Gruppo Nazionale di Vulcanologia

2000-2003 Framework Program

Final Evaluation Report

Preamble

The Program 2000-2003 of the Gruppo Nazionale di Vulcanologia (GNV) concluded its scientific activities at end 2004. All project final reports were submitted to the Evaluation Committee (EC) by early December 2004. The EC conducted its final evaluation on December 18-20, 2004 in Naples, in occasion of the 2004 GNV national assembly.

Goals of the final meeting were

- to review the status and progress of the 2000-2003 GNV framework programme,
- to evaluate the 3rd year reports and the final reports submitted by all Research Units
- to formulate an overall judgement on the GNV program and to highlight its strengths
- to provide elements for the formulation of the forthcoming 2005-2008 plan

This report contains the following sections:

1. *Mandate and activities of the evaluation committee*
2. *Overall Program Evaluation*
3. *Adherence to the objectives of the Framework Program*
4. *Evaluation of individual projects*
5. *Lessons learned*
6. *Recommendations*

1. MANDATE AND ACTIVITIES OF THE EVALUATION COMMITTEE

The Evaluation Committee was established by the Dipartimento di Protezione Civile (DPC) on November 30, 1999, and its mandate was extended to December 31, 2004, to cover the whole implementation of the GNV 2000-2003 Framework Program.

Mandate

The mandate of the Evaluation Committee included the following tasks and duties:

- ensure a peer-reviewed evaluation of the proposals submitted to GNV;
- evaluate the proposals taking into account the objectives of the Programma Quadro GNV approved by DPC;
- approve the budget and activities of all GNV projects;
- review the yearly reports submitted by the project coordinators;
- authorize the yearly GNV funding; conduct the final review;
- submit to DPC periodic reports and the final evaluation report.

Composition

The GNV 2000-2003 Evaluation Committee is composed by

Prof. Paolo Gasparini, GNV Director, University of Napoli Federico II

Prof. Domenico Giardini, ETH Zurich, Switzerland

Dr. Gudmundur Sigvaldasson[†], Nordic Volcanological Observatory, Iceland

Prof. B. Marjorie Wilson, University of Leeds, UK

In the first year of activities, the EC included also Dr. Enrico Bonatti, CNR Bologna, who was replaced in the second year by P. Gasparini.

Activities

The Board met in several official evaluation sessions, and attended the GNV national assemblies. After each meeting, status and evaluation reports were submitted to the DPC.

October 18-20, 1999. Start-up meeting in Roma.

January 10-13, 2000. Review meeting in Catania-Roma. With specific regard to surveillance, the DCP convened on January 11, in Catania, a joint meeting with representatives of the agencies/programs responsible for volcano monitoring (POSEIDON, OV, INGV) to present the status of the surveillance activities and the overall monitoring strategy for Italian volcanoes.

October 7-8, 12, 2001. First year evaluation meeting in Roma. First year reports and second year executive projects presented by the project coordinators were evaluated; activities and budgets for the second year were approved. On October 9-11 the yearly assembly of GNV took place, and all projects were presented to the Italian scientific community. On October 12 the Review Committee met again to complete the first year evaluation.

October 24-25, 2002. Review meeting in Roma.

[†] Dr. G. Sigvaldasson died on December 16, 2004, only days before the final meeting of the Evaluation Committee. The EC incorporated in its evaluation the final comments submitted prior to the meeting by Sigvaldasson.

January 27-28, 2003. Second year evaluation meeting in Roma. Second year reports and third year executive projects presented by the project coordinators were evaluated; activities and budgets for the third year were approved.

November 11, 2003. Review meeting in Roma. The meeting was held jointly with the Working Group GNV-DCP, formed in 2003 with the task of coordinating the GNV deliverables to the Dipartimento Protezione Civile (DPC), following the recommendation of the EC after the review of the 2nd year of the GNV programme. Goals of the joint meeting were to review the status and progress of the 2000-2003 GNV framework programme, to evaluate the delays in funding allocation and the additional committments due to the recent volcanic crises at Etna and Stromboli, and to establish a new programme schedule.

December 18-20, 2004. Final review meeting In Neaples. Organized in occasion of the GNV Assembly, held in Neaples on December 20-22.

In addition, the Board met informally to discuss status and progress in occasion of various AGU and EGS assemblies.

All Board decisions were taken unanimously.

Evaluation criteria

All proposals submitted to the GNV 2000-2003 program were subjected to a peer-review process and to the overall EC evaluation. After review, projects were (A) approved for funding with requested modifications, (B) approved for revision and subsequent funding, (C) rejected. The Board proposed a funding ceiling for the first year and an overall expected project ceiling for the three years; all projects in class A and B were requested to submit a revised detailed budget for the first year. Executive projects and funding requests for the 2nd and 3rd years were submitted with the activity reports of the previous year. Yearly budgets were approved for each year.

The criteria used in the evaluation of the proposals included:

- *Significance for GNV*. The adherence of the proposals to the GNV targets and overall philosophy, and specifically to the seven research lines contained in the 2000-2002 GNV Framework Program.

- *Scientific excellence*. Each proposal was assigned to two Board members, as primary and support internal reviewers, with the duty of coordinating the external review process. All projects were subjected to international peer review by external referees. Each project was sent to at least two foreign referees and to one italian referee; referees were chosen among the foremost scientists in the relevant field. Criteria for the scientific review included originality and innovation, scientific advancement, scientific curriculum and past achievements of the proponents.
- *Proposal structure*, evaluated on the basis of careful planning and detailed presentation of the overall project and of all individual research units, the successful integration of tasks and research units in coordinated projects, realistic schedule and research goals to be achieved in 3 years, a reasonable itemized budget, the justification of personnel requests, a convincing management structure, the integration and coordination with foreign and national research projects and agencies.
- *Project coordination and management*. With the goal of eliminating duplications, increasing integration and achieving a more tight and homogeneous definition of large coordinated projects, the Board proposed several changes to the presented projects, including joining projects with similar or common targets and eliminating tasks and research units with insufficient overall standards.
- *Budget and personel*. The EC strived to build a culture of excellence in reporting, and requested that each project specify the qualification, need and budget for all requested personnel units (PhD, postdoc, assistant, technical).

The approved GNV projects did not specifically covere monitoring and surveillance activities of active Italian volcanoes, as these are covered through a separate DPC contract to INGV.

It was agreed that the EC would not be responsible nor would carry out any formal audit of the financial statements of the project coordinators.

2. OVERALL PROGRAM EVALUATION

The GNV 2000-2003 Program has been very successful. The scientific productivity, the production of reports geared toward practical applications, the build-up of technical expertise and know-how useful in case of emergency planning and management demonstrate the validity of the approach followed by GNV.

The high scientific quality of the performed activity is in most cases demonstrated by the overall number of publications in peer reviewed journals. More than 400 articles have been published or are in print, several others have been submitted or are in preparation. As it should be expected, not all the projects had the same level of productivity and scientific level. Inequalities occur even within a single projects, mainly in those covering many themes and with many Research Units. However, lack of delivery in single objectives did not prevent the achievement of most of the objectives, and 9 out of the 19 projects produced deliverables of immediate use and data which are useful as a reference in case of an emergency.

Generally nearly all of the projects have some useful deliverables. In some cases they have not been adequately indicated by the coordinators, but they are apparent from the RU reports. It will be useful if the

final report delivered to Civil Protection will include an annex with a specification of the single available deliverables, their format (maps, data archives, etc.), where they are available and the suggested way to make them available to Civil Protection and the volcanological community.

Some relevant technological deliverables were developed; they are usually software for fast data processing or interpretation and prototypes of instruments. They are meant to be used to improve volcano monitoring. So the transfer to volcanological observatories must be pursued.

Another strong point of GNV activities has been the attention devoted to the formation of young researchers. GNV has supported the participation of young researchers to international meetings where they presented their contribution to the FP. Moreover GNV supported financially grants and fellowships through which a group of young volcanologists was formed with experience in the various fields of volcanology. They are the future of volcanology in Italy. In summary we believe that through the present project there has been a spectacular improvement of the level of knowledge of volcanic hazard at Campi Flegrei and Stromboli. Volcanic and gas emission hazards were for the first time estimated at Colli Albani and Panarea islands. For the first time a coordinated effort was dedicated to the assessment of volcanic and slope instability hazard for Stromboli and Ischia islands.

