2004-07 EMSEV ACTIVITIES
IN THE FRAME OF IUGG INTER-ASSOCIATION INITIATIVES

Title: Electromagnetic Study of Earthquakes and Volcanoes through Training Local Scientists and Transferring Monitoring Techniques to Developing Countries

Background and Scope:

The EMSEV group is developing a four year project through which we try to help developing countries initiate and develop seismo-volcanic electromagnetic research within their own capabilities and constraints. EM monitoring, when conducted properly, is an effective tool for the study of the physics of volcanic eruptions and earthquakes. This discipline includes geomagnetic, geoelectric and electromagnetic sub-disciplines, each of which deals with a wide variety of frequencies, using varied instruments and methodologies. Accordingly, the degree of progress also varies from one Hazard to another and from one sub-discipline to another. For local scientists in developing countries to be successful in their research, we consider that the transfer of knowledge should start with the more promising sub-disciplines which can be easily implemented and maintained while also encouraging attacks on frontier aspects of science. As our science progresses, methods now at preliminary stages may become more firmly based and generally adopted. Therefore, it is important that aspects of the program allow evolution and modification with time.

It should be stressed here that, in order to attain fuller understanding on how earthquakes and volcanic eruptions occur, it is necessary to closely integrate EM studies with other fields of study, such as seismic, geodetic, geothermal, hydrological and geochemical. Data gathering efforts in these other fields are not included in our project, but integration efforts with them will be emphasized.

Work Plan in Volcanology

In this domain, we help the Philippines to establish EM volcano monitoring systems. At the IUGG supported EMSEV-PHIVOLCS (The Philippine Institute of Volcanology and Seismology) workshop held in January 2003 in Manila, it was concluded that electromagnetic monitoring of the basaltic Volcano Taal near metropolitan Manila was most urgently needed. This volcano is expected to erupt in near future.

EM methods, together with other techniques, have been demonstrated to work at practical level for Japanese volcanoes, such as Usu and Miyake-jima, and several researchers affiliated to EMSEV are experts in these fields of researches. So, several EMSEV members have taken the responsibility to help Philippines to develop EM studies in the following years.

On Taal volcano PHILVOLCS routinely monitor the activity with real-time seismic and GPS networks. Geochemical analyses are also done regularly.

Since 1992, sporadic seismic crises have been accompanied by opening of fissures, ground deformation (up to 21 cm), and geothermal activity. Felt earthquakes are also regularly recorded. The last seismic crisis started in September 2006. Taal volcano has to be considered in a possible stage for developing a new eruption in the nearby future. Moreover, since 1754, 33 eruptions have been recorded and 28 of them occurred with intervals less than 30 years (88%): The last eruption took place in 1977 (30 years ago) and several geophysical parameters actually indicate that the volcano unrest starts.

2004:

In 2004 EMSEV received $3,000 for initiating field works on Taal volcano. This cooperative project was based on an official agreement between PHILVOLCS and EMSEV and signed in December 2004 for a period of 5 years.

Complementary budgets were obtained in 2003, 2005 and 2006 by the different EMSEV members involved in the project.

A 10 day field visit was carried out early in January 2005 to image the volcano structure and in particular the geothermal fields which show a noticeable activity. Ground magnetic, self-potential, CO_2 soil degassing and ground temperature surveys were simultaneously carried out on the volcano at the same time. Highly active geothermal zones were well - recognized and delineated; some of them are located along trails and vista sites used by one or two hundred tourists each day. The best sensor configuration for repeated monitoring networks has been identified and was ready for implementation. The field work was an efficient way to train Philippine colleagues so they could do the re-surveying of the profiles on their own.

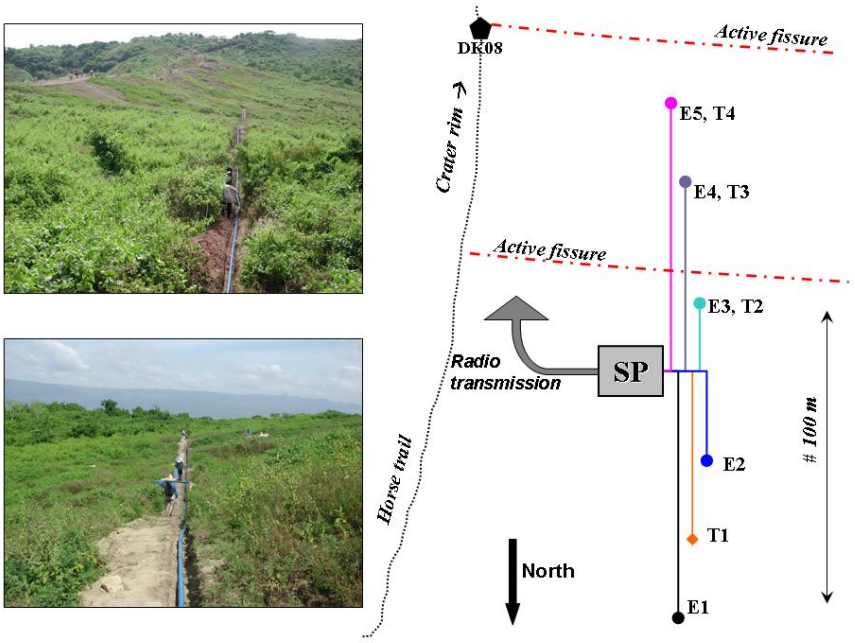
A second survey was then carried out in February by PHIVOLCS team. Several magnetic and electric anomalous areas were found and correlated with the main volcanic features (crater, fissures, etc). From this survey it was also observed that drastic changes in both magnetic and electric fields had taken place since the first field work. During the time between surveys, several felt earthquakes had also occurred.

