

**2009 Annual Report of Inter-Association (IAGA/IASPEI/IAVCEI)  
Working Group of Electromagnetic Studies  
on Earthquakes and Volcanoes (EMSEV)**

<http://www.emsev-iugg.org/emsev/>

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## 1) Introduction

EMSEV has maintained a high level of activity during 2009, promoting outstanding studies on magnetic and electric studies of earthquakes and volcanoes. An increasing number of new areas of research have resulted from new national and international cooperation's, and mixing of different expertise has contributed to better understanding of EM and other related phenomena. The scientific communities dealing with ionospheric EM signals and lithospheric EM signals are now working together and new ideas emerge in the interpretation of EM signals from the source to the ionosphere.

EMSEV also continues to strongly support activities in developing countries by introducing EM techniques, organizing regional workshops, and teaching young scientists.

Finally, EMSEV is extremely active in organizing specific sessions in regional and international meetings. During 2009, the EMSEV working group was involved in seven major international meetings.

## 2) Membership

During the last plenary XII<sup>th</sup> business meeting held during IAGA-2009 meeting at Sopron (Hungary), EMSEV members decided to nominate new members:

- **Dr Anatoly Rybin** from the International Geodynamic Research Center in Bishkek-city in Kyrgyzstan. A. Rybin is director of Research Station RAS in Bishkek. He is also in charge of the EM studies in Tien Shan geodynamic polygon.
- **Dr Ciro Del Negro** from the Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Italy. Ciro Del Negro is a widely well known expert in the studies of volcanoes from the integrated EM monitoring systems and data analyses to the knowledge of the physical mechanisms.

### 3) Web site

Toshiyasu Nagao, Secretary of EMSEV, maintains the EMSEV web site the URL of which is <http://www.emsev-iugg.org/emsev/>. This Web site has been updated in November 2009.

This Web site is under the IUGG organization, and EMSEV Inter-Association Web site is linked to the three supporting associations IAGA, IAVCEI and IAVCEI. Useful information can be founded as recent annual and business meetings reports, mailing list, past and future activities.

At present, the EMSEV mailing list is limited to a message size of 50 Kb. Larger than 50 Kb size should be sent to [T. Nagao: nagao@scc.u-tokai.ac.jp](mailto:T.Nagao@scc.u-tokai.ac.jp)

The maximum storage capability is 40 Gb. This allows exchange of papers, data, and presentations. The number of EMSEV mailing list members is now about 250 representing 14 countries.

### 4) Organizational Activity in 2009

#### 4.1 EGU, Vienna, Austria, 19-24 April, 2009

EMSEV members were active in the organization of three sessions:

##### *NH5.2/SM4.6*

Seismic hazard evaluation, precursory phenomena and reliability of prediction

Convener: M. E. Contadakis,| Co-Conveners: P.F. Biagi, J. Zschau

##### *NH5.3/SM6.3*

Electric, magnetic and electro-magnetic phenomena related to earthquakes

Convener: P.F. Biagi, Co-Conveners: M. Hayakawa, O. Molchanov

##### *NH5.4/SM6.5*

Deformation processes and accompanying mechanical and electromagnetic phenomena, for rocks and other materials, from the laboratory to the geophysical scale

Convener: K. Eftaxias, Co-Conveners: T.L. Chelidze, Dr. Nomicos

#### 4.2 2009 International Workshop on Validation of Earthquake Precursors by Satellite, Terrestrial and other Observations (VESTO). Case studies of the recent Asian events, Chiba University, and Japan March 26-28, 2009

This workshop was organized in the frame of EMSEV activities. D. Ouzounov, K. Hattori and T. Liu organized this workshop.

The aim of this workshop was to provide a forum for discussion and exchange of different experience in the science and cross validation of earthquake related signals. The main goal of this meeting was to cross-examine the results of precursory detection for several major earthquakes by applying different methodologies for analysis of ground-based and satellite data for the four major most recent earthquakes in Asia. VESTO LOC has proposed four major earthquakes for common validation:(1) Sumatra (Indonesia) 2004.12.26 M9.2; (2) Ping Tong (Taiwan) 2006.12.26 M7.0×2; (3) Chuetsu Oki (Japan) 2007.7.16 M6.8 and (4) Wenchuan (China) 2008.5.12 M7.9.

