspond to subduction zones, in the Indonesian archipelago. Gravity was also the first geophysical method used to discover a major oil deposit in the United States in 1924 (Gibson, 1998). Despite these early successes, the adaptation of gravity to an airborne platform, capable of providing results with useful sensitivity and spatial resolution was considered impossible well into the 1960s, and has gained broad acceptance only in the last decade. This is due to the fact that to produce useful results, sensitivities less than 1 mgal are required—that is, less than 1/1,000,000th of the Earth's average gravitational field measurement. However, as is well known from the General Theory of Relativity, accelerations due to sources of interest are indistinguishable from accelerations due to the platform motion, which are orders of magnitude higher. Thus the only way that adequate sensitivity could be obtained was to average over long periods of time, thus reducing the spatial resolution problem. As early as 1978, Carson Aerogravity had developed systems using stabilized platforms and was offering gravity surveys for hydrocarbon exploration. However, it was the development of the full Global Positioning System (GPS) that has made it possible to consider actually measuring the instantaneous accelerations of the aircraft with adequate precision and frequency to separate them from the acceleration due to the geological source of interest. At the present time contractors are offering primarily two types of gravimeter systems—those that use stabilized platforms, thus trying to eliminate as much effect of aircraft acceleration as possible, and those that use fixed or "strapped down" gravimeters that depend on measuring the accelerations of the platform with sufficient accuracy to separate the tiny "signal" from geological sources from the accelerations due to the platform. A resolution of 1 mgal is considered achievable, although ultimate sensitivity and spatial resolution are dependent on the filtering used, speed of the aircraft, and amount of redundancy perpendicular to the traverses. Like aeromagnetic survey systems thirty years ago, these systems tend to be specialized for each individual contractor, thus organizations contracting these services must make a specific effort to know exactly what methodology is being used and what filtering has been carried out to produce the final result. A second and competing technology is the gravity gradiometer, which owes much of its development to military requirements of the cold war. Basically, three horizontal components of the gradient tensor are measured on opposing pairs of sensors such that accelerations of the platform are cancelled out. From these measured components it is straightforward to calculate the vertical component. Incredible accuracy has been reached with these instruments, equivalent to 1 Eötvös Unit (one millionth of a mgal/cm), while 5 E.U. are achievable with the airborne version.

Gravimeters measure the anomalous value of the earth's gravity vectors (or gradient of the vectors for gradiometers) caused by contrasts in gravity. A good example, and one of major interest for both hydrocarbon exploration and hazard studies, is a normal or reverse fault, which can produce an anomalous mass. Unfortunately, a range of densities exists even within specific rock classifications. For example, basalt is denser than rhyolite; however, in general, mixed basement rock is denser than sedimentary rock, producing a contrast in the order of 0.5 g/cc (see Thomas, 1999, for typical density ranges). Determining the detectability of a fault is not simple because it depends not only on the density contrast but also on the specific geometry of the fault. However, at altitudes that are large compared to the dimensions of the fault, the anomaly can be approximated simply by considering the excess mass as represented by a simplified geometry and these types of calculations can be used to estimate the detectability with a system of a given sensitivity. For example, if a source can be reasonably represented by a triangular shape as shown in Fig. 1, and has a density contrast of 0.5, the anomaly 1000 m above the fault, which includes the depth of sediments plus aircraft altitude, would be approximately 3 mgal. Thus this anomaly should be detectable with a system with sensitivity of 1 mgal, assuming the spatial resolution is adequate, a value considered achievable by airborne systems. At 2000 m depth, the anomaly would still be detectable in principle but would be close to the limits of the system. An associated question is at which depth range gravity or gravity gradient will give better sensitivity and resolution. At shallow depths, a gradiometer system will give better resolution; however, the gradient amplitude does decrease more with depth, so that there is a depth at which gravity becomes the better method. An excellent discussion of vertical resolution, comparing gravity and vertical gravity gradient for particular geometries, is given by Li (2001). Using a sphere model and limits of 0.1 mgal and 5 E.U. for gravity and gravity gradient, he calculated a transition depth of 400 m, which for that type of source, the gradiometer would give better resolution above that depth, the gravimeter below. If the gravity sensitivity is reduced to 1 mgal, the transition depth (for a sphere) becomes 4000 m. Unlike aeromagnetics and airborne spectrometry which have developed well accepted instrumentation and procedures to ensure that the final product is of highest quality, airborne gravity as an emerging technology requires more careful analysis of systems offered and processing procedures.

Another potential application of airborne gravimetry applied to hazard studies includes the mapping of faults at depth and monitoring of fault movement. An airborne gravity gradiometer survey is scheduled to be carried out in May, 2005 at a test area over the San Andreas fault that coincides with an International Continental Drilling project site. The survey is being carried out under the direction of Dr. Manik Talwani of Rice University and is designed to map the low density zone associated with the fault down to several kilometres, and offers the potential to provide a baseline for monitoring temporal changes along the fault zone. (Talwani, 2004; see also http://www.phyorg.com). The interested reader should be able to monitor the progress of this experiment on the Rice University webpage. (http://www.geophysics.rice.edu/department/faculty/talwani/sanandreas.html). Dr Talwani has also discussed the possibility of monitoring magma movement in active volcanoes with an example from Mt. Etna using airborne gravity.

### Conclusions

Clearly airborne gravity and gradiometry are emerging technologies that will have significant importance to hazard detection and monitoring, particularly as sensitivities continue to improve and costs decrease. Readers are invited to consult the references below and contractor websites such as http://www.aerogravity.com for more comprehensive discussions and examples relating to mineral and hydrocarbon exploration and mapping. It is important to note that many of the objectives of hydrocarbon exploration and hazard mapping are common; the mapping of faults beneath sedimentary basins thus provides a growing body of data for comparison.

Dr. Dennis Teskey

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