

ESF LESC EXPLORATORY WORKSHOP

LIFE AND ENVIRONMENTAL SCIENCE COMMITTEE



***GASES IN MAGMATIC EVOLUTION: FROM DEPTH TO ATMOSPHERE,
FROM MICRO TO MACRO-SCALE, FROM CALCULATION TO
OBSERVATION***

11-13 MAY 2003, ROME

ESF EVENT IN PARTNERSHIP WITH:



**Istituto Nazionale
di GEOFISICA e
VULCANOLOGIA**

**INGV SEZIONE DI NAPOLI
"OSSERVATORIO VESUVIANO"**

**INGV SEZIONE DI ROMA 1
SEDE DI PISA**

**INGV-GNV, Gruppo Nazionale
per la Vulcanologia**

Workshop Scientific Report

by Roberto Moretti and Paolo Papale

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1. Executive summary

The ESF event EW 02-35 “Gases in Magmatic Evolution: from depth to atmosphere, from micro to macro-scale, from observation calculation”, GaME Workshop, was regularly held from May 11th to 13th in the INGV Conference Hall, located at the INGV headquarters (Via di Vigna Murata 605, Rome).

The objectives of the workshop have been fully achieved, determining the scientific and organizational success of the workshop. About 40 scientists met in Rome to discuss the perspectives for a new collaborative research initiative, offered by an integrated and multidisciplinary approach to the study of magma-related degassing from Earth interior to atmosphere.

The workshop was funded by ESF and INGV, through its departments “Osservatorio Veuviano”, “Roma 1” and “GNV – Gruppo Nazionale per la Vulcanologia”. The INGV facility provided also meals at lunch time, except for the first day (May 11th, Sunday), when a buffet lunch was provided by the workshop organization. Participants were accommodated quite close to INGV headquarters, at the 4 stars Aran Hotel where welcome cocktail and dinner were offered the day of their arrival. The administration of the workshop was taken by “Osservatorio Vesuviano”. Perkin Elmer SpA provided each participant with a bag and writing material. The workshop organization also provided i) programme and abstract volume, ii) the ESF 2003 brochure, iii) personal badge, iv) ‘Annals of Geophysics’ material (block-notes and a CD-ROM of Journal presentation).

Participants were drawn from diverse disciplines, such as physical chemistry of Earth materials, fluid geochemistry, volcanology, petrology, applied spectroscopy, solid state-physics, fluid dynamics and atmospheric science. Interactions between scientific representatives from eight European countries were high and fruitful. Scientific excellence was also enhanced by the participation of a Canadian colleague. Attendance to the meeting was minimally affected by illness of a few participants (Guido Ventura, Pierre Delmelle and Thor Hansteen) or first priority job commitments (Marie Edmonds).

After the welcome of Giovanni Macedonio, Director of INGV “Osservatorio Vesuviano”, the workshop was introduced by Demir Altiner, ESF representative, who gave a presentation on ESF functions and initiatives. Moreover, a presentation by Paolo Gasparini, GNV-INGV Director, gave an overview of European funding initiatives. The meeting was structured in seven sessions, chaired by Roberto Moretti, Paolo Papale, Don Fraser, Mike Carroll, Don Baker, Giovanni Chiodini and Augusto Neri who led discussion related with the talks. Every day a final session devoted to general discussion was scheduled. Each invited speaker gave a lecture about twenty minutes long.

The seven thematic sessions of the workshop covered the following themes: i) parameterisation and modelling of physical and chemical properties of silicate melts and gases, in light of recent experimental and theoretical advancements; ii) measurements on natural materials, experimental investigation and theoretical modelling of the solubility and speciation of volatiles in silicate melts; iii) experimental and theoretical constraints on multicomponent magmatic degassing; iv) numerical modelling and experimental/natural evidences on the complex roles of volatiles in magma and eruption dynamics; v) volatile constraints from melt inclusions and phase equilibria experiments on pre-eruptive magma conditions; vi) evaluation of gas emission budgets and geochemical cycles; vii) atmospheric circulation and impact of volcanic gases, volcano monitoring and hazard forecasting.