#### 4.3 Second International Seminar on Prediction of Earthquakes, Lisbon, Portugal, 29-30 April, 2009

J. Zlotnicki represented EMSEV.

In the frame of the Year of the Planet Earth, a second International Seminar on Prediction of Earthquakes was held in Lisbon on April 29-30, 2009. It was held during the 100<sup>th</sup> anniversary of the Benavente 1909 earthquake ('1909 Lisbon Earthquake'). The objectives were to (i) provide the largest platform for discussing observations made along active faults, (ii) to state the

level of knowledge in the prediction of earthquakes, and (iii) to promote international cooperation in the field of earthquakes prediction. Plenary sessions were devoted to advanced research:

- In seismology (Giuliano Panza), from statistic evaluations of impending earthquakes based on different word-scale software to the evaluation of the predictability of earthquakes,
- In electromagnetism (Jacques Zlotnicki) where recent progresses in the analysis of observations have been highlighted,
- In multi-parametric observations (Max Wyss, Heiko Woith) in which cross-correlation of data allows determine the sensitivity of methods applied to Earthquake monitoring (gas, fluid, geodesy, seismicity ...),
- In paleoseismology (Tom Rockwell) which has shown the applications in the long term forecasts of large earthquakes.

The conclusions and recommendations of the meeting were that earthquake prediction research has made progress in the last decades, but earthquake prediction remains an unsolved domain. The earthquake prediction requires an international coordinate strategy in which multi-disciplinary co-operation should be promoted.

#### **4.4 International Conference “Electronic Geophysical Year: State of the Art and Results”, Pereslavl-Zalessky, Russia, 3-6 June 2009**

<http://elpub.wdcb.ru/ebooks/absegy.pdf>. J. Zlotnicki represented EMSEV.

Among the topics reported during the conference, several of them were in the scope of EMSEV activities: GIS and artificial intelligence methods in geoscience; problems of geoinformatics in seismology, data processing and signal recognition, and geoecology, transition of World Data Centres into the World Data System as well as geomagnetic observations, and virtual observatories. About 150 attendees from Russia, Austria, Germany, USA, Iran, Slovakia, Ukraine and France held over 120 presentations at six scientific sessions.

#### **4.5 AOGS 2009 meeting, Singapore, 11-15 August, 2009**

\* The Philippines Institute of Volcanology and Seismology presented one talk on PHIVOLCS-EMSEV observations on Taal volcano.

\* Session: IWG07 : Seismo Electromagnetics: Lithosphere-Atmosphere-Ionosphere Coupling  
Convener: Katsumi Hattori, Co-Convener: Liu, Jann-Yenq (Tiger), Huang, Qinghua

Session description: There have been accumulated a lot of convincing results on electromagnetic effects associated with earthquakes, and these electromagnetic phenomena are considered as useful for short-term earthquake prediction. The aim of this session was to have a forum to highlight the electromagnetic phenomena associated with crustal activity taking place in the lithosphere, atmosphere and ionosphere/magnetosphere and their related phenomena. The session was planned to evaluate and discuss the state of the art and the recent progress in Seismo-Electromagnetics research. The scope of this session was in the following;

- Ground-based earthquake-related electromagnetic phenomena
- Ground-based volcano-related electromagnetic phenomena
- Satellite based earthquake/volcano-related phenomena
- Signal Processing
- Observation / Instrumentation / Data integration
- Physical mechanism / Theory
- Lithosphere-Atmosphere-Ionosphere Coupling
- Space weather and Lithosphere weather

13 oral and 4 poster papers were accepted and presented.

#### 4.6 XIth IAGA 2009 meeting, Sopron, Hungary, 23-30 August, 2009

Session I06, Crustal tectonic processes constrained by electromagnetic observations, was organized by T. Harinarayana and Y. Ogawa.