3. ADHERENCE TO THE OBJECTIVES OF THE GNV FRAMEWORK PROGRAM

Overall, the objectives and milestones foreseen by the Framework Program for the GNV 2000-2003 have been achieved. Only in a few cases, ambiental conditions or the failure of specific instrumentation or even more rarely the lame performance of single Research Units, have prevented from following more closely the Framework Program.

For each of the 7 Themes of the Framework Program, we provide in Appendix a detailed list of the expected objectives and their achievement.

4. EVALUATION OF INDIVIDUAL GNV PROJECTS

All GNV projects have been periodially reviewed by the EC. In Appendix we provide the final evaluation sheet for all projects. Here we group the projects in four ranking classes (A-D), depending on the achievement and success of each project. We note that the EC evaluation is positive for all projects, with difference levels of success.

A. Excellent projects under all points of view, which met or exceeded all the expected objectives, with an excellent management

01 Chiodini: Diffuse gas emissions in volcanic areas. Geochemical and structural features, and physical models of the process. Development of monitoring techniques

02 De Natale: Development of an integrated spectroscopic system for remote and continuous monitoring of volcanic gases

11 Marzocchi: Identification and interpretation of the pre-eruptive seismic patterns for the worldwide effusive and explosive volcanoes

13 Coltelli: Development and application of remote sensing methods for the monitoring of active italian volcanoes

14 Zollo: Integrated seismic methods applied to the investigation of the active volcano structure. An application to the Campi Flegrei caldera

15 Chiocci-Marani: The Submarine Portions of Italian Volcanoes: their Survey and Assessment of the Potential Volcanic hazards

16 Orsi: Volcanic hazards assessment and zonation at the resurgent Campi Flegrei caldera and their effects on man and environment

17 Papale: Simulation of Eruptive Scenarios at Phlegrean Fields Based on Field, Laboratory, and Numerical Studies, and Implications for Volcanic Hazard

19 Barberi: Risk scenarios for an underwater eruption East of Panarea

B. *Very good projects, which produced most of the expected objectives, with a very good management*

05 Valenza: Multidisciplinary investigations on the mass and energy budgets in the italian active volcanoes

06 Bonafede: Study and constraints on intermediate storage, magma uprise and conduits through modelling of strain fields, velocity and attenuation tomography at mt. Etna

07 Rosi: Hazard assessment of Stromboli Volcano

08 Santacroce: Explosive eruptions of italian acctive volcanoes eruptive scenarios, hazard and risk maps: Vesuvio, Vulcano, Lipari

12 Pareschi: Creation of Volcanic Tematic maps

18 Funiciello: Hazard from emission of endogenous gases at Colli Albani

C. *Good projects, which produced uneven results in different tasks or needed more integration*

03 Del Negro: Technological innovation and automation in the integrated applications of Electromagnetic and POTential field methods in active volcanic areas

09 Trigila: Eruptive scenarios from physical modeling and experimental volcanology

D. *Fair projects, requiring significant improvement*

04 Stanzione: Chemical and isotopic characteristics of gases and groundwaters at Vesuvio, Campi Flegrei, Ischia e Vulcano: evaluation of the volcanic risk

10 Vezzoli: Study of the Etna pyroclastic deposits aimed to largest explosive eruptions reconstruction and volcanic hazard assessment

5. LESSONS LEARNED

Very large projects do not, in general, result in added value

When the number of individual research units is greater than 7 or 8 there can be very serious concerns about the effectiveness of project coordination. Few project leaders have the necessary management expertise, particularly if they are younger scientists.

Small research groups, particularly in the smaller universities, can struggle and should not be left isolated, but incorporated into a larger Research Unit

It is sometimes the case that very small research units (1-3 persons), particularly in smaller, less well funded, universities, lack the critical mass in terms of necessary infrastructural support and human resources (analytical facilities, technicians etc) necessary to carry out their part of the project successfully. Project coordinators need to consider this issue carefully when they put their project teams together.

Younger coordinators are one of the key success factors for GNV projects

THE ITALIAN VOLCANOLOGICAL COMMUNITY HAS SOME EXTREMELY TALENTED YOUNGER SCIENTISTS (BOTH MEN AND WOMEN <45 YEARS) WHO HAVE THE POTENTIAL TO LEAD MULTI-DISCIPLINARY PROJECT TEAMS. MORE OF THEM SHOULD BE ENCOURAGED, AND, IF NECESSARY, SHOULD BE PROVIDED WITH APPROPRIATE MANAGEMENT TRAINING.

A new generation of highly skilled, young researchers is emerging and their potential needs to be developed

A significant number of PhD students and post-docs are trained in the broad field of volcanology and volcano geophysics each year. Some of these may become leaders of GNV projects in the future. Efforts must be made to provide appropriate career pathways for these people to ensure retention of the very best within the Italian scientific community.

PhD students working within project teams should be encouraged to publish more

There needs to be a cultural shift towards encouraging PhD students to publish their results in international journals (as first author) before they have submitted their theses. This will require considerable support from more senior project participants.

New methodologies and applications (remote sensing, marine geophysics, numerical modelilng) produce more immediate benefits for Civil Protection

IN MANY CASES, NOVEL TECHNOLOGIES AND THEIR APPLICATION APPEAR TO PRODUCE RESULTS OF MORE IMMEDIATE BENEFIT FOR CIVIL PROTECTION. THIS DOES NOT IN ANY WAY MEAN THAT MORE TRADITIONAL APPROACHES (IN, FOR EXAMPLE, PETROLOGY OR EXPERIMENTAL PETROLOGY) ARE NOT IMPORTANT. PROJECT COORDINATORS DO, HOWEVER,

NEED TO DEMONSTRATE THE IMPORTANCE OF SUCH RESULTS FOR CIVIL PROTECTION PURPOSES RATHER THAN FUNDAMENTAL SCIENTIFIC UNDERSTANDING.

Technological innovation must be supported and encouraged

The development of new kinds of instrumentation for volcano monitoring and improved software codes for data processing should be integral parts of future GNV projects. Consideration must be given to ownership of Intellectual Property (IP) rights. Funding and long-term maintenance of major infrastructures producing data of relevance for DPC must be better regulated. Access to such infrastructure must be preserved.

Project data must be organised, archived and distributed widely

Data obtained as part of individual projects must be made available for use by the wider volcanological community in an easily acessible (web-based) format. Such web sites should be hosted by INGV with links to the web sites of volcano observatories (e.g. OV) and those of individual research units.

There needs to be much better integration of data sets (and their interpretation) between different research groups and scientific disciplines

It is important that data sets for individual volcanic regions should be brought together. If this is not done the opportunities for added-value are lost.

The involvement of foreign units needs to be carefully managed

The involvement of research units of other countries can be of great benefit where know-how or laboratory facilities are not available in Italy. When such units receive research funding directly from GNV, however, their programme of their work needs to be much more carefully managed by the Italian project co-ordinator to ensure that it remains focussed and relevant to the needs of Civil Protection.

6. RECOMMENDATIONS

We present here a summary of recommendations which should be taken into consideration in developing the Final Report and in planning the next Framework Program.

Products

A major effort has been undertaken in order to provide the DPC with products and tools of direct application for risk mitigation meaures. An ad-hoc DPC-GNV working group has been set up to this purpose. Still, the EC notes that many projects should have worked more in the third year in order to transform some of the excellent research results into useful products. This result could be achieved with minor effort in a follow-up phase.

Program Database

There is an urgent need to collect and integrate all the data, results and simulations obtained in the 2000-2003 in a comprehensive database, so that scientists, civil protections and administrative workers, as well as

the general public may have access to the GNV spectacular results through a dedicated portal. The DPC should invest to make sure that the GNV results do not get lost in the near future.

Final Report

Only part of the Final Reports submitted to the EC is already in a suitable form to be translated for DPC and included in the Final Program Report.

