

## PROJECT TITLE

CHEMICAL AND ISOTOPIC CHARACTERISTICS OF GASES AND GROUNDWATERS AT VESUVIO, CAMPI FLEGREI, ISCHIA AND VULCANO: EVALUATION OF THE VOLCANIC RISK

### Scientific Coordinator

Name-Position: Stanzione Damiano - Full Professor

Affiliation : Dip.to di Scienze della Terra, Univ. di Napoli FEDERICO II

## ACTIVITY REPORT –2nd YEAR

### PROJECT PARTICIPANTS

RU	AFFILIATION	RESPONSIBLE
DST-NA	Dip.to Scienze della Terra Univ. of Napoli FEDERICO II	STANZIONE DAMIANO
DST-NA	Dip.to Scienze della Terra Univ. of Napoli FEDERICO II	PECE RAIMONDO
DSA-CE	Dip.to Scienze Ambientali Univ. of Napoli 2	TEDESCO DARIO

#### • GENERAL OBJECTIVES

The aim of this project is to evaluate by multidisciplinary studies the chemical and isotopic characteristics of the deep and superficial sources of the emergent fluids in the volcanic systems of the Somma-Vesuvio, the Campi Flegrei, the island of Ischia and the island of Vulcano.

The purpose will be pursued through the study of:

- Chemical-isotopic compositions of groundwater (principal and trace elements,  $\delta^{18}\text{O}$ ,  $\delta\text{D}$  and  $\delta^{13}\text{C}$ );
- of the radioactive gases present in waters, in the grounds and in the fumaroles;
- of the isotopes of the rare gases (through the study of the gases trapped in the phenocrystals and from the fumarolic gases).

In the interpretation of the collected data, different parameters will be taken into account:

- the role of the local tectonics in the areas taken in examination;
- the chronological evolution of the possible source region of the fluids
- the importance of the possible modifications induced from the interactions between the deep fluids with the gases and the superficial aquifers, with the wall-rocks and with the atmosphere.

The main scope of this reasearch is to understand the meaning of the observed chemical and isotopic variations in the volcanic products emitted both in the past and currently in the circulating fluids of the studied areas.

#### • II YEAR OBJECTIVES

Maintenance and further development of monitoring network of chemistry of underground waters.

This purpose has to be reached through:

- 1) Localization of the zones that can be most interesting to study the deep volcanic system on the basis of data obtained in the past years;
- 2) The geochemical monitoring of waters in sites chosen in the interesting areas;
- 3) Analyses of water samples in the Campi Flegrei Caldera

Surveys - mappings of chemical, isotopic composition and radioactivity of groundwaters emerging in the investigated volcanic areas. The program is based on periodic sampling campaigns, bimonthly Campi Flegrei and six-monthly at Ischia, Vulcano Islands.

Mappings of measurements of Radon and Mercury Vapor in soils of the selected volcanic areas

Acquisition and proof of alfa spectrometry instruments; setup of chemical methods of separation of Thorium and Uranium.

The measurements to perform are:

Tracers: Radon, Mercury Vapor ( $\text{Hg}^\circ$ ), Boron and radioactive isotopes of the natural radioactive series in geothermal and/or volcanic fluids (waters, fumaroles, soil atmospheres). Radioactive isotopes are to be determined by gamma spectrometry using Ge HP and NaI(Tl) crystals

Sampling Surveys for chemical and isotopic composition and radioactivity of fumarolic and natural gas emanations (and groundwaters) occurring in the investigated volcanic areas. The program is based on periodic sampling campaigns, monthly at Campi Flegrei and six-monthly at Mt Vesuvius, Ischia island and Vulcano Islands.

Field surveys for rock sampling to be used to analyse phenocrystals (olivines and piroxenes) for isotopic measurements in fluid inclusions.

Field measurements in close areas to Mt Vesuvius and Campi Flegrei Caldera to be used for genetic/origin comparisons with fluids belonging to volcanic areas.

Acquisition and proof of new instrumentation for quadrupole mass spectrometry and gas chromatography.

The measurements to be performed:

- chemical tracers: chemical composition of fumarolic fluids ( $\text{He}$ ,  $\text{Ne}$ ,  $\text{Ar}$ ,  $\text{H}_2$ ,  $\text{N}_2$ ,  $\text{CH}_4$ ,  $\text{CO}$ ,  $\text{H}_2\text{S}$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ );
- isotopic ratios of:  $^3\text{He}/^4\text{He}$ ,  $^{40}\text{Ar}/^{36}\text{Ar}$  and  $^{13}\text{C}/^{12}\text{C}$ . It is wide angle monitoring work related to a new base line of these isotopic ratios and to understand and to model the possible source-region(s). This kind of sampling will be done on all volcanic (and natural) working areas.