Topic: Study of the crustal processes helps to delineate the natural resources, seismically active zones, geothermal regions etc. The session is devoted to research contribution of electromagnetic studies in resolving structural features of crust ranging from Archean to Recent in age. Recent review paper on EM investigations of the lithosphere in Europe provided an overview of the large-scale EM surveys on a regional scale. We particularly invite such large scale studies. The session also addressed the role of EM in monitoring crustal processes. EM monitoring of seismic and volcanic processes have examined correlation of electrical resistivity models with crustal melting, seismicity, and fault zones.

*The XII<sup>th</sup> EMSEV business meeting was held during IAGA meeting; the XIIth business meeting report can be found at: <http://www.emsev-iugg.org/emsev2009/page017.html>.*

#### 4.7 AGU 2008 Fall meeting, San Francisco, 14-18 December 2009

Two sessions were held in the EM field.

##### ***NH11: Terrestrial and Satellite Observation Related to Abruzzo M6.3 Earthquake of April. 6, 2009***

[http://www.agu.org/meetings/fm09/program/scientific\\_session\\_search.php?show=detail&sessid=402](http://www.agu.org/meetings/fm09/program/scientific_session_search.php?show=detail&sessid=402)

Conveners: Pier Francesco Biagi, Vincenzo Lapenna, Dimitar Ouzounov, Valerio Tramutoli  
Description: The 2009 L'Aquila earthquake was an earthquake of magnitude 6.3 that occurred in the central Italian region of Abruzzo on 6 April 2009, following a series of hundred minor aftershocks. The majority of the damage occurred in the medieval city of L'Aquila (capital city of the Abruzzo region) and the surrounding villages. About 300 people are known to have died, making this the deadliest earthquake to hit Italy since the 1980 Irpinia earthquake. The cost to human life of such events is another indication to the science community that development of an earthquake risk management scheme requires diverse interdisciplinary efforts. Main scope of the proposed session is to introduce interdisciplinary approach of studying M6.3 Abruzzo event from multiple satellite and terrestrial observations. The science community and the operational agencies are struggling with how to provide early detection of such catastrophic events and reduce the loss to humans and property. The recent advances in solid earth sciences and remote sensing capabilities make the multidisciplinary approach possible and could provide additional information to the other methods of monitoring and early detection of earth movement, such as GPS and InSAR. Topics of this session are extending the discussion about M6.3 Abruzzo earthquake proposed by the Union session "An Earthquake in an Ancient City: the April 2009 L'Aquila (Central Italy) Seismic Sequence" and include geophysical imaging of active faults, satellite thermal imaging, electromagnetic, geochemical and gas observation, atmospheric, ionospheric and GPS/TEC observations. The papers are invited from international community composed of scientists, decision-makers, first responders, and operations experts who are involved in new space- and ground-based observation related to disaster risk management.

##### ***NH12: Multidisciplinary Approach for Earthquake Precursors Validation***

Conveners: Dimitar Ouzounov, Sergey Pulinets, Michel Parrot, J Y Liu, Katsumi Hattori

[http://www.agu.org/meetings/fm09/program/scientific\\_session\\_search.php?show=detail&sessid=403](http://www.agu.org/meetings/fm09/program/scientific_session_search.php?show=detail&sessid=403)

Description: Within the last several years there have been major earthquakes that caused great devastation and significant loss of life. We propose this session to validate the results of precursory detection for major earthquakes by using different methodologies with the hope that

development of such a multidisciplinary approach could provide significant early warnings for such catastrophic events such as the recent M7.8 earthquake in Sichuan, China and M6.3 earthquake in Abruzzo Region, Italy. The observational evidence from the last twenty years suggests the existence of geochemical, atmospheric, ionospheric and electromagnetic phenomena accompanying or preceding some earthquakes. Recent studies, presented at the 2009 International Workshop on Earthquake precursor Validation (VESTO) in Japan, provided new evidence for a distinct coupling between the atmospheric boundary layer and the ionosphere, which are strongly related to an enhanced tectonic activity. Still, more validation work in this area is needed to address the concerns of some in the science community that is whether such signals actually precede and were related with these earthquakes. Topics include case studies related to investigating large earthquakes, statistical theory of precursor validation, reanalysis and new observations and a theory relating tectonic stress changes to electrical, electro-chemical and thermodynamic processes. Contributions are also solicited on all possible new space- and ground-based methodologies of studying earthquake related phenomena