Final project report should adhere to the prescribed structures and include:

- Original project description.
- Director report: project summary, adherence to original project description, key results, strong points, open questions, unresolved issues, technological innovations, failures and international cooperation, related projects and matching funds, future outlook.
- Scientific report for each task.
- Statistical data: PhDs and Tesi di Laurea (include names and dates), researchers and personnel (name, qualification, duty, percentage of employment on the project, percentage of employment supported by GNV), publications in three classes (international peer-reviewed journals, reports and volumes, abstracts), special activities (workshops, meetings).

GNV relevance and visibility

Particular emphasis must be placed on the visibility and relevance of the GNV programme. Activities could include:

- A comprehensive web infrastructure, including the full GNV scientific results (i.e. all published papers in pdf form or link) and a full integrated database of all data and maps.
- A web information portal for general public and schools (with links and material geared to different information levels and a popular divulgation of volcano science).
- Special volumes and reports.
- Program summaries published on journals such as AGU EOS and Science.

GNV finances

The funding allocation during the GNV 2000-2003 Framework Program experienced continuous delays and required changing the program schedule and deadlines several times in this period, to the point that the program finished over 1 year later than originally anticipated. We compliment again the project coordinators for succeeding in carrying out the project under such uncertain and erratic constraints. We recommend that DPC and INGV establish a rigorous financial framework for the next Framework Program.

Emergencies

As it might be expected when working on volcanoes, a number of emergencies required the full attention of many of the GNV teams: Stromboli 2002-2003, Etna 2001 and 2002, Nyiragongo Task Force 2003. The

response of GNV received widespread praise at all levels. However, the engagement in unexpected surveillance and investigation activities also slowed the progress of some GNV projects. We extend the full compliments of the EC to the project coordinators for their capacity to react under pressure and the quality of the work performed during these emergencies.

This report is unanimously approved by the whole Evaluation Committee.

Napoli, December 31, 2004

The GNV Evaluation Committee:

P. Gasparini, D. Giardini, M. Wilson, G. Sigvaldasson†

Appendices

19 Individual project evaluation sheets

THEME: 1

Project: # 1
Coordinator: Giovanni **CHIODINI**, INGV Osservatorio Vesuviano
Expected ceiling budget: 630 Ml
Received budget: 630 ML (325 kEuro)
Participating UR: 6
Original grade: A
Final Grade: A

TITLE: Diffuse gas emissions in volcanic areas. Geochemical and structural features, and physical models of the process. Development of monitoring techniques.

Achievements of objectives
The project comprised 8 original objectives; the major aim was to develop new monitoring techniques for the study of diffuse degassing (DDS) of active volcanoes which may be useful in eruption forecasting. Most objectives have been fully accomplished., and in some cases work has progressed beyond that originally anticipated (e.g., measurement of soil degassing and interpretation of DSS degassing). The study of DDS at the summit of Etna could not be completed because of ongoing eruptions. Additionally, the coordinator agreed with EC that studies on paleodegassing should be cancelled from the second year

New Technology Development:
The project aimed to develop new instrumentation for the measurement of CO_2 flux. Two new instruments have been deployed: a LICOR sensor, and associated software which allows faster measurements to be made, and an Eddy correlation continuous instrument (a new concept in volcanology) at the Solfatara crater.

Deliverables useful for Protezione Civile:
Detailed maps of $C0_2$ degassing from soil at Solfatara (Campi Flegrei) Mt. Vesuvius summit area, Ischia, Vulcano, Lipari, Pantelleria, Latera and some non Italian volcanic areas.
Electrical resistivity map of Solfatara crater
Map of temperature gradients at Pantelleria.
Archive of results of continuous monitoring of infrared images at Vesuvius and Solfatara.

Scientific products:
28 publications in international peer reviewed journals.

Significant scientific results:
Innovative results concerning the role of diffuse and DSS degassing in volcanic areas.
Demonstration that volcanoes emit most of the heat energy through soil degassing rather than conductive flow.
Strong indication that episodes of degassing can cause volcano unrest which are not necessarily followed by eruptive activity.
Fluids may be an important controlling factor in caldera deflation.
There are links between hydrothermal fluid circulation and ground deformation that may generate a measurable gravity signal.

Collaborations outside GNV:
GNV project triggered an EU funded project (Geowarn)
Good international cooperation established by RU1 and RU6 with colleagues in USA, New Zealand, Switzerland and Germany which has resulted in joint publications

Involvement of RU: Somewhat unequal. Most of the work appears to have been done by RUs 1 (who has been active in 6 Tasks out of 8), 5 (two tasks) and 6 (modelling). RUs 2, 3 and 4 have made smaller contributions.

Researchers with more than 5 mmy: 14

GNV supported: 1 (full project)

PhD thesis: 2

Tesi di laurea: 4

Overall evaluation: The project coordinator's report is very clear. The project can be considered to have fully accomplished its tasks producing a good range of results for Protezione Civile and high quality scientific achievement.

THEME: 1

Project: # 2
Coordinator: Paolo **DE NATALE**, INOA Firenze
Expected ceiling budget: 900 Ml
Received Budget: 900 ML (465 kEuro)
Participating RU: 4
Original grade: A
Final Grade: A

Title of project: DEVELOPMENT OF AN INTEGRATED SPECTROSCOPIC SYSTEM FOR REMOTE AND CONTINUOUS MONITORING OF VOLCANIC GAS.

Achievements of objectives
The project's main objective was the development and field testing of infrared laser and UV spectrometers for gas concentration monitoring and *in situ* C isotope measurement in harsh volcanic environments. These objectives appear to have been fully achieved. The project team have demonstrated the first ever successful field operation (at Solfatara) of a diode laser spectrometer capable of providing accurate determinations of the $^{13}C/^{12}C$ isotopic ratio in volcanic gases. This achievement makes continuous, remote analysis of the C isotope composition of volcanic gas plumes a real possibility for the future; this could lead to significant improvements in understanding of volcano degassing.

New Technology Development:
This project involves significant new technology development. The development of a new instrument for the measurement of $^{13}C/^{12}C$ isotopic ratios in situ must be regarded as an exceptional development in volcanology. However, it is not clear to the Evaluation Committee to which group the Intellectual Property (IP) rights (and any related international or national patents) belong. The USA partner in the project (RU4) appears to have developed the technology, whilst RU2 built a portable instrument for deployment in the field. It is surprising that there is no joint publication between the two groups.
RU1 has developed an improved laser spectrometer for *in situ* CO_2 and water vapour measurements which is lightweight, portable and capable of fully automated on-line retrieval of gas concentration data and temperature.
RU2 has built a system for the continuous extraction of CO_2 from volcanic gas designed to be installed at Solfatara.

Deliverables useful for Protezione Civile:
The new spectroscopic systems can be utilized for gas composition analysis in volcanic environments for volcano monitoring by observatories. We note, however, issues relating to IP rights concerning further development (and marketing) of the devices.

Scientific products:
About 40 publications in international peer reviewed journals.
Development of innovative new spectroscopic systems.
The project coordinator should write a paper on the C isotope sensor for a leading journal as soon as possible to validate and publicise this achievement.

Collaborations outside GNV:
Good international collaboration with non Italian external groups (USA and UK) participating to the project. However it is disappointing that there does not seem to have been any exchange of personnel between the Italian and US groups developing the new devices or any joint publications/patents.

Involvement of RU: Well balanced (but see comment above)

Researchers with more than 5 mmy: 7
GNV supported: 1 (full project)
PhD thesis: 2
Tesi di laurea: 3

Overall evaluation: The overall objectives can be considered as achieved at a high level. The project coordinator has not provided much comments in his report on the degree of accomplishment of the project and on future developments. It is hoped that collaboration with appropriate groups in the volcano observatories will make the new spectrometers fully usable for geochemical monitoring studies. The scientific production and quality is very good. If the routine field measurement of in situ C isotopes in volcanic gases becomes a reality then the scientific outcome of this aspect of the project may be considered exceptional.

THEME: 1

Project: # 3
Responsible: Ciro **DEL NEGRO**, INGV Catania
Expected ceiling budget: 830 Ml
Final received budget: 785 Ml (405 kEuro)
Participating RU:
Original grade: B
Final grade: C

TITLE: Technological innovation and automation in the integrated applications of electromagnetic and potential field methods in active volcanic areas

Achievements of objectives
This project covers a wide spectrum of methodological developments aimed at developing and standardizing the applications of electromagnetic and potential field methods in active volcanic areas. The specific goals were:

1. development of suitable methods of forward and inversion modelling
2. application of advanced technologies to process continuously recorded signals
3. automation of monitoring and management systems and of surveys in real time

Overall, the project covers all the foreseen activities, achieving only a part of the expected results. The achievement of objectives can be estimated to be around 50%.