Every session stressed the importance of integrated approaches involving experimental determinations, theoretical investigation and field measurements. Two working groups, the first one involving scientists dealing mostly with physical chemistry of magmatic processes, and the second

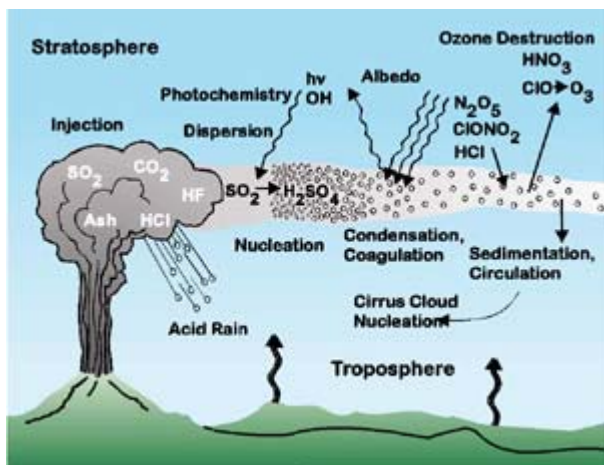
one with dynamics of degassing, eruption, and atmospheric plume dispersion, convened in the night of third day. The aim of such working groups was that of identifying specific research topics to be jointly approached in order to push integration in the European research on geodynamic gases a step forward. Reports by the two working groups were presented during the final General Discussion. Future activities to be undertaken on the way of structuring and integrating the European Research Area were also discussed and identified during the final General Discussion.

2. Scientific Report

2.1 Aims of the Workshop

Magmatic volatiles are of extreme relevance in Earth dynamics, since they deeply affect all the physico-chemical processes from Earth's mantle convection and magma segregation at depth to magma ascent and eruption dynamics and impact on the surface. Volatiles profoundly affect the molecular structure of silicate liquids, melts and glasses of natural as well as industrial relevance, largely determining their physical properties and behaviour. Geodynamic released volatiles have a regional to planetary impact spanning from generation of acid rains and polluting aerosols, accumulation of toxic gases in natural basins and ground depressions, modification of the Earth's radiation balance, destruction of the Ozone layer. Single large scale volcanic events may shock the atmospheric composition at the regional scale, and represent an important contribution to the global atmospheric and climate change.

The aim of the workshop is that of bringing together different expertise on the several roles of magmatic volatiles in determining geodynamic processes, material properties, and atmospheric effects, and define common strategies and synergetic approaches for optimal use of the European resources.



Sketch of the main atmospheric processes associated with degassing from volcanoes and soils. From McGee *et al.*, U.S. Geological Survey Open-File Report 97-262, 1997.

2.2 Session Contents and Description

The scientific topics treated in the communications cover from physical chemistry and structure of silicate liquids, melts, and glasses, physico-chemical magma properties, dynamics of magma ascent and eruption, volcanic column and pyroclastic flow dynamics, volcano degassing and degassing from non-volcanic areas, plume chemistry and dynamics, plume dispersion and impact in the atmosphere. The common link is represented by volatiles, as expressed by the title of the workshop.

It was recognised the great improvements that a true and deep integration of physical and chemical aspects of volatile-related processes may bring to the evaluation of geodynamic released gas budgets and to the assessment of natural hazard and environmental impact from volcanic and non-volcanic degassing. Many contributions highlighted such an integration, and many others offered a perspective in the same direction. Interactions and cooperation with industries and companies were foreseen, with the goals of i) cooperating to the design, build-up, calibration and testing of new instruments for laboratory and field measurements and experiments, and remote sensing, ii) providing expertise and skills to solve specific problems in a range of applications from metallurgy, manufacturing of glass, ceramics, cement, etc...to more environmental issues, going through the revolutionary domain of nanomaterials and nanotechnologies. Such an interaction requires competitive target-focused profiles and therefore the constitution of durable links through education of PhD students on industry-oriented research topics.