## **5) EMSEV activities in Philippines**

### **5.1 2009 EMSEV activity on Taal volcano**

#### **5.1.1 Frame of the cooperation**

The Philippines is a highly populated developing country that faces serious Natural Hazards from Volcanic Eruptions and Earthquakes. Risk assessment is a key issue for Civil Authorities and Official Institutions (such as the Philippines Institute of Volcanology and Seismology - PHILVOCS) responsible for delivering reliable information on volcanic unrest and potential earthquakes. In 2004, a PHIVOLCS-EMSEV agreement was signed. The common objective of PHIVOLCS and EMSEV is to develop a new scientific community of both young and experienced Philippine scientists who are skilled in EM methods for the study of volcanoes and earthquakes. The rational way to achieve this objective is to combine EM methods with other geophysical methods to study known geophysical hazards. Priority was given to Taal volcano which has exhibited signs of unrest since 1992. The surrounding population exceeds several hundreds of thousands of local inhabitants.

Since 2005, an international Japan-French EMSEV team has visited Taal about twice a year with a PHIVOLCS EM team with the objectives to understand the structure, the dynamism and the heat and fluid transfers, as well as to monitor the volcano activity.

#### **5.1.2 IUGG two years grant (Sept. 2008 – Aug. 2010)**

EMSEV submitted one proposal to IUGG based on the on-going cooperation with PHIVOLCS, which is “Monitoring Taal volcano unrest in Philippines based on a joint Electromagnetic and multi-disciplinary educational EMSEV-PHIVOLCS program”. The IAGA and IAVCEI Associations supported the project. IUGG Executive Committee, at its meeting in Karlsruhe in August 2008, reviewed the recommendation of the IUGG Bureau regarding the project and decided to award the project. The amount of the IUGG grant is US\$9,300 for the 2 years project. In addition to the research and training program, EMSEV will organize a workshop focused on training young scientists in Asian countries.

#### **5.1.3 2009 field activity**

EMSEV-PHIVOLCS have focused their studies on:

- Large scale self-potential, magnetic, electric resistivity surveys for mapping the upper part of the hydrothermal system, the fissures from which magmatic/hydrothermal gases escape, and the hydrothermally altered areas which can collapse into the crater owing to mechanical instability.
- Large scale temperature and degassing surveys on the ground and in the Crater Lake. Results will provide information on the thermal state of the volcano and on its changes with time.
- The bathymetry and the surface temperature of the Main Crater Lake.

In addition, an EM network based on multi-parametric stations is continuously upgraded:

- Two continuous stations located inside and outside the crater records the electric and magnetic fields, the ground temperature and the gradients, the seismic noise (RMS). The data of these stations are telemetered in real time at the local observatory where a first level analysis is done, before an internet transfer to PHIVOLCS headquarter and France.
- Two proton precession magnetometers are continuously recording the total magnetic field inside and outside the crater.
- One continuous station is recording the temperature and the water level of the Main Crater Lake.

*The complete first year report can be found on EMSEV Web site: <http://www.emsev-iugg.org/emsev/page005.html>*

## **5.2 2010 EMSEV activity on Taal volcano**

Two field campaigns are scheduled in 2010. One will follow EMSEV-PHIVOLCS workshop in February (see next paragraph) and the second field work will be scheduled in October-November 2010.

For both campaigns repeated surveys will be performed and new electric/magnetic profilings will be achieved. Continuous stations will be completed by new sensors, as a seismometer in DAK station.

Continuous efforts will be done for educating more deeply PHIVOLCS colleagues in EM methods applied to volcano monitoring. Effort will also be done in the knowledge of data processing and interpretation. PHIVOLCS EM team could already be ready to perform by itself SP and magnetic surveys on other volcanoes in Philippines.