Deliverables useful for Protezione Civile
The report does not provide sufficient details on the present or future application of the deliverables foreseen for the DPC. It appears that two main deliverables have been achieved:

1. Improved software for automatic processing of gravity and magnetic data for volcano monitoring
2. New flux-gate magnetometers, of possible widespread use in future monitoring

Scientific products.
23 publications in international peer reviewed journals (3rd yr).

Collaborations with other GNV projects: Not evident. The project presents clear duplications or areas where integration with other GNV projects should have been pursued and achieved. Examples are the development of inversion techniques based on SAR data covered also in the GNV P13, or the need to integrate the EM tomography with seismic and gravity tomography performed in GNV P6.

Collaborations outside GNV: Not evident

Involvement of RU: Not well balanced. The project fails to bring together the RUs in a coherent framework and remains too fragmented, with small contributions from some RU not integrated together with other RU. The report leaves the impression that the project has not achieved consistent added value by bringing together many RU, as several of them appear to have worked in isolation.

Coordination: The project was kept together and produced results notwithstanding difficulties with funding continuity. The project was successful in bringing together all participants in workshops. However, more effort could have been expected in bringing more unity to the project.

Researchers with more than 5 mmy: 18
GNV supported: 1
PhD thesis: 2
Thesis: 3

Overall evaluation: The overall objective of the project – developing EM methodologies to a level suitable for routine application in volcano monitoring – can be considered as only partly achieved. The work remains in progress. The publication rate is uneven between different RU but overall reasonable.

THEME: 1

Project: # 4
Coordinator: Damiano **STANZIONE**, Università di Napoli Federico II
Expected ceiling budget: 420 Ml
Received budget: 248 ML (128 kEuro)
Participating UR: 3
Original grade: B
Final grade: D

TITLE: CHEMICAL AND ISOTOPIC CHARACTERISTICS OF GASES AND GROUND WATERS AT VESUVIO, CAMPI FLEGREI, ISCHIA E VULCANO: EVALUATION OF THE VOLCANIC RISK.

Achievements of objectives
The project aimed at carrying out continuous measurements of chemical and isotopic composition of emergent fluids at four locations (Vesuvius, Campi Flegrei, Ischia and Vulcano) in order to "produce models and/or to revise old models" for the sources and circulation of fluids in the volcanic areas under study. The coordinator's report indicates that the measurements were actually carried out, but no model of circulation or source of fluids was produced. Furthermore, the collected data have not been organized in a data base usable for INGV Osservatorio Vesuviano and INGV Catania, although it was recommended from this EC in the evaluation of first and second year.
Percentage of achievement: 40%

Deliverables useful for Protezione Civile:
Not a single one at this stage. The data base of collected data would be useful for geochemical monitoring of the four volcanoes and should be delivered to OV and INGV.

Scientific products:
5 publications in international peer reviewed journals, relevant to this project.

Collaborations outside GNV: None

Involvement of RU: Well balanced, as indicated in the Director Report, but RU 3 did not present a final report

Researchers with more than 5 mmy: unspecified
GNV supported: unspecified
PhD thesis: 5
Tesi di laurea: 5

Overall evaluation: The project has only partly accomplished its objectives. Additionally the data are not presented in the report. An improvement can be achieved by making available to Osservatorio Vesuviano the database of all collected data.
The scientific production is rather poor.

THEME: 1

Project: # 5
Coordinator: Mariano **VALENZA**, Università di Palermo
Expected ceiling budget: 900 Ml
Received budget: 885 Ml (457 kEuro)
Original grade: B
Final grade: B
Participating UR: 9

TITLE: MULTIDISCIPLINARY INVESTIGATION ON THE MASS AND ENERGY BUDGETS IN THE ITALIAN ACTIVE VOLCANOES.

Achievements of objectives
The general objective of the project was to estimate the mass and energy budget of Italian active volcanoes with a focus on Mt.Etna through determination of the composition of (a) the volcanic plume (b) the soil degassing and (c) the groundwater. The determinations have been carried out as expected by the project and innovative techniques have been applied as shown in the detailed RU reports. The mass and energy budget from Mt. Etna volcano, however, do not seem to have been determined. Estimated achievement of the project can be estimated at 80%.

New Technology developments:
1) A new UV spectrometer (DOAS) has been developed which is both cheaper, more compact and more accurate than COSPEC.
2) An automatic stand-alone UV station has been developed; 4 of these have been installed on Stromboli. These devices measure the CO_2 flux every 4-6 minutes.
3) A new method has been developed to measure *in situ* soil permeability.
4) A prototype multi-parameter probe has been developed to measure T, piezometric level, pH and conductivity in natural waters at 50-120 °C.

Deliverables useful for Protezione Civile:
The development of new instrumental capability and the assessment of the range of sulphur and carbon dioxide emissions in the Mt. Etna gas plume are extremely useful products both for monitoring the activity of the volcano and for the assessment of the risk for air traffic in and around the Catania airport. Careful assessment of rain water composition is also essential to model the magma contribution to chemical and isotope variations of groundwater, hence for eruption alert.

Scientific products:
Among the scientific results are two which could develop in future indicators of use for DPC: the diffuse degassing budget of Etna, found to be one order of magnitude less than the crater output, and the correlation of soil CO_2 fluxes with crater plume SO_2 emissions.

23 publications on international peer reviewed journals.

Collaboration with other GNV Projects: A collaboration with Project n. 2 on UV instrumentation.

Collaborations outside GNV: None

Involvement of RU: Reasonably well balanced

Total Researchers: 28
Researchers with more than 4 mmy: 10
GNV supported: 2
PhD thesis: none reported
Tesi di Laurea: none reported

Overall evaluation: The project has accomplished its objectives related to the experimental part. A final synthesis of the very good data collected in terms of energy and mass budget has not been performed. However the availability of the data makes this objective feasibile also by other research groups. Scientific production and quality are competitive at international level.

THEME: 2

Project: # 6
Coordinator: Maurizio **BONAFEDE**, Università di Bologna
Expected ceiling budget: 880 Ml
Final received budget: 840 Ml (434 kEuro)
Participating RU: 8
Original grade: B
Final grade: B

TITLE: Study and constraints on intermediate storage, magma uprise and conduits through modelling of strain fields, velocity and attenuation tomography at Mt. Etna

Achievements of objectives
The project had different goals, the great majority being satisfactorily accomplished. The parts that are still to be finished are the velocity tomography of Mt. Etna and the laboratory determinations of rocks physical properties.
The Moment Tensor inversion has only partly been achieved, with the unacceptable justification that the RU was separated by another RU in a different GNV project.
The percentage of achievement can be estimated at 80%.

Deliverables useful for Protezione Civile:
The new structural models derived by the project are extremely useful in determining the characteristics of earthquakes and ground deformations related to eruptive activity.
Procedures to locate volcanic earthquakes with a 3D model and tracing (the actual application in monitoring at INGV is highly recommended).
The project has organized data in several data bases which will be extremely useful in this respect (Hypocenters 1994-2002, Fault Plane Solutions 1994-2001, Fault Plane Solutions 1988-2002, Volcanic Tremor).
An important collateral product is the implementation of a continuous GPS network for ground deformation on Mt. Etna.

Scientific products:
28 publications in international peer reviewed journals.

Collaboration with other GNV projects: fairly extensive, with few exceptions

Collaborations outside GNV: good. Collaboration with EU funded projects

Involvement of RU: Well balanced for most units. Three units do not appear to focus specifically on the topic of this GNV project, but work on a wide range of interesting, even if sometimes unrelated, volcanological and seismological problems.

Coordination: good

Reserchers involved: 62
Researchers with more than 5 mmy: 17
GNV supported: 4
PhD thesis: 4
Thesis: 11

Overall evaluation: It is a well coordinated project which has produced a significant advancement of the knowledge of Mt. Etna structural characteristics that are useful for eruption monitoring. The report is good and exhaustive. The scientific production and quality are competitive at international level.