The scientific sessions were developed over three days (day 2 to 4 of the workshop). Abstracts of presentations are provided in the attached document. Session names and scientific clues which emerged for an effective improvement and integration of the European research are described in the following.

Day 2.

Session I. Modelling the properties of silicate melts and gases: experimental and theoretical constraints under different P, T, X conditions.

Session II. Solubility and speciation of volatiles in silicate melts: theory, experiments and natural cases.

Session III. Magmatic degassing of multicomponent fluid systems: experimental and theoretical constraints.

General Discussion. Identifying tasks for developing efficient model-experiment interfaces.

Developing efficient model-experiment interfaces is crucial for understanding and predicting liquid, melt, and glass structure and properties. Experimental techniques are developing rapidly, and the rate of production of high quality experimental data on silicate systems is growing as well. On the other side, more sophisticated models for multiphase multicomponent silicate systems based on thermodynamic, polymeric, and *ab initio* approaches are being developed. Lack of synergy between experiments and modelling may largely affect the interpretation of data, the relevance of selected experimental conditions, and the capability of models to reproduce properties and processes. Programs of experiments for modelling-oriented purposes should be designed, with positive feedback between the two approaches. In such programs, available or newly developed models should be used to define the most relevant experimental conditions for model calibration and testing, and the results from the new experiments should be used to refine the models and identify physical and chemical aspects on which to concentrate the theoretical investigation. An increased level of interaction between experimentalists should be oriented to define common protocols for experimental procedures. In the same way, increased interaction between modellers should lead to model intercomparison and possibly to the unification of different models. Simple relationships to describe relevant quantities at given *P-T-x* conditions should be extracted by complex models, and made available to the broader scientific community for daily use (*e.g.*, for a first estimate of properties, to define proper ranges for experimental design, or to evaluate order of magnitudes of processes). Complex models for silicate system properties and multiphase multicomponent equilibria should be used for the production of look-up tables available on the internet, that can be

used by the scientific community for rapid consultation or be included within other models which necessitate such information (e.g., tables of multicomponent volatile saturation that can be included within thermo-fluid dynamic models of magma and eruption dynamics).

Day 3.

Session IV. The role of volatiles in volcano dynamics as inferred through numerical modelling and experimental/natural evidences.

Session V: Pre-eruptive conditions of melts: volatile constraints from melt inclusions and phase equilibria experiments.

Session VI: Emission budgets of volatiles and geochemical cycles: the role of magmatic systems.

General Discussion: Identifying tasks for developing efficient model-field data interfaces.

Numerical models of volcanic and degassing processes can address several – but still not all – aspects of gas and magma ascent to the surface and injection into the atmosphere. As long as the models become able to address more sophisticated physical and chemical processes, the need for high quality measurements on the real world grows accordingly. Estimates of volatile budgets in erupted magmas have been principally based on the study of glass and fluid inclusions within magmatic crystals. These studies produce data which are critical to determine the type of volatiles and the phase equilibrium relationships, and provide important constraints to P - T - x conditions in intratelluric environments where magmas rising from the Earth's mantle reside and differentiate. However, they are not sufficient to determine the total budget of volatiles in magmas, since they provide intensive information which do not contain the gas to liquid mass ratios. Such information is on the contrary obtainable at erupting volcanoes, provided that inclusion data are used in conjunction with plume chemistry and multicomponent volatile saturation modelling. Unfortunately, cases where such data are available are extremely scarce, resulting in large uncertainty in estimated total amounts of volatiles released during volcanic eruptions. Recent detailed measurements on the degassing from active volcanoes and non-volcanic areas suggest that the budget of geodynamic released volatiles may have been largely underestimated, with important implications on the atmospheric budgets at the global scale. Programs of data collection and processing on degassing non-volcanic areas (e.g., Central Italy, and the Pannonian and Rhine basins) and active volcanoes are therefore needed to evaluate the relevance of geodynamic released volatiles, especially greenhouse gases like carbon dioxide (the second most abundant volatile component of natural magmas after water), with respect to anthropogenic emissions. Sulphur dioxide and so-called minor volatiles like fluorine, chlorine, bromine, are as important as well for their impact on the environment, through the formation of acid rains and pollution of agricultural products and cattle pastures. Selection of a few laboratory volcanoes where to concentrate the investigation in order to set up coordinated field, experimental, analytical and modelling procedures aimed at determining the real volatile budgets is envisaged. Italian, Icelandic, French/English volcanoes (the latter in overseas ex-colonies) with frequent eruptive activity, as well as many other active volcanoes with abundant degassing and hydrothermal activity in the European territory, provide a formidable chance to such aim, and a variability of magmatic types and geodynamic environments which should result in a comprehensive evaluation of magmatic volatile budgets.