Specific new tasks will be added to regular repeated surveys:

- Imaging the hydrothermal system by resistivity soundings,
- Imaging the volcano structure and the hydrothermal system by magnetotelluric soundings
- Mapping the water temperature of the floor of Main Crater Lake,
- Setting of three continuous GPS-EM stations in the frame of a JICA program (T. Nagao, Japan),
- Setting of borehole seismometer or tiltmeter by Malcolm Johnston (USG, IASPEI support).

## **5.3 2010 EMSEV-PHIVOLCS workshop**

### **5.1.1 Scope**

Following the first Workshop held in 2003 for initiating Seismic and Electromagnetic Monitoring in Asian Countries, EMSEV and PHIVOLCS (<http://www.phivolcs.dost.gov.ph/>) organize an international workshop on February 25-27, 2010 at PHIVOLCS headquarter (Quezon City, Philippines) entitled: MONITORING ACTIVE VOLCANOES BY ELECTROMAGNETIC AND OTHER GEOPHYSICAL METHODS.

This second workshop will highlight techniques and methodologies for monitoring active volcanoes with the application to Philippines and other Asian volcanoes. Topics will focus on advanced multi-methodological methods based on electromagnetic and other geophysical methods for understanding volcanic structures and monitoring awaking volcanoes and

hydrothermal/magmatic unrests. A particular attention will be paid to volcanic hazards, public information and risk management in highly populated volcanic areas. The five years cooperation between EMSEV and PHIVOLCS on Taal volcano will be exploited for educating young scientists to field work.

Detail information can be downloaded from EMSEV Web site: <http://www.emsev-iugg.org/emsev/>

#### **5.1.2 Topics of the Workshop:**

- Volcanic risks in Asian countries,
- Volcanic risk assessment, education, information and education,
- Historical activity of volcanoes in Asian countries: Existing precursory phenomena?
- Advanced electromagnetic methodologies for imaging volcanoes,
- Electromagnetic and other geophysical methodologies for monitoring hydrothermal/magmatic systems,
- Satellite observations,
- Data processing and modeling,
- Special session on Taal volcano: historical eruptions, structure, hydrothermal activity and magma injection. What to monitor and how? Real time monitoring and processing, risk mapping, predictability.

### **6) Plans for 2010 meetings**

As for the past years EMSEV will be involved in many international meetings.

#### **6.1 2010 EMSEV-PHIVOLCS workshop**

##### **6.1.1 PHILVOLCS-EMSEV meeting 2010**

This workshop is organized in the frame of the 2008-2010 IUGG grant “Monitoring Taal volcano unrest in Philippines based on a joint Electromagnetic and multi-disciplinary educational EMSEV-PHIVOLCS program”; Information is given above.

##### **6.1.2 EGU meeting, Vienna, Austria, 2-5, May, 2010**

In Natural Hazards session, one session (*NH2.3*) related to Volcanic Hazards is entitled: Applications of integrated electromagnetic and other geophysical methods on active volcanoes. The aim of the session is the application of multi-methodological geophysical methods based on electromagnetic (EM) and other geophysical methods to volcanic unrests and related natural hazards. Combined methods are the most efficient approach for understanding the physical structure and the dynamics of active volcanoes, reducing interpretative ambiguities. In order to highlight the state of art in these domains, the session will focus on:

Tomography of active volcanoes and geothermal fields by multi-parametric methods,

EM observations along with other geophysical methods,

Advanced electromagnetic and potential field methods in integrated time series inversion,

Advanced technologies for processing time series of EM and potential fields,

Development of automatic data processing; adaptation of monitoring systems and analyses in real time,

Modelling volcanic unrests and predictability.

Information: <http://meetingorganizer.copernicus.org/EGU2010/sessionprogramme/NH>

Convenors: J. Zlotnicki, Ciro Del Negro, V Lapenna

### **6.1.3 Cities on Volcanoes, CoV6-Tenerife 2010, Tenerife, Canary Islands, Spain, May 31 – June 4, 2010**

CoV6-Tenerife 2010 is an international forum on volcanic risk management. Scientific and technical sessions are planned to bring together geoscientists working on active volcanoes, authorities, civil protection specialists, city planners, social scientists, economists, psychologists, educators, health specialists, engineers, mass media and general members of communities living in active volcanoes to exchange and understand their experiences and knowledge in order to evaluate and improve prevention/mitigation actions, land-use planning, emergency management, and all required measurements to improve volcanic risk management in densely populated volcanic regions.