## • II YEAR RESULTS

As planned for the second year, the objective of the II years research was maintenance and further development of monitoring network of chemistry of underground waters.

- Campi Flegrei: we have collected waters from 24 sampling locations and analyzed the samples for chemical and chemico-physical parameters. Basing on data obtained from analyses we have chosen 10 sites in interesting areas. Waters from these locations have been collected bi-monthly (2001) and three -monthly (2002) for geochemical surveys.
  - Weekly measurements of gas Radon using the Track-Etch method, pH, T and Electrical Conductivity in 2 water wells
  - Monthly measurements of gas Radon using the Track-Etch method in 5 holes in the soils distributed in the phlegraean caldera
- Ischia: we have collected waters from 10 thermal wells and we have analysed the samples for chemical and chemico-physical parameters
  - Measurements of Rn by EDA RD-200 portable instrument, pH, T ed  $\text{Hg}^\circ$  in the waters of 10 wells
  - Measurements of gamma radioactivity by using NaI(Tl) detector in the waters of 10 waters wells to determine K40, Ra226, Bi214 and Tl208
- Vulcano: two field trips have been performed to collect samples from 15 water wells, located at Vulcano Porto.
  - Measurements of chemical and physical parameters have done.
  - Mapping of Rn by EDA RD-200 portable instrument, and  $\text{Hg}^\circ$  in the atmosphere of the soils
  - Measurements of Rn by EDA RD-200 portable instrument, pH, T ed  $\text{Hg}^\circ$  in the waters of 15 wells
  - Measurements of gamma radioactivity by using NaI(Tl) detector in the waters of 15 waters wells to determine K40, Ra226, Bi214 and Tl208
  - Measurements of Rn in 2 fumaroles (Crater and Eastern Beach)
  - Sampling of a fumarolic condensate at the Fumarole F5 on the Great Crater.
- Vesuvius: In this area in the first year of this program a gamma radioactivity mapping was carried out by helicopter in co-operation with the Austrian Geological Survey. Maps of total gamma radioactivity, and of the K40, Bi214 (i.e. Ra226), Tl208 (i.e. Th232) have been produced and in the 2<sup>nd</sup> year several profiles E-W and N-S have been carried out in orde to compare the two methodologies.

### Chemical and isotopeic Analyses of fumaroles and waters

We had continued to collect monthly at the Solfatara crater, for both chemical and isotopic composition.

Major ( $\text{H}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{S}$ ), minor ( $\text{N}_2$ ,  $\text{H}_2$ ,  $\text{CH}_4$ ,  $\text{CO}$ ,  $\text{Ar}$ ,  $\text{He}$  and  $\text{Ne}$ ) and trace (hydrocarbons) chemical species have been analyzed. Analysis of  $^3\text{He}/^4\text{He}$ ,  $^{20}\text{Ne}/^{22}\text{Ne}$ ,  $^{21}\text{Ne}/^{22}\text{Ne}$ ,  $\delta^{13}\text{C}$  have been performed on gas samples. We have collected gases at the Bocca Grande fumarole and at the Soffione. Measurements of chemical and physiscal parameters have been also done at the Fangaia. Similarly to Solfatara crater, at Ischia island, two field trips have been conducted and we have collected volcanic gases from fumaroles in several part of the island, waters (hot and cold). Chemical components analysed are the same as for the Solfatara crater fumaroles. Again similarly the same isotopic ratios have been analysed from gases. Anions, cations and metals, plus oxygen and deuterium isotopic composition have been analysed from waters.

Fumaroles (from both crater and beach) and water wells (cold and hydrothermal) at Vulcano island have been collected twice during two different field trips. In addition to gases analysed at Solfatara and Ischia island, at Vulcano crater we have also analysed acid species, such as  $\text{SO}_2$ ,  $\text{HCl}$  and  $\text{HF}$ .

We have collected submarine fluids from fumaroles located between 2 and 30 meters at Campi Flegrei caldera, Ischia island, Vulcano island and Panarea island.

Two field trips on one week each at Campi Flegrei caldera, have been dedicated to install a continuous monitoring stations at the Bocca Grande fumarole. At the same time soil gases have been analysed in one dedicated field trip, CO<sub>2</sub>, CH<sub>4</sub> and trace species have been analysed. Total budgets have been computed.

One soil gas flux campaign, measuring CO<sub>2</sub>, CH<sub>4</sub> and NO<sub>x</sub>, at the Solfatara crater in November 2002.