Day 4.

Session VII. Atmospheric effects, volcano monitoring and forecasting.

General Discussion. Identifying tasks for developing efficient model-field data interfaces.

Volcanic eruptions exert a large impact on the environment at a global scale through injection into the atmosphere of huge amounts of volcanic gases and ash. Sulphate aerosols formed as a consequence of sulphur dioxide emission during the Pinatubo (Philippines) eruption in 1991 resulted in increased reflection of solar radiation back into the space and lowering of the Earth surface temperature by 0.72 degrees for the three years following the eruption (McGee et al., U.S. Geological Survey Open-File Report 97-262, 1997). Global budgets of volatiles released from geodynamic activity need to be further investigated in order to fully assess their impact on the Earth surface system. Numerical models of plume formation, evolution, and dispersion in the atmosphere also addressing the microphysics related with chemical reactions in the plume, and coupled with large scale modelling of atmospheric circulation, allow the simulation of plume-atmosphere interaction, generation of polluting phenomena like acid rains, and long term evaluation of volcanic driven climate change. New instruments for remote sensing, either from the ground or from satellites, brought into routine monitoring of active volcanoes in last years, are allowing order of magnitude increase in the number and quality of data systematically collected for surveillance purposes. It is necessary to improve further the quality of data collection through development and implementation of new technical capabilities which bring about new perspectives. Particularly relevant is the design of networks of multiple sensors capable of collecting a multi-parametric spectrum of data, and the establishment of intense and continuative relationships with equipment providing companies to identify problems and get together to best technical solutions. New instruments need to be employed in routinely surveillance of active volcanoes in order to collect time series of signals related with geochemical activity and recognize eruption precursors. Although such precursors have been sometimes described and used to predict volcanic phenomena, very different behaviours have been observed for eruptions of different volcanoes and different eruptions at the same volcano. Geochemical processes occurring at shallow levels in and around ascending magma bodies can be extremely complex since they involve a very large number of often unconstrained chemical and physical variables playing in multiphase multicomponent open system processes. This implies the necessity of high quality data and sophisticated modelling to extract the complex roles of shallow processes, *e.g.* those occurring in hydrothermal systems, interfering with magmatic degassing.

Final Discussion and Feedback. Recommendation and formal establishments of future research guidelines.

The workshop themes and discussions demonstrate the present high level of European research on geodynamic degassing at various spatial and temporal scales and magmatic to atmospheric domains. At the same time, the strong needs for harmonization of European research and added values coming from integration of European infrastructures and definition of common research strategies clearly emerged from the workshop. The enthusiastic response and active participation of convened scientists represents an optimum starting point to move forward to coordinated European activities. In this perspective, general agreement was found on the following actions.

1. Opening of a web site where i) posting scientific contributions in terms of abstracts and electronic presentations (subjected to approval by authors), ii) collecting all documents related with workshop and associated activities, iii) discussing on a dedicated forum the development of initiatives following the workshop and aimed at organising European research activities. To-date the web site is functioning and accessible at the address www.ov.ingv.it/ew0235/volatiles2fp6.htm.