THEME: 2

Project: # 7
Coordinator: Mauro **ROSI**, Università di Pisa
Expected ceiling budget: 900 ML
Received budget: 1007 ML (520 kEuro) (+ Progetto speciale Stromboli)
Participating RU: 9
Original grade: B
Final grade: B

TITLE: Hazard of Stromboli volcano

Achievements of objectives
The project had the following main objectives:

- Better understanding of how the magmatic system works;
- Definition of condition and possibility of occurrence of a new slope collapse at Sciara del Fuoco;
- Development and application of a code for numerical simulation of tsunami generated by landslides;
- experimentation of automatic measurements systems for CO_2,
- geochemical modelling of deep fluid circulation systems based on chemical and isotopic data for fumarolic and dissolved gases, thermal waters and rain water
- Reconstruction of evolution processes of the shallow magmatic system;
- Characterization of the volcano basement and its interaction with the erupted magmas.

All of the objectives were achieved in a satisfactory way.
Percentage of achievement: 90%

Deliverables useful for Protezione Civile:
This project produced several products significant for application by DPC. The numerical simulation of tsunamis generated by landslides is the most complete. Others products include the reconstruction of past eruptive history of the volcano and the assessment of possible lateral eruptions and further collapses of Sciara del Fuoco. The petrological indications of how outbursts of explosive activity are generated are very useful but must be combined with explosion-induced seismic tremor data. Bathymetric data have been obtained for the near shore area and sediment cores collected for detailed correlation with the onshore tephrostratigraphy.
It is not clear whether a hazard map has been prepared.

Scientific products:
22 publications on international peer reviewed journals
2 technical reports for ProCi
1 geological map

Collaboration with other GNV projects: with Chiocci-Marani project

Collaborations outside GNV: some collaboration with the Geological Survey of Japan for tsunami modelling.

Involvement of RU: Well balanced

Coordination: fairly good during the project with project meetings held every year. There is, however, a lack of real synthesis of the collected data.

Reserchers involved: 36

Researchers with more than 5 mmy: 13
GNV supported: 2
PhD thesis: none reported
Tesi di Laurea: none reported

Overall evaluation: The project has produced a lot of data and useful products. The most noteworthy are the reconstruction of the eruptive history of the volcano, the petrochemical and isotopic data concerning the

feeding system, the assessment of stability of Sciara del Fuoco and the gas geochemistry. However this amount of data badly need a final work of synthesis.
The scientific output is good.

THEME: 2

Project: # 8
Coordinator: Roberto **SANTACROCE**, Università di Pisa
Expected ceiling budget: 900 ML
Received budget: 900 ML (465 kEuro)
Participating RU: 7
Original grade: A
Final grade: B

TITLE: EXPLOSIVE ERUPTIONS OF ITALIAN ACTIVE VOLCANOES - ERUPTIVE SCENARIOS, HAZARD AND RISK MAPS: VESUVIO, VULCANO, LIPARI

Achievements of objectives
The project had the following main objectives:

(a) Reconstruction of Mt. Vesuvius eruptions AP2, AP3, 472, 512, 1631 and Vulcano eruptions of Commende (VI century), Pietre Cotte and 1888-1890 and the most recent Lipari eruptive activity
(b) Hazard and risk zoning at Mt.Vesuvius and Vulcano;
(c) Reconstruction of feeding systems of Mt. Vesuvius, Vulcano and Lipari using petrological and geochemical methods
(d) Eruptive dynamics and emplacement mechanism of different deposits.

Achievements:

(a) Most of the objective at Mt. Vesuvius and Vulcano have been achieved. The percentage of achievement at Lipari is uncertain.
(b) Different hazard maps at and around Vesuvius have been produced. No maps have been produced for Vulcano.
(c) This objective was extensively pursued and the achievement can be considered complete.
(d) The results obtained fit the objectives in a satisfactory way.

The coordinator indicates an overall percentage of achievement of about 80% which we support.

Deliverables useful for Protezione Civile:
This is one of the project which has produced a significant number of deliverables for Civil protection. The results have been considered in the report made for the Civil Protection Committee for the Emergency Plan of Vesuvius and Campi Flegrei. The scientific coordinator complains however that results were not fully considered.
The most useful products concern Mt. Vesuvius and consist of a series of maps and results on the depositional mechanism of flows.
Reconstruction of the Commende and 1888-1890 eruption of Vulcano are useful for hazard evaluation.

Scientific products:
43 publications on international peer reviewed journals
1 technical reports for DPC
6 maps of hazard and distribution of eruptive products for Mt. Vesuvius

Collaboration with other GNV projects: limited

Collaborations outside GNV: some interaction with EU funded project (e.g. Exploris)

Involvement of RU: Well balanced for RU 1-6. The non-Italian partner in the project (RU 7, Scaillet) did not completely achieve their original objectives due to experimental problems in the second year and an underestimation of the difficulties of performing the experiments.

Coordination: fairly good. The coordinator report gives a comprehensive and clear synthesis of the obtained results.

Reserchers involved: 38

Researchers with more than 5 mmy: 7

GNV supported:1
PhD thesis: 1
Tesi di Laurea:

Overall evaluation: This is one of the projects which has produced useful deliverables for Civil Protection. The activity is very concentrated on Mt. Vesuvius for which a significant advance was made. The activity concerning Vulcano is qualitatively rather good, but no attempt to convert the results in usable products was made. The activity on the Aeolian island islands, although more extensive than proposed at the beginning, is not well finalized.
On average it is a good project with a satisfactory coordination.
The scientific level is very good.

THEME: 2

Project Number: # 9
Project Coordinators: Raffaello **TRIGILA**, UNI LA SAPIENZA ROMA
Expected ceiling budget: 1800 Ml
Received budget: 1800 Ml (930 kEuro)
Original grade: B
Final grade: C
Participating RUs: 16

TITLE: ERUPTIVE SCENARIOS FROM PHYSICAL MODELING AND EXPERIMENTAL VOLCANOLOGY

Achievement of Objectives:
The original aims of the project were extremely ambitious – to produce a quantitative parametric description of volcanic processes at Italian active volcanoes (Vesuvius, Campi Flegrei, Stromboli and Etna) by integration of geological data, physical modelling and laboratory experiments.
The overall goals can be summarized as follows:

(1) The role of volatile species in magma evolution.
(2) The dynamics of magma chamber feeding systems and relation to volcanic structure
(3) Magma ascent and eruption mechanisms (including degassing phenomena and magma vesiculation).

Results appear to be most advanced for Vesuvius and Campi Flegrei. Overall, the project covers a large spectrum of activities but achieves only part of the expected objectives. The achievement of objectives is very different in the five tasks, ranging between 30% and 90%.

Deliverables useful for Civil Protection:
A number of results obtained for Vesuvius and Campi Flegrei are scientifically significant and very useful for the characterization of eruptive scenarios (for example for the parameterisation of eruptive scenarios for the 1944 and AD 79 eruptions of Vesuvius, or the bradyseism of Campi Flegrei), but they have not been finalized in a form of use by Civil Protection.

Scientific Products
Good scientific productivity for many of the units, testified by 99 publications on international peer-reviewed journals in the 3rd year.
The scientific level of the results is competitive at international level for at least six of the RU.

New Technology Developments: none evident

Collaboration outside of GNV: This project involved one foreign RU. No other relevant collaboration specific for this project can be identified, even if some of the RU actively cooperate in the European arena.

Collaboration with other GNV projects: The project presents clear duplications or areas where integration with other GNV projects should have been pursued and achieved. We note that two units (RU 13 and 15) should be encouraged to pursue more active cooperation within the volcanological community.

Involvement of the RUs: The level of interaction between the different RUs appears insufficient. The project fails to bring together the RUs in a coherent framework and remains too fragmented, with small contributions from some RU not integrated together with other RU.
The UK research unit (RU 14) does not appear to have contributed results significant for the project and did not integrate their activities well with any of the Italian RUs.

Coordination. Fair. This project had the second highest budget of all the projects initially submitted to GNV and the largest proposed structure; initially there were 25 RUs which were subsequently reduced to 16. The overall level of achievement of the project is not adequately summarised by the coordinator in his report. More effort could have been expected in bringing more unity to the project.
The report leaves the impression that the project has not achieved consistent added value by bringing together many RU, as most units appear to have worked in isolation.
In addition, some of the tasks fail to produce sufficient input of relevance for application by Civil Protection to justify future investment in basic research.