Two campaigns, at the Solfatara crater and Vulcano island have been done to calibrate, according to Paolo De Natale, the new laser optic instrumentations of INOA. Both campaigns have given promising results.

A specific device have been used at the Solfatara of Pozzuoli to continuously monitor volcanic gases. For the first time, the whole gas phase has been monitored for several days. A Quadrupole Mass Spectrometer coupled with a Gas Chromatograph have been used in the field. He, Ar, H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, H<sub>2</sub>S, CO<sub>2</sub> and H<sub>2</sub>O. It is the first time that such a system is used on an active volcanic area. Data have been compared to those obtained by alkaline solution flasks and analysed later in the laboratory. Instrumentation have been calibrated both, in the laboratory and in the field during chemical analysis.

#### • RESEARCH PRODUCTS

- International papers: 6
- National papers 1
- Abstract of International Congresses 8
- Abstract of National Meetings 3

#### PUBLICATIONS LIST

- International papers: 6

VOLTAGGIO M., BRANCA M., TEDESCO D., TUCCIMEI P AND DI PIETRO L. , 2002. Radium<sup>226</sup> excess during the 1631-1944 activity period of Mt. Vesuvius (Italy): A model of alpha recoil enrichment in a metasomitized mantle and implications on the current state of the magmatic system. *Geochim. Cosmochim. Acta* (accepted for publication).

ESPOSITO E., PECE R. , PORFIDO S. , TRANFAGLIA G. (2001) - Hydrological Anomalies Connected to Earthquakes In Southern Apennines (Italy) - *Natural Hazard and Earth System Sciences*, 1 : 137-144

AVINO R., CAPALDI G., DI MATTEO V. PECE R. Radon and mercury in the groundwaters of Phlegraean fields (southern Italy): temporal and spatial variations. *Sub. JVGR*

VALENTINO G.M, STANZIONE D. (2002) Source processes of the thermal waters from the Phlegraean Fields (Naples, Italy) by means of the study of selected minor and trace elements distribution. *Chemical Geology* (in press)

VALENTINO G.M, STANZIONE D. (2002) Geochemical monitoring of the thermal waters of the Phlegraean Fields (Naples, Italy). *Sub. J. Volcanol. Geotherm. Res.*

NAIMO D., BALASSONE G., BERAN A., AMALFITANO G., IMPERATO M., and STANZIONE D., (2002) - Garnets in volcanic breccias of the Phlegraean fields (southern Italy): mineralogical, geochemical and genetic features. *Mineralogy and Petrology*, 1-12.

- National papers 1

VALENTINO G.M, STANZIONE D. (2001) - Localizzazioni storiche e caratteristiche principali del sistema idrotermale flegreo *Boll.Soc.Natur. Napoli Nuova serie Vol. I* (2001) 123-142

- Abstract of International Congresses 8

TEDESCO D., PAPALE P., VASELLI O., DURIEUX J., 2002. The January 17<sup>th</sup>, 2002 eruption of Nyiragongo, Democratic Republic of Congo. Report UN-OCHA Consultant Volcanologists Team, p. 52.

VASELLI O., TASSI F., CUCCOLI F., BELOTTI C., MONTEGROSSI G., TEDESCO D., FACHERI L., 2002. A geochemical and IR Laser System survey at the fumarolic field of the "LA Solfatara" (Phlegraean Fields, Southern Italy). 82<sup>nd</sup> SIMP Congress, 18-20 September, 2002, Cosenza (Italy), 287-288.

AVINO R., CAPALDI G., DI MATTEO V., PECE R. - Geochemical Investigations in Soils and Waters of Ischia Island (Southern Italy) - Presented at EGS 2002, Nice (France), 21-26 april 2002

AVINO R., CALIRO S., CHIODINI G., DEL GAUDIO C., DI MATTEO V., PECE R., RUSSO M. - Geochemical monitoring in Campi Flegrei from 1970 to 2000 - Presented at EGS 2002, Nice (France), 21-26 april 2002

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VALENTINO G. M., STANZIONE D. (2001) – Geochemical investigations at Phlegraean Fields (Italy): Variations in thermal waters during 1992-1999. 26<sup>th</sup> General Assembly of the European Geophysical Union, Nice, 26-30 March 2001, Abstracts Volume 3.

VALENTINO G. M., STANZIONE D. (2001) – Lead distribution in the thermal waters of the Campi Flegrei (Naples, Italy). Water-Rock Interaction 10, Cagliari, Italia.. R. Cidu (ed), Balkema, Rotterdam, vol 2, 1025-1028.