2. Publication of a Special Issue of [Annals of Geophysics](#), collecting original papers on the research themes of the workshop, highlighting new perspectives in the investigation of volatiles and related topics. Papers on theoretical and experimental techniques which can be developed from the integration of different skills and expertises are expected, particularly emphasising how current results may be enhanced whenever framed in synergetic approaches. We aim in fact at editing the scientific and methodological manifesto of the “volatiles” community which has agreed in moving towards European coordinated activities. To-date the Special Issue has been launched, and declarations of interest in submitting manuscripts with the above target are being received.
3. Preparation of a proposal for constitution of a ESF Network, to be submitted within the November 30, 2003 deadline. The Network will be aimed at consolidating the European community in the field of geodynamic degassing, establishing collaborative links between scientists in the disciplines related with magmatic volatiles and their roles in determining geodynamic processes, material properties, and atmospheric effects, and defining common strategies and synergetic approaches for optimal use of the European resources.
4. Evaluation of the opportunities offered by the Sixth Frame Program (FP6) of the European Commission in the creation and harmonization of a European Research Area, and the feasibility of application on the themes of the workshop. The participants recognise that many of the themes treated at the workshop, including global geodynamic gas budget evaluation, global change and ecosystems, aircraft safety, natural disasters and disaster management, development of new equipments for satellites, material sciences and nanotechnologies, constitute priority thematic areas under Blocks 1 and 3 of Activities in the FP6. They also agree that the Research Infrastructure programme under Block 2 of Activities might be the natural programme for promoting cooperation and synergies at the European level with the aim of creating a long-term integrating effect in the European research, fitting very well the ESF workshop and future ESF Network objectives. Specific activities to be carried out under a possible future integrated research at the European level include the followings:
 - Creation of a common database – this should include both thermochemical ‘best’ database to be adopted by the whole consortium, database of measured properties, and database of measured quantities on geodynamic-related degassing;
 - Definition of modelling-oriented experiments and measurements, both in the lab and in the field, and positive feedback between experiments, theory, and measurements;
 - Evaluation and comparison of different existing models, and definition (through comparison with experiments and measurements) of the range of conditions over which each given model reasonably reproduces the observations;
 - Creation of next-generation modelling for physical and chemical properties of multicomponent silicate liquids, either magmatic or industrial, through a comprehensive approach based on the polymeric and/or configurational properties of the liquids;
 - Inclusion in the thermochemical magma modelling of major as well as minor volatiles, which can be important as pollutants or tracers of deep processes; possibly, inclusion of other polluting components like heavy metals;
 - Generation of user-friendly interfaces for usage of thermochemical models by the broad community
 - Use of new thermochemical models in conjunction with physical models describing volcanic and eruption processes (magma chamber dynamics, ascent and fragmentation of magma, gas flow through volcanic systems, country rocks, and

- aquifers, plume dispersion in the atmosphere, etc...); applications to natural labs, interpretation of observations and measurements;
- Develop new methods and paradigms for the estimation of volatile budgets in magmas from past eruptions, or from degassing non-erupting volcanoes;
 - Development and testing of new instruments for near and remote sensing, in close cooperation with industries. Design, develop, and test networks of multiple sensors for plume analysis
 - Assess the budget of greenhouse and pollutant (or impacting) volatile species from geodynamically-related degassing (either associated or not with volcanic activity). Heavy use of recent as well as future instruments for near and remote sensing, and of the existing and newly developed modelling resources;
 - Use of new detailed measurements to test numerical models, find out model weaknesses, and attack them through the inclusion of more sophisticated physics and chemistry as required, as well as of more accurate system definitions including factors, like weather conditions, which contribute to control the degassing;
 - Investigate the large scale impact of volcanic gases and pollutants during pre, syn, and post eruptive degassing, both through parametric studies on the controlling factors, and through applications to the test volcanoes; use of large-scale physical and chemical models of plume dispersal and atmospheric circulation.

3. Final Programme

1st day: 18.30: Arrival, workshop registration, accommodation and icebreaker.
20.30: Dinner (Aran Restaurant).