Researchers more than 5mmy: data not available
Number of PhDs: not specified
NUMBER OF MASTER'S THESES: NOT SPECIFIED

Overall Evaluation:
The EC recognises that this was a difficult project to coordinate because of its size and the range of different research objectives. Nevertheless the EC notes that more efforts should have been done to bring together the whole project. For example, significant advances in understanding appear to have been made in a number of areas (e.g. volatile species in magmas) but have not been integrated in a coherent form. Additionally there appears to have been a lack of focus among the different groups working on experimental projects – these do not appear to have been working towards common goals.
The project coordinator must be required to produce a better summary report which highlights specific deliverables for Civil Protection; this report must also include the statistical data requested by GNV in terms of publications, PhD studentships etc.

THEME: 2

Project: **# 10**
Coordinator: Luigina **VEZZOLI**, Università dell'Insubria, Como
Expected ceiling budget: 350 ML
Received budget: 350 ML (181 kEuro)
Participating RU: 3
Original grade: B
Final grade: D

TITLE: Study of pyroclastic deposits of Mt.Etna finalized to the reconstruction of the major esplosive eruptions, evaluation of their hazard and environmental impact.

Achievements of objectives
The project focussed on a study of Etna's pyroclastic deposits with emphasis on the largest explosive eruptions and volcanic hazard assessment, through tephro-chronological studies, radiometric and palinological dating and petrological studies. Activities were divided into 4 tasks: tephra-stratigraphy of the last 4000 years, C14 dating and relative chronology, physical characteristics of the eruption, hazard assessment.
The final report describes many activities made in each of these tasks, but no results are mentioned. Therefore it is not possible to make a reasonable estimate of the level of achievement of the objectives.

Deliverables useful for Protezione Civile:
No deliverable usable for Civil Protection is mentioned, except one data base of radiometric and palynological data, of unclear availability. The same can be said for the mentioned hazard zonation maps of tephra fallout.
The results of the research would be very useful, but no publication is mentioned where the data are available or peer-reviewed.

Scientific products:
3 publications on international peer reviewed journals
1 data base of tephra layers, geochronology and palinology.

Collaboration with other GNV projects: with project 13

Collaborations outside GNV: with volcanologists from New Zealand and Hawaii.

Involvement of RU: well balanced, as reported by the coordinator. However, RU2 has not presented a scientific report.

Coordination: fairly good. However, the coordinator's report is poor and does not provide results.

Researchers involved: 16

Researchers with more than 5 mmy: 5
GNV supported: 1
PhD thesis: none reported
Tesi di Laurea: none reported

Overall evaluation: All the RUs have performed activities aimed at achieving the objectives of each task. However, the actual results are not shown in the final report and their quality or usefulness cannot be gauged. The coordinator must produce an appendix to the report where tephrochronological layers, chronological and palynological data are commented and the data base in attached.
The scientific production is moderate, consisting essentially of presentations to international meetings and articles published on international books.

THEME: 3

Project: **# 11**
Coordinator: Warner **MARZOCCHI**, INGV Bologna
Expected ceiling budget: 230 ML
Received budget: 292 ML (151 kEuro)
Participating RU: 4
Original grade: A
Final grade: A

TITLE: Identification and interpretation of the pre-eruptive seismic patterns for the worldwide effusive and explosive volcanoes

Achievements of objectives
The original main goal of the project was to define quantitatively the distinctive peculiarities of the local and regional seismic activity that precede a volcanic eruption, and to interpret the results obtained by considering the eruptive dynamics. The project fulfils fully these goals. During its course, the project has approached further goals of primary importance for crisis management such as a first attempt to define quantitatively the probability of eruption by taking into account all the available information, theoretical knowledge, past data, and the monitoring of the volcano.
The level of accomplishment of the objective is 100%.

Deliverables useful for Protezione Civile:
The main products to DPC consist of scientific reports written by the scientific coordinator relative to the probabilistic hazard assessment for Mount Vesuvius. These reports have been acquired by the scientific/DPC committee responsible for writing the new Emergency Plan of Mount Vesuvius.
The project has development some technological innovative tools as:
- Development of pattern recognition codes that can be applied to volcanological datasets
- Implementation of a new numerical procedure based on parallel/vectorial codes running on a cluster of NEX SX4 and IBM SP supercomputers to estimate stress interaction.

Scientific products:
22 publications on international peer reviewed journals
1 Report for the Committee for the Emergy Plan of Mt.Vesuvius and Campi Flegrei

Collaboration with other GNV projects: no

Collaborations outside GNV: excellent, USGS

Involvement of RU: Well balanced for most units

Coordination: Good (but it was not difficult)

Researchers involved: 18
Researchers with more than 5 mmy: 7
GNV supported: 1
PhD thesis: 2
Thesis: 4

Overall evaluation: The products of this projects are of great interest for Protezione Civile and have a great innovation value. The scientific quality is competitive on an international level. The publication record on top international journals, including the direct participation of PhD students, is exceptional.

THEME: 3

Project: **# 12**
Coordinator: Maria Teresa **PARESCHI**, CNR Pisa (now INGV Pisa)
Expected ceiling budget: 188 ML
Received budget: 200 ML (103 kEuro)
Participating RU: 1
Original grade: B
Final grade: B

TITLE: GIS system for a thematic cartography in volcanic areas.

Achievements of objectives
The main goals of the project were achieved during the second year. Several GIS relative to Mt. Vesuvius, Mt. Etna, Vulano, Lipari and Stromboli were made available. Hazard maps, digital terrain models (georeferenced, digital data) on CD and on paper were delivered to GNV and the Italian Civil Protection Department on October 2004.
Achievement percentage is about 100%.

Deliverables useful for Protezione Civile:
GIS thematic maps and DEM of Mt.Etna, Stromboli, Vulcano, Lipari and Mt.Vesuvius and surrounding areas.

Scientific products:
7 publications on international peer reviewed journals
Maps for the Committee for the Emergency Plan of Mt.Vesuvius and Campi Flegrei

Collaboration with other GNV projects: the project consisted of a single RU; direct cooperation not evident, but publication record shows some cooperation with other GNV projects

Collaborations outside GNV: EU projects

Involvement of RU:

Coordination:

Researchers involved: 8

Researchers with more than 4 mmy: 3

GNV supported: -
PhD thesis: -
Thesis: -

Overall evaluation: The high quality digital terrain models and the GIS maps are of great interest as base documents for the scientific community and the Civil Protection. In future the development of cartography products and digital models should not be handled as a GNV research project, but as a structural activity, with a clear open availability policy.

THEME: 4

Project: # 13
Coordinator: Mauro **COLTELLI, INGV CATANIA**
Expected ceiling budget: 1510 ML
Final budget: 1510 ML (780 kEuro)
Original grade: A
Final grade: A
Participating UR: 15

Title of Project: Development and application of remote sensing methods for the monitoring of active Italian volcanoes

Achievement of Objectives:
The main aim of this project is to develop a package of remote sensing techniques (spaceborne, airborne and ground-based) which could be used in volcano monitoring and to enable timely identification of eruption precursor phenomena which might lead to eruptive events. Five different methods were identified: SAR interferometry; development of DTMs via GPS studies; thermal anomalies (ASTER satellite); eruption clouds (Doppler radar) and the study of volcanic plume gases (CO_2 and SO_2).

The project has been very successful and has almost fully achieved its original objectives (80-90%). Some specific objectives could not be reached for technical reasons outside of the project responsibility.

New Technology Development:
New instrument for studying eruption columns by Doppler radar (Voldorad-2) for installation on Etna. Improved software algorithms for processing of gas composition from satellite-derived data.

Deliverables useful for Protezione Civile:
This project was specifically geared to produce deliverables for direct implementation by DPC in routine and emergency monitoring. An exhaustive list of such deliverables is given in the Report. Among them: DTMs of Stromboli used in the 2002-3 eruption; Time series (1984-2003) LANDSAT and ASTER data for Etna; New Doppler radar system for volcanic plume monitoring; Georeferenced databases for Stromboli and Vulcano.