CENNAME P., CINIGLIA C., VALENTINO G. M., STANZIONE D. (2002) – Interaction between acidic geothermal waters and algae living in Pisciarelli (Naples, Italy). Geoch. Cosmoch. Acta, 66 n°S1, 12° V. M. Goldschmidth Conference, Davos, Switzerland, August 18-23/2002, 126

- Abstract of National Meetings 3

TEDESCO D., VASELLI O., TASSI F., 2001. Chemical and isotopic measurements of volcanic and natural fluids in southern Italy. GNV-Meeting, 9-11October, 2001, Abstracts, p. 39.

AVINO R., CAPALDI G., DI MATTEO V., PECE R., PINTO A. (2001) – Radon in active volcanic areas Italy - GNV-Meeting, 9-11 October, 2001, Abstracts, pp. 35-36.

VALENTINO G.M, STANZIONE D. (2001) – Geochemical variations in the thermal waters of the Phlegraean Fields (Italy) during 1992-1999. GNV-Meeting, 9-11 October, 2001, Abstracts, pp. 37-38.

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CHEMICAL AND ISOTOPIC CHARACTERISTICS OF GASES AND GROUNDWATERS AT VESUVIO, CAMPI FLEGREI, ISCHIA AND VULCANO: EVALUATION OF THE VOLCANIC RISK.

**RU Responsible: Damiano STANZIONE**

Name-Position : Full Professor

Affiliation : Dip.to Scienze della Terra - Univ. of Napoli FEDERICO II

ACTIVITY REPORT–2nd YEAR

RU PARTICIPANTS

Name-Position	Affiliation	man/month
Damiano STANZIONE, Professor		6
Stefano CALIRO, Ph. D. stud	Università degli Studi di Napoli	4
Gheta Maria VALENTINO, Ph. D.	Federico II	6
Massimiliano IMPERATO, Ph. D.	Dipartimento di Scienze della Terra	6
Debora NAIMO, Ph. D.		6
Giuseppe GIAQUINTO, technician		4
Vincenzo MONETTI, technician		4

- 2nd YEAR OBJECTIVES

Surveys - mappings of chemical composition of groundwaters emerging in the investigated volcanic areas (Campi Flegrei, Ischia, Vulcano). The program is based on periodic samplings, bi-monthly at Campi Flegrei and six-monthly at Ischia and Vulcano Islands.

The measurements to be performed:

- chemical composition of major, minor and trace elements
- chemico-physical parameters (pH, Cond., TDS, Eh, temperature)

- 2nd YEAR RESULTS (max 1 page)

- methodologies

Spring water samples were collected in plastic bottles.

Temperature, pH, electrical conductivity,  $\text{HCO}_3^-$  (titration with HCl) and  $\text{NH}_4^+$  concentrations were determined in the field using standard methods. Atomic absorption spectrophotometry (AAS) analyses were used to determine cations, ion-chromatography for anions.

- Data acquisition

As planned for the second year, the objective of the II years research was maintenance and further development of monitoring network of chemistry of underground waters.

- Campi Flegrei: we have collected waters from 24 sampling locations and analyzed the samples for chemical and chemico-physical parameters. Basing on data obtained from analyses we have chosen 10 sites in interesting areas. Waters from these locations have been collected bi-monthly (2001) and three -monthly (2002) for geochemical surveys.

- Ischia: we have collected waters from 10 thermal wells and we have analysed the samples for chemical and chemico-physical parameters

- Vulcano: two field trips have been performed to collect samples from 15 water wells, located at Vulcano Porto. Measurements of chemical and physical parameters have done.

- Data processing and interpretation

Collected data are used to define the spatial distribution of geochemical features of underground waters and their temporal variations. At Campi Flegrei obtained evaluations suggest some minor variations that may be correlated to thermodynamical changes in the volcanic systems. Some interesting wells have been selected as the more interesting for volcanic and seismic forecasting. These wells result to be related to the deep system in a very interesting way. At Campi Flegrei, Ischia and Vulcano Rn measures have been performed together with waters sampling to individuate possible correlations between chemical parameters and Rn variability. A Vulcano chemical data indicate that only two wells show temperatures higher than 31°C (respectively 65 and 72°C) indicating a possible feeding by deep thermal fluids. Data from the two sampling performed during the last year show no interesting variations in chemical and chemico-physical parameters. Processed data have been presented to international meetings and are to be submitted for publication.

- RESEARCH PRODUCTS

International Journals: 3

National Journals: 1

International meetings: 3

National meetings: 1

- PUBLICATIONS LIST (inclusive of papers in prints and accepted)

VALENTINO G.M, STANZIONE D. (2001) – Geochemical variations in the thermal waters of the Phlegraean Fields (Italy) during 1992-1999. GNV-Meeting, 9-11 October, 2001, Abstracts, pp. 37-38.