2nd day: 8.15-9.00: Departure of Shuttles to Via di Vigna Murata and accommodation at the INGV Conference Hall.

9.00-9.15: Welcome Intervention from Giovanni Macedonio, Director of INGV–Osservatorio Vesuviano.

9.15-9.30: Opening Session on ESF and LESC (Life and Environmental Sciences Committee) activities for promotion of science, by Deniz Altimer, ESF representative, National Reserach Council of Turkey.

- Session I: **Modelling the properties of silicate melts and gases: experimental and theoretical constraints under different P, T, X conditions**

9:30-9:50: Don Fraser (Univ. Oxford, UK)

“Acid Base Properties, Structons and the Thermodynamic Properties of SilicateMelts”

9:50-10:10: Giulio Ottonello (Univ. Genova, Italy)

“Flory-Huggins, Quasi-Chemical and Polymeric model analogies in the treatment of reactivity and mixing properties of melts”

10:10-10:30: Christian De Capitani (Univ. Basel, Switzerland)

“The Computation of Equilibrium Assemblages: A Tool for Exploring the Implications of Solution Models in Melts”

10:30-10:50: Pascal Richet (IPGP, France)

“Effects of water on the physical properties of magmas”

Break and group photo

11:10-11:30 Don Dingwell (Univ. Munich, Germany)

“The central role of volatiles in controlling melt rheology and kinetics.”

11:30-11:50 Brent Poe (Univ. Chieti, Italy)

“Determination of Electrical and Elastic Properties of Silicate Melts Using In-situ High-pressure High-temperature Techniques”

- 11:50-12:10 Lilly Freda (INGV Roma, Italy)
 “Water and Carbon Dioxide Diffusion in a Trachytic Melt”
- 12:10-12:30 Claudia Romano (Univ. Roma 3, Italy)
 “Compositional parameterisation and the role of pressure on the viscosity of hydrous silicate melts”
- 12:30-12:50 Sergey Churakov (CSCS, Switzerland)
 “Thermodynamic properties and phase equilibria in multicomponent fluid systems at high P and T predicted by the theoretically based EOS.”

12:50-13:40 – Buffet lunch

- Session II: **Solubility and speciation of volatiles in silicate melts: theory, experiments and natural cases**

- 13:40-14:00 Marcus Nowak (Univ. Hannover, Germany)
 “Speciation and diffusion of H₂O and CO₂ in silicate melts”
- 14:00-14:20 Simon Kohn (Univ. Bristol, UK)
 “The dissolution mechanisms of water and carbon dioxide in silicate melts”
- 14:20-14:40 Mike Carroll (Univ. Camerino, Italy)
 “Chlorine solubility and melt-vapor partitioning in evolved alkaline magmas”
- 14:40-15:00 François Holtz (Univ. Hannover, Germany)
 “Solubilities of mixed volatiles in silicate melts”
- 15:00-15:20 Paolo Papale (INGV Pisa, Italy)
 “Thermodynamics of multicomponent gas – liquid equilibrium in silicate systems”

Break

- 15:40-16:00 Roberto Moretti (INGV Osservatorio Vesuviano, Italy)
 “The role of polymerization, acid-base and redox exchanges on the solubility and speciation equilibria of iron, sulfur and water in melts”
- 16:00-16:20 Klaus Heide (Univ. Jena, Germany)
 “The formation of methane in silicate melts - observations and experimental studies”

- Session III: **Magmatic degassing of multicomponent fluid systems: experimental and theoretical constraints**

- 16:20-16:40 Klaus Heide (Univ. Jena, Germany)
 “Determination of volatiles in volcanic rocks by high-vacuum-high-temperature degassing”
- 16:40-17:00 Antonio Paonita (INGV Palermo, Italy)
 “Modeling and applications of inert gas degassing from H₂O-CO₂ bearing silicate melts”.
- 17:00-17:20 Giovanni Chiodini (INGV Osservatorio Vesuviano, Italy)
 “Physico-numerical modelling of degassing hydrothermal systems: the case of Solfatara di Pozzuoli”

- General discussion: **Identifying tasks for developing efficient model-experiments interfaces.**

3rd day: - 8.00-8.30: Departure of shuttles to Via di Vigna Murata and accommodation at the INGV Conference Hall.