CoV6 organizing committee accepted a session led by EMSEV.

Electromagnetic and other geophysical methods for monitoring and predicting volcanic eruptions.

ElectroMagnetic (EM) fields are particularly sensitive to rather shallower parts of a volcano because of their penetration depth. They often manifest anomalous changes simultaneously with geochemistry, temperature and potential field signals. EM observations are mainly based on the detection of signals in (1) the geomagnetic field, (2) the electrical resistivity, (3) the self electric potential (SP) and (4) the EM emissions. Volcanic eruptions generate various kinds of EM signals, from the ground to the ionosphere, which can also be detected by satellites as GPS-TEC or DEMETER observations. Combined EM methods turn into a very powerful tool for volcano monitoring when other geochemical and geophysical observations are associated. Also, EM methods can be effective for monitoring phreatic explosions, which sometimes show no mechanical forerunners.

This session will focus on:

- Volcano structure as revealed by combined EM and other geophysical methods.
- Geochemistry and thermal budget of sources for volcano-EM signals.
- Joint EM, geochemical and geophysical observations.
- Joint modelling of EM and other geophysical data.
- Advanced technologies for time series analyses of EM signals.
- EM and other signals related to phreatic and phreato-magmatic explosions.
- Satellite and other remote sensing of EM signals related to volcanic activities.
- EM emissions related to volcanic eruptions and pyroclastic flows.
- Mapping volcanic hazards by EM, geochemical and geophysical methods.

Information: <http://www.citiesonvolcanoes6.com/ver.php>

Convenors: Y. Sasai, J. Zlotnicki

### **6.1.4 Second International Symposium on Radio Systems and Space Plasma, August 25-27, 2010 – Sofia, Bulgaria**

Scope: The goal of this symposium is to focus on the broad range of aspects beginning from the intelligent methods of radio-communication systems and signal processing, transionospheric propagation, through the updated methods for analyzing non-linear interactions of space plasma, up to radio science aspects of space solar power systems. The symposium aims at contributing to the dissemination of research results, and supporting in this way the wider applicability of advanced radio-communication technology.

Topics of interest for the symposium include, but are not limited to:

- Radio-Communication and Telecommunication systems
- Spectrum and Medium Utilization
- Information Theory, Coding, Modulation and Detection



- Signal and Image Processing in the area of Radio Science
- Transionospheric Propagation
- Investigation of Space Environments via Satellite Observations
- Generation and Propagation of Waves in Plasmas
- Interaction between Waves and Wave Particles
- Plasma Turbulence and Chaos
- Spacecraft-Plasma Interaction
- Solar Power Satellite (SPS) Systems and related Radio Technologies
- Influence and Effects of SPS – Radio Science Aspects
- Further Directions in SPS Systems

Website: <http://www.isrssp.org>

M. Parrot belongs to the program committee.

#### **6.1.5 20th electromagnetic induction workshop, Egypt, 15-28 September, 2010**

Scope: The workshop will include review papers on the following topics:

- Global induction studies with emphasis on satellite studies,
- Three dimensional magnetotelluric inversion,
- Near-surface EM studies. Magnetotelluric measurements along the San Andreas Fault,
- a review Ocean EM studies for resources and tectonics,
- Making and breaking of a continent – what we can learn from MT in Africa,
- Galvanic distortions and phase tensor.

Website: <http://www.20emiw.info/>

The workshop is organized by the National Research Institute of Astronomy and Geophysics NRIAG, India and by Prof T. Harinarayana ([thari54@yahoo.com](mailto:thari54@yahoo.com)).

#### **6.1.6 EMSEV 2010 meeting, Chapman University, Santa Ana, USA, October 3-6**

Our next International EMSEV meeting will be held at Chapman University, Santa Ana, in USA. During this workshop, most of the EM studies related to earthquakes, tsunamis, and active volcanoes are discussed and evaluated. It is a key issue for promoting advanced EM studies.