Scientific Products:
The project has a strong technological component, so many results appear in technical reports and meeting proceedings. In addition, 25 publications plus a large number of manuscripts submitted to peer reviewed international journals have been produced.

Collaboration with other GNV projects: # 6, # 7, # 15.

Collaborations outside GNV: A good range of collaboration: e.g. Jet Propulsion Laboratory (actually an RU) and NASA (USA); Open University & Cambridge University, UK; Universities of South Florida and Miami (USA); Aerospace Institute of Germany;

Involvement of RU: The interaction among the RU was very successful considering the large number of units and the complex interrelation between the objectives and tasks.

Coordination: excellent. With the help of Task coordinators, the project coordinator managed to keep together a large project and to ensure deliverables across all the tasks. The final report is very well written and coordinated, with clear description and reasoning of the final objectives. The deliverables to DPC are also clearly identified. The report however lacks graphical illustrations on the scientific and technical achievements.

Researchers with more than 5 mmy: 15
GNV supported: 4
PhD thesis: 10
Masters Thesis: 13

Overall evaluation
This large, well coordinated project achieves a new level in the usage of remote sensing technologies and data for the monitoring of volcanic eruptions and precursors. The prospects for further development in the use of such technologies are excellent and must be further supported. The role of young scientists in the success of this project has been instrumental. A larger participation of the technical teams in the scientific use of the data and technologies is encouraged.

THEME: 5

Project: #14
Responsible: Aldo **ZOLLO**, Università di Napoli Federico II
Expected ceiling budget: 850 Ml
Final received budget: 850 Ml (439 kEuro)
Original grade: A
Final grade: A
Number of RU: 9

TITLE: Integrated seismic methods applied to the investigation of the active volcano structure: an application to the Campi Flegrei caldera

Achievements of objectives
The main objectives of this innovative project were:

- the application of 2D/3D techniques for the analysis and interpretation of seismic data, active and passive, in highly heterogeneous data.
- the determination of a detailed 3D image of the volcanic structure at local and regional scale, in terms of models of seismic velocity and attenuation, including estimates of the related uncertainties and spacial resolution. These studies will focus on the identification and mapping of the conduit and feeding system in the Phlaegrean area.
- the comparison of the seismic imaging with different geological and geophysical evidence, derivde in the field and in laboratory measurements, in order to check the consistency of the proposed models and understand its volcanological implications. Thermo-mechanical modeling of the active physical processes will be also performed.
- Design and implementation of a database of digital seismic signals for micro-earthquakes and seismic experiments recorded in the Phlaegrean area and at Etna.
- Analysis of the data collected during the SERAPIS campaign.

Overall, the project covered a large spectrum of diverse activities and achieved all the main project goals, with different levels of completion. Of particular interest has been the “blind test” carried out to validate and compare the different approaches used in tomographic imaging. The attenuation model has been completed only for the P-wave attenutaion; the SERAPIS data were acquired in the second year of the project and produced a substantial re-alignment of activities. The achievement of objectives can be estimated to be around 90%.

Deliverables useful for Protezione Civile

- Very-high resolution imaging of the buried structure of the Campi Flegrei caldera to 2 km depth, with detailed imaging of the caldera rim.
- The location of the depressed basemenet beneath the caldera at less than 4 km depth, while no evidence is found of shallower magmatic bodies. Multi-data evidence for the presence of fractured, over-pressured, gas-bearing formations at 4km depth below Pozzuoli, but no evidence for molten rocks.
- Mapping of the lithological units at depth under the bays of Napoli and Pozzuoli. No evidence is found for an extended magma chamber in the upper 6 km beneath the Bay of Neaples. Evidence for a 8-10 km deep seismic discontinuity beneath Vesuvius, confirming a previous intepretation as the roof of en extended magmatic sill.
- New databases of seismic data, microseismicity, focal mechanisms. Synthetic waveforms for earthquake scenario modeling.
- A number of innovative numerical and data-processing methodologies, which can be applied on other volcanoes.

Scientific products: 27 publications in international peer reviewed journals, with a consistent participation of the PhD students.

Collaborations with other GNV projects: Not evident. An extension of the work to the Etna area could be expected in the future.

Collaborations outside GNV: Good international participation in the project.

Involvement of RU: Generally well balanced.

Coordination: Excellent coordination. To be noted is the change of priority and the ability to merge in the GNV project the SERAPIS campaign and the subsequent data analysis. Very well done reports during the whole project.

Researchers with more than 5 mmy: 18
GNV supported: 5
PhD thesis: 3
Tesi di Laurea: 6

Overall evaluation: An excellent project, which sets the standards of how modern geophysical methodologies should be developed and used toward a better imaging of the internal structure of the volcano and an improved understanding of its functioning.

THEME: 6

Project Number: #15
Project Coordinators: F.L. **CHIOCCI**, UNIROMA LA SAPIENZA – M. **MARANI**, CNR BOLOGNA
Expected ceiling budget: 1200 MI
Received budget: 1200 MI (620 kEuro)
Original grade: A
Final Grade: A
Participating RU: 8

TITLE: THE SUBMARINE PORTIONS OF ITALIAN VOLCANOES – THEIR SURVEY AND ASSESSMENT OF POTENTIAL VOLCANIC HAZARDS.

Achievement of Objectives:
The main goals of this integrated project were:

(1) to define and morphologically characterise all the possible features that can be related to large-scale instability of volcanoes in the Tyrrhenian Sea, Ischia, Stromboli, Vulcano and the west flank of Etna
(2) To understand the triggering mechanisms of flank instability
(3) To establish a large database of marine geology
(4) To study comprehensively the submarine parts of the Italian active volcanoes
(5) To assess the level of risk of flank instability

These objectives were clearly very ambitious, considering the very sparse knowledge available before this project. As recognized also by the coordinators, it is clear that a complete knowledge of the submarine parts of the Italian active volcanoes remains far from complete. In particular there has not been much work done on offshore Etna. There has only been limited possibilities for direct sampling of seafloor sediments because of limited ship time available. In addition, the 2002 Stromboli emergency focussed the activities of this project for over a year. Thus, even if the project diverted from the foreseen objectives, it has been very successful, beyond expectations, in achieving the first comprehensive picture of the submerged flanked of many volcanic islands. In addition, the project identifies clearly the needs for future exploration. In this respect, we consider that the project has achieved 100% of the possible objectives.

Deliverables useful for Civil Protection:
The recognition that flank instability is extremely common and much more frequent than previously thought; additionally that submarine flank instability may induce subaerial. slope failure. This provides an improved understanding of the tsunami risk for coastal communities.
The development of integrated onshore and offshore DTMs.
Novel methods of geotechnical analysis of slope failure applied to the flanks of active volcanoes.
Deep towed TOBI dataset for the first time provides evidence for flank instability on the eastern submerged flank of Stromboli.
Better definition of the volcaniclastic fan offshore of the Sciara del Fuoco which exerts control on the pathways of gravity flows, leading to improved understanding of the linkages in behaviour of the onshore and offshore parts of the volcano.
A reconstruction and dating of past flank collapse and submarine slumping offshore Ischia.

Scientic Products:
20 publications in international journals (although not all are clearly linked to this project).

Collaboration outside of GNV: One of the project coordinators has identified active collaboration with: the University of Mississippi (USA), USGS, Liverpool University, UK; Austrian Geological Survey; Kyoto University, Japan.

Collaboration with other projects: The work by RU Marani was carried out in cooperation with Project N.7, as indicated also in the reports. Additional collaborations with projects #13 and #1

Involvement of the RUs: well balanced for about 75% of the units

Coordination: excellent. It should also be considered that this project originated from merging two projects originally submitted separately. The two coordinators have been successful in bringing together the project and ensuring valuable deliverables.

Researchers more than 5mmy: 10
GNV supported: 4
Number of PhDs: 4
TESI DI LAUREA:12

Overall Evaluation:
This very active, successful project has paved the way for a comprehensive understanding and characterisation of the offshore parts of the Italian active volcanoes.