- 8:30-9:00-Opening session on project strategies and synergetic approaches in modern geosciences, by Paolo Gasparini, Director of INGV-GNV

- Session IV: **The role of volatiles in volcano dynamics as inferred through numerical modelling and experimental/natural evidences**

- 9:00-9:20 Don Dingwell (Univ. Munich, Germany)
 “Degassing versus destruction: the fate of volcanic domes ... a material challenge”
- 9:20-9:40 Don Baker (Mc Gill Univ-, Canada)
 “Bubble Formation in High-Silica Melts”
- 9.40-10:00 Paolo Papale (INGV Pisa, Italy)
 “Roles of volatiles on the dynamics of magma flow and fragmentation in volcanic conduits”
- 10:00-10:20 Margherita Polacci (INGV Pisa, Italy)
 “Magma vesiculation and ascent along volcanic conduits by pumice textures and numerical simulations”

Break

10:40-11:00 Augusto Neri (CNR-IGG, Italy)
"Influence of volatile content on the style of explosive eruptions"

11:00-11:20 Piero Salatino (Univ. Napoli, Italy)
"Fluidization and pyroclastic flows: what's next"

- Session V: **Pre-eruptive conditions of melts: volatile constraints from melt inclusions and phase equilibria experiments**

11:20-11:40 François Holtz (Univ. Hannover, Germany)
"Pre-eruptive conditions and pre-mixing conditions: the example of Unzen volcano"

11:40-12:00 Nicole Métrich (CEA/CNRS Saclay, France)
"Bromine behaviour in magmas"

12:00-12:20 Nicole Métrich (CEA/CNRS Saclay, France)
"Volatile constituents dissolved in magmas as recorded by melt inclusions. Inference on the gas phase composition, the dynamics of degassing and the eruptive dynamisms"

12:20-13:30 - Lunch

13:30-13:50 Max Wilke (Univ. Potsdam, Germany)
"Iron in dry and hydrous magmas"

13:50-14:10 Bruno Scaillet (CNRS Orléans, France)
"Experimental investigations on the role of sulfur in magmas."

14:10-14:30 Michel Pichavant (CNRS Orléans, France)
"Experimental phase equilibria: data and models"

- Session VI: **Emission budgets of volatiles and geochemical cycles: the role of magmatic systems**

14:30-14:50 Steve Blake (Open Univ., UK)
"Volcanic influences on the atmospheric budget of methane"

14:50-15:10 Luigi Marini (Univ. Genova, Italy)
"Emission of volatiles from magmas and interfering processes"

Break

15:30-16:00 Patrick Allard (CEA/CNRS Saclay, France)
"Compositional changes and emission rate of magmatic gases from basaltic volcanoes: constraints and questions upon magma degassing processes and budgets".

16:00-16:20 Steve Blake (Open Univ., UK)
"Quantifying sulphur emissions from basaltic volcanism"

16:20-16:40 Giovanni Chiodini (INGV Osservatorio Vesuviano, Italy)
"Volcanic and non-volcanic degassing in central-southern Italy"

16:40-17:00 Manfred Van Bergen (Univ. Utrecht, Holland)
"Recycling of volatiles in island arcs: clues from Indonesian magmatic systems"

-General Discussion: **Identifying tasks for developing efficient model-field data interfaces.**

4th day: - 8.20-8.50: Departure of shuttles to Via di Vigna Murata and accommodation at the INGV Conference Hall.