2005-2007:

In 2005, the budget we had for developing EM research on Taal was 740 euros (from IAGA), together with $1,000 $ (from IAVEI). The second EMSEV-PHIVOLCS campaign was scheduled for November 2005. After a half-day discussion on results related to the recent past activity, the field work was completed in the next 6 days. Two objectives were achieved:

1. We re-surveyed several paths across active fissures and extended the surveys where anomalous areas were observed.
2. A station for continuous recording of the self-potential (SP) and ground temperature (GT) at several points along a buried line across active fissures was constructed.

In 2006, installation of a second station was planned with $2,300 ($2,000 from IAVCEI + $300 from Pulinets saving), but the plan was postponed to 2007 because a severe cyclone hit the area. PHIVOLCS team, however, carried out another repeat survey of the area.
In 2007, radio transmission of data should also be implemented (on foreign national budgets).



Continuous SP and GT station on the northern volcano flank.
Ei are electrodes and Ti temperature sensors.

2006:

New magnetic and SP surveys were organized by the PHIVOLCS EM team in February 2006. In this area, repeat measurements of magnetic and self-potential anomalies, at well located points, were found almost constant with time.
Another important field effort was organized for October 2006. Several objectives were planned: (1) to re-survey and extend ground surveys and to complete map the soil-degassing, (2) check the continuous SP and Ground temperature data from the datalogger, and (3) start a magnetotelluric survey of volcano. Unfortunately just before the field work, a huge thunderstorm hit Manila and its vicinity, and thousands of people were evacuated. Due to the evacuation priority and the sensitivity of EM surveys to large rainfall, it was decided to postpone the field work.

Observations and results were presented in several international meetings. Two articles were dedicated to our 2004-2006 observations. One was mainly devoted to magnetic anomaly mapping (Harada et al., 2006), and the other to Self-potential, Magnetic, CO2 soil degassing and ground temperature (Zlotnicki et al., submitted).

2007:

After the first magnetotelluric survey (initially scheduled in Oct. 2006) we plan to leave the equipment in the Philippines to allow PHIVOLCS team to make several soundings by themselves. We have further scheduled another EMSEV-PHIVOLCS field expedition before the 2007 rainy season to achieve: (1) the superficial tomography of the volcano by magnetotelluric surveys, (2) to re-survey the ground maps, and (3) possibly to complete the installation of the new combined continuous SP-GT and magnetic station.

Depending on the budget we will get, we also would like to plan an International Workshop on EM monitoring in Manila with EM training on Taal. We will invite all the Asian colleagues. This plan is based on several ideas. First, several repeated surveys have been done on Taal during the last few years, and results will be broadly and widely discussed in regard to all other real time observations (seismicity, ground deformation, thermal imaging, geochemistry, etc). Second, the development of an EM real time monitoring system will be investigated and the best system chosen. Third, the 'Taal case study' will be used to investigate the application of EM methods to other volcanoes (Indonesians for instance). And fifth, we will organize further field work on Taal with EM methods (mainly those easily done by small teams (surveys)).

For this project we ask for 3000 Euros from IIASPEI and IASPEI in the frame of EMSEV activities. Complementary budgets are also requested from various national funds for the equipments and their transportation.

Further developments:

For the next few years, we plan to extend similar work to other volcanic/seismic developing countries. Indonesia, depending on further development of the planning and their funding possibility, will be one of the next targets; JSPS started to support EM studies on earthquakes.

Earthquake and eruption prone countries in Latin America and in the Middle East (India) will also be candidate countries. In Mexico, there are experts on the subject, including an active EMSEV member, and by 2006 their monitoring and analysis program was in operation. In South America, some interest could be raised as a result of our activities at 2004 IAVCEI General Assembly, and 2005 IAGA General Assembly at Toulouse (France), and 2005 IASPEI General Assembly in Chile. In Caucasian countries, active programs for earthquake investigations and hazard warning have been in operation since the Soviet days, and EM study in these areas will be greatly assisted by experts from nearby countries, including 5 Russian EMSEV members.

In summary, considering our present capability, dictated largely by man power and resources, we would like to continue our efforts in the Philippines, and to start cooperative EM studies in Indonesia (2000 Euros are requested) and India (Koyna). We will organize meetings and field training in these countries. After the planned activity of Integrated EMSEV Symposium and

Meeting in Perugia IUGG General Assembly 2997, we will have in 2008 our international workshop and meeting in Romania (IWEMSEV-2008). For this, 2000 Euros will be requested from our Associations in 2008.

Utmost efforts will be constantly made to draw external additional funds, using IUGG support as seed money. Although not guaranteed, substantial progress can be counted on in our discipline in the near future and the progress of information technology will make transmission/handling of large amount of data rapidly inexpensive. If so, our campaign, with these more innovative techniques, will provide improved chances of success as time goes on.

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