THEME: 6

Project: # 16
Coordinator: Giovanni **ORSI**, INGV OV
Expected ceiling budget: 1700 ML
Received budget: 1691 ML (873 kEuro)
Participating RU: 14
Original grade: A
Final grade: A

TITLE: VOLCANIC HAZARDS ASSESSMENT AND ZONATION AT THE RESURGENT PHLEGREAN FIELDS CALDERA AND THEIR EFFECTS ON MAN AND ENVIRONMENT

Achievements of objectives
The main objective of this proposal was to assess the volcanic hazards at the Phlegrean Fields caldera in the event of a short- to medium-term renewal of volcanic activity. This involved definition of the structural setting of the caldera, the present state of the magmatic system, the areas of highest probability of opening of a new volcanic vent and expected eruption scenarios and their environmental impact.

The project was remodulated during its course in agreement with the EC. All the major (and most significant for Protezione Civile) objectives have been achieved. Some minor objectives have not been fulfilled. The overall percentage of achievement can be estimated around 90%.

Deliverables useful for Protezione Civile:
The project has produced a number of documents on hazard, vulnerability and risk, as indicated in the final report. They have been a most important contribution to the report made by Papale for the Commission which is updating the emergency plan of Mt. Vesuvius and Campi Flegrei.

Scientific products:
65 publications in international peer reviewed journals, plus a further 10 submitted or in review.
Maps and documents for the Committee for the Emergency Plan of Mt.Vesuvius and Campi Flegrei

Collaboration with other GNV projects: the cooperation with project 17 has been satisfactory.

Collaborations outside GNV: good. The coordinator and the participants have very good collaborations with several European and non European research groups.

Involvement of RU: the large number of RUs makes a comparative estimate of the level of participation to the project quite difficult. A least 70% of the RU have significantly contributed to the project.

Coordination: very good. The project had a large number of RU. The coordinator was successful in keeping them engaged and in making sure that the significant projects objectives would be reached. The coordinator has produced a very clear and comprehensive report.

Researchers involved: 70
Researchers with more than 4 mmy: 18
GNV supported: 10
PhD thesis: 30
Tesi di Laurea: -

Overall evaluation: It has been a very good project with a high quality scientific production and the preparation of many useful documents for Civil Defence purposes. The integration among the results obtained by the different units is good.

THEME: 6

Project: # 17
Coordinator: Paolo **PAPALE**, INGV Pisa
Expected ceiling budget: 500 ML
Received budget: 735 ML (380 kEuro)
Participating RU: 7
Original grade: A
Final grade: A

TITLE: SIMULATION OF ERUPTIVE SCENARIOS AT PHLEGREAN FIELDS BASED ON FIELD, LABORATORY, AND NUMERICAL STUDIES, AND IMPLICATIONS FOR VOLCANIC HAZARD

Achievements of objectives
The project has fulfilled the original objectives quite satisfactorily, and the adherence to the original project description has been nearly complete. This project has increased substantially our knowledge of the Phlegrean Fields system, of the characteristics of some of its most relevant eruptions, particularly the Agnano Monte Spina eruption which represented the major target of the proposed research, of the characteristics and properties of the trachytic magmas of Phlegrean Fields, and of the dynamics of explosive eruptions including conduit flow and pyroclastic dispersion dynamics. The project has generated an interdisciplinary group of international researchers.

The project was remodulated during its course in agreement with the Evaluation Committee. All the major (and most significant for Protezione Civile) objectives have been achieved. The overall percentage of achievement can be estimated between 80 and 90%

Deliverables useful for Protezione Civile:
The results of this project have high relevance of the work to DCP.
The project has produced a number of documents on hazard, vulnerability and risk, as indicated in the final report. The coordinator has also produced a report for the Commission which is updating the emergency plan of Mt. Vesuvius and Campi Flegrei. This document summarises the contributions by this project and by projects #16 and #14, to improve the level of knowledge on Campi Flegrei. As a consequence of these projects the level of knowledge of hazard and risks to Campi Flegrei is significantly increased.

Scientific products:
33 publications on international peer reviewed journals
1 Report for the Committee for the Emergency Plan of Mt.Vesuvius and Campi Flegrei

Collaboration with other GNV projects: the cooperation with projects 16 and 14 has been satisfactory. Part of the work was carried out in coordination with project 9, where Papale was also involved.

Collaborations outside GNV: good. The coordinator and the participants have very good collaborations with several European and non European research groups. Two international partners were involved in the project (Dingwell in Germany and Rutherford in the USA); these groups have made important contributions to the project and provided young Italian researchers with the opportunity to visit their laboratories.

Involvement of RU: well balanced

Coordination: excellent, also in consideration of the needs to coordinate with other GNV projects.

Researchers involved: 30
Researchers with more than 4 mmy: 9
GNV supported: 3
PhD thesis: 4
Tesi di Laurea: 4

Overall evaluation: This has been a very good project with a high quality scientific production and the preparation of many basic documents for Civil Defence purposes. The integration among the results obtained by the different units is very good. The coordinator has produced a very clear and comprehensive report.

THEME: 2

Project: # 18
Coordinator: Renato **FUNICIELLO**, Università di Roma 3
Expected ceiling budget: 240 ML
Received budget: 240 ML (124 kEuro)
Participating RU: 3
Original grade: -
Final grade: B

TITLE: GAS HAZARD AT COLLI ALBANI VOLCANO

Achievements of objectives
The main objectives were:

(a) identification of anomalous degassing area and characterization of gas emission;
(b) evaluation of the groundwater level variations, of time variations of lake water level and of carbon dioxide flux
(c) evaluation of the carbon dioxide and sulphur hydrate level in and around houses;
(d) evaluation of hazard of carbon dioxide outpouring at Albano and Nemi lakes.

Objectives a), b) and d) have been almost fully achieved. It is not clear how much of objective (c) is fulfilled. The level of achievement is not less than 80%.

Deliverables useful for Protezione Civile:

1) Borehole data base (c/o GIS idro)
2) Soil distribution gas map
3) Geological map with specific details on impervious cover
4) High hazard areas 3D geological model
5) Water table artificial lowering map
6) Conductivity and pH water table map
7) Regional aquifer map

Scientific products:
6 publications on international peer reviewed journals
1 data base

Collaboration with other GNV projects: not evident

Collaborations outside GNV: not evident.

Involvement of RU: Well balanced.

Coordination: Good. The report should be more complete.

Researchers involved: 20
Researchers with more than 5 mmy: no data available
GNV supported:
PhD thesis: -
Tesi di Laurea: -

Overall evaluation: This is a project which had a duration of 2 year, activated upon request from Protezione Civile. The project raises the attention to a volcanic hazard not yet well recognized and identifies needs for future monitoring and investigations. It has produced the expected products for Protezione Civile. The scientific quality and publication rate are good.

THEME: 2

Project: # 19
Coordinator: Franco **BARBERI**
Expected ceiling budget: 80 ML
Received budget: 80 ML (41 kEuro)
Participating RU: 3
Original grade: -
Final grade: A

TITLE: ELABORATION OF A RISK SCENARIO FOR CIVIL PROTECTION PURPOSE IN CASE OF A SUBMARINE ERUPTION TO THE EAST OF PANAREA ISLAND

Achievements of objectives
This project was initiated by DPC in response to observed gas emissions offshore Panarea in November 2002. The study was approved by the EC and aimed at performing a detailed geological survey onshore and conducting geophysical and geochemical monitoring of the area. The objectives of the project (definition of the characteristics of the most recent products of the island and definition of eruption hazard) are fully achieved (100%).

Deliverables useful for Protezione Civile:
The project has already provided Protezione Civile with two reports. The final report to GNV provides an eruption risk assessment, including suggestions for continuing geophysical and geochemical monitoring.

Scientific products:
1 publication in international peer reviewed journals
1 data base

Collaboration with other GNV projects: with projects 7, 15, 12

Collaborations outside GNV: not evident.

Involvement of RU: Well balanced.

Coordination: Very good. The project was put together very rapidly, under the pressure of a possible emergency in the Aeolian.

Researchers involved: 15
Researchers with more than 5 mmy: no data available
GNV supported:
PhD thesis:
Tesi di Laurea:

Overall evaluation: It's a project which had a duration of 1 year, activated upon request from Protezione Civile. It is well finalised, and it has completely achieved its objectives. This project demonstrates how the scientific community is capable of reacting to national emergencies.