- Session VII: **Atmospheric effects, volcano monitoring and forecasting**

8:50-9:10 Teresa Ferreira (Centro Vulc. Avaliação Riscos Geologicos., Portugal)
"Fluid geochemistry monitoring in the Azores archipelago: A review"

9:10-9:30 Bruno Capaccioni (Univ. Urbino, Italy)
"Geochemical evolution of the submarine fumaroles at Panarea: insights on the November 2002 degassing event"

9:30-9:50 Nemesio Perez (ITER Canaria, Spain)
"Diffuse carbon dioxide emission and relation to earthquakes and volcanic activity"

9:50-10:10 Mike Burton (INGV Palermo, Italy)
"Measurements of magmatic gas emissions using remote sensing; constraints on magma supply and ascent rates"

Break

10:30-10:50 Clive Oppenheimer (Univ. Cambridge, UK)
"Spectroscopy of volcanic gas concentrations and fluxes"

10:50-11:10 Paolo De Natale (INOA, Italy)

- “Novel laser-based techniques for monitoring of volcanoes.”
 11:10-11:30 Christiane Textor (LSCE CEA/CNRS, France)
 “The behaviour of volcanic gases and particles inside volcanic eruption column”
 11:30-11:50 Eliza Calder (Open Univ., UK)
 “Constraining conduit processes at basaltic volcanoes by time series SO₂ measurements”
 11:50-12:10 Hans Graf (Max Planck Inst. Meteorol., Germany)
 “Volcanic gases: Fate and effects in the atmosphere”
 12:10-12:30 Antonio Costa (Univ. Bologna, Italy)
 “Investigation of gas dispersion from natural sources”
 12:30-13:30 Lunch
 - General Discussion: **Identifying tasks for developing efficient model-field data interfaces.**
Break
 - Final discussion and feedback: **recommendation and formal establishments of future research guidelines.**
 - Farewell speech, by Enzo Boschi, President of INGV.

5th day: - Departure of participants.

3. Final list of participants

3.1 Affiliation and Contact Address

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3.2 Short Statistics on Invited Speakers

Name	Gender	Country (of work and residence)
Patrick ALLARD	M	France
Don R. BAKER	M	Canada
Steve BLAKE	M	United Kingdom
Mike BURTON	M	Italy
Eliza CALDER	F	United Kingdom
Bruno CAPACCIONI	M	Italy
Michael CARROLL	M	Italy
Giovanni CHIODINI	M	Italy
Sergey CHURAKOV	M	Switzerland
Antonio COSTA	M	Italy
Christian DE CAPITANI	M	Switzerland
Paolo DE NATALE	M	Italy
Donald B. DINGWELL	M	Germany
Teresa FERREIRA	F	Portugal
Donald G. FRASER	M	United Kingdom
Carmela FREDA	F	Italy
Paolo GASPARINI	M	Italy
Hans-F. GRAF	M	Germany
Klaus HEIDE	M	Germany
François HOLTZ	M	Germany
Simon C. KOHN	M	United Kingdom
Giovanni MACEDONIO	M	Italy
Luigi MARINI	M	Italy
Nicole METRICH	F	France
Roberto MORETTI	M	Italy
Augusto NERI	M	Italy
Marcus NOWAK	M	Germany
Clive OPPENHEIMER	M	United Kingdom
Giulio OTTONELLO	M	Italy
Antonio PAONITA	M	Italy
Nemesio M. PEREZ	M	Spain
Michel PICHAVANT	M	France
Brent POE	M	Italy
Margherita POLACCI	F	Italy
Pascal RICHEL	M	France
Claudia ROMANO	F	Italy
Piero SALATINO	M	Italy
Bruno SCAILLET	M	France
Christiane TEXTOR	F	Germany
Manfred J. VAN BERGEN	M	The Netherlands
Max WILKE	M	Germany

The organization of the ESF event co-sponsored by INGV invited 41 speakers, from 8 European countries + Canada.

Summarising, we had 18 speakers from Italy (16 scientific reporters plus 2 INGV institutional representatives), 7 from Germany, 5 from UK, 5 from France, 2 from Switzerland, 1 from Spain, 1 from Portugal, 1 from The Netherlands and 1 overseas from Canada.

Among them, 7 were female and 34 were male.