Six sessions are scheduled:

Session I - Electric, magnetic, and electromagnetic methods related to earthquakes, tsunamis, volcanic, landslides and geothermal activities,

Session II - Seismicity, Geophysical and Seismo-electromagnetic studies along San-Andreas Fault,

Session III - Techniques for correction of EM data and identification of EM Signals associated with Earthquakes and Volcanoes,

Session IV - Multi Sensor Data and Integration of Geophysical Observations Related to Volcanic and Earthquake studies,

Session V - Generation and propagation mechanism of EM signals and Laboratory studies,

Session VI - Ionospheric and GPS studies associated with Seismo-Electromagnetic processes.

Prof. R.P Singh is organizing this EMSEV meeting with the help of several EMSEV members.

Information is be provided at: <http://sites.google.com/site/emsev2010/Home>

#### **6.1.7 AGU Fall Meeting, San Francisco, December 2010**

Proposed sessions are still under discussion

## 7) Financial Report 2009

### 7.1 2009 EMSEV incoming support

- IUGG, EMSEV general activity: received 1424 Euros (\$2,000)
- IAGA, International cooperation: received 755 Euros (\$1,000)

### 7.2 2009 EMSEV outgoing

- Support to PHIVOLCS infrastructures on Taal (\$1,300)
- Support to VESTO meeting (950 €)
- Provision to EMSEV-PHIVOLCS February 2010 meeting (1000 €)
- Provision to EMSEV October 2010 meeting (1000 €)
- Provision for CoV6 (800 €)

Remaining EMSEV budget on December 1<sup>st</sup>: 436 €

### 7.3 2008-2009 IUGG grant

- First year support: 3890 €(\$5,000)

### 7.4 2008-2009 IUGG grant outgoing

- 2CV motor boat engine for experiment in Taal Crater Lake, GPS
- Support to February PHIVOLCS-EMSEV field campaign
- Support to November-December PHIVOLCS-EMSEV field campaign
- Provision to EMSEV-PHIVOLCS February 2010 meeting (1500 €)

Remaining IUGG grant budget on December 21<sup>st</sup>: 724 €

## 8) **Concluding Remarks**

Founded in 2001 by IUGG, the Inter-Association Working Group of Electromagnetic Studies on Earthquakes and Volcanoes is supported by IAGA, IASPEI and IAVCEI associations. As a matter of fact, the understanding of earthquakes processes and volcanic eruptions, and the ability to detect and analyze EM signals related to active tectonic processes require expertise in many fields of researches: physics of the Earth, physics of fault rupture and volcanic eruptions, laboratory experiments, physical mechanisms generating magnetic, electric and electromagnetic signals, role of fluids, gas and thermal fluxes in the crust, propagation of EM signals in the crust and towards the ionosphere.

One of EMSEV's primary objectives is to keep a good balance between all these domains of research. The EMSEV WG strongly promotes the highest quality researches in advanced countries (Japan, France, USA, Greece, Italy, China ...), organizes sessions and meetings at international level, endorses outstanding observations and results, and expands EM activities in developing countries as well.

In recent years, much of the effort from the EMSEV community has focused on developing more intensive international cooperation at the frontiers of the different related disciplines (EM, geodesy, seismology, hydrology, geochemistry, volcanology and laboratory studies). Earthquakes are now often studied from the source to the ionosphere by land and satellite observations, laboratory experiments and EM generation processes are jointly studied, remote sensing combine different techniques and cross correlate observations for identifying anomalies above prone seismic areas, etc.

EMSEV has succeeded in promoting joint multi-disciplinary researches at the highest level. For instance, geochemical, thermal fluxes, gas emission, seismicity observations are combined with magnetic and electric studies of the activity on Taal volcano (Philippines). This multi-parametric approach is also performed on other volcanoes (Etna volcano in Italy, volcanoes in Japan) and in seismically active regions (i.e. Corinth gulf in Greece, San Andreas Fault).

These new steps in understanding earthquakes and volcanic physics and eruption consequences have followed the acquisition of more reliable observations and have provided better understanding of the role of EM phenomena in these processes.