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RU Responsible:

Name-Position : Pece Raimondo - Associate Professor

Affiliation : Dept Scienze della Terra Univ. of Napoli FEDERICO II

ACTIVITY REPORT–2nd YEAR

RU PARTICIPANTS

Name - Position	Affiliation	man/month
Capaldi Giuseppe - Full Professor	Dept Geofisica e Vulcanologia Univ. of Napoli FEDERICO II	2
Pece Raimondo - Associate Professor	Dept Scienze della Terra Univ. of Napoli FEDERICO II	2
Pinto Alessandro - Ph D student	Dept Geofisica e Vulcanologia Univ. of Napoli FEDERICO II	4
Di Matteo Valentina - Ph D student	Dept Geofisica e Vulcanologia Univ. of Napoli FEDERICO II	2
Avino Rosario - Technician	Osservatorio Vesuviano INGV	1
Astarita Sergio - Technician	Dept Geofisica e Vulcanologia Univ. of Napoli FEDERICO II	2

• 2nd YEAR OBJECTIVES

A) Measurements of geochemical parameters (T, pH, EC, Rn, Radioactivity, Hg, etc..) in control sites (waters, soils, fumaroles) of the volcanic areas under study in order to evaluate the variations in time of the thermodynamic state of the volcanic system:

Groundwaters: Surveys - mappings of chemical, isotopic composition and radioactivity of groundwaters emerging in the investigated volcanic areas. The program is based on periodic sampling, bimonthly at Somma-Vesuvio and Campi Flegrei and six-monthly at Ischia and Vulcano Islands.

Soil atmospheres: Mappings of Radon, Mercury Vapor in soils of the volcanic areas

The measurements to perform are:

Tracers: Radon, Mercury Vapor ( $Hg^{\circ}$ ) and radioactive isotopes of the natural radioactive series in geothermal and/or volcanic fluids (waters, fumaroles, soil atmospheres). Radioactive isotopes are to be determined by gamma spectrometry instruments using Ge HP and NaI(Tl) crystals.

B) Acquisition and proof of alpha spectrometry instruments; setup of chemical methods of separation of Thorium and Uranium in order to measure the Th and U isotopic ratios.

• 2nd YEAR RESULTS (max 1 page)

• methodologies

- 1) Measurement of Rn in waters: sampling with 1 lt. bottles; Rn extraction with air bubbling in closed loop; measurements with ZnS (Ag) cells and EDA RD 200 instruments (average of 10 measures after 5 minutes)
- 2) Measurements of Rn in soils: sampling at 70 about cm depth; 3 measurements with EDA RD 200 instruments to determine  $^{220}Rn$  and  $^{222}Rn$
- 3) Measurements of Hg in waters: in laboratory, after chemical extraction, with instrument Jerome 511
- 4) Measurements of Hg in soils: sampling of B soil horizon; measurement in laboratory, after chemical extraction, with instrument by Jerome factory
- 5) Measurements of gamma radioactivity in waters: sampling in 1 lt Marinelli bottles; measurements with HPGe or NaI(Tl) detectors and Ortec Nomad Multichannel Analyzer
- 6) Measurements of gamma radioactivity in situ on rock lithotypes: measurements with NaI(Tl) detector and Ortec Nomad Multichannel Analyzer directly in situ on rock
- 7) Isotopic Ratios of U and Th: even if these measurements have not yet carried out, we are preparing the laboratory separation and purification of these radioelements in order to measure the  $^{234}/^{238}U$  and  $^{230}/^{232}Th$  ratios by alfa spectrometry (at CNRS Paris, or at Vesuvian Observatory).

• Data acquisition

### Campi Flegrei:

- Weekly measurements of gas Radon using the Track-Etch method, pH, T and Electrical Conductivity in 2 water wells
- Monthly measurements of gas Radon using the Track-Etch method in 5 holes in the soils distributed in the phlegraean caldera
- Sampling and control of waters from 24 sampling locations for chemical and chemico-physical parameters. Basing on data obtained from analyses 10 sites have been chosen. Waters from these locations are now collected bi-monthly (2001) and three -monthly (2002) for Radon and gamma radioactivity measurements..

### Vulcano:

- Mapping of Rn by EDA RD-200 portable instrument, and Hg<sup>o</sup> in the atmosphere of the soils of this island
- Measurements of Rn by EDA RD-200 portable instrument, pH, T ed Hg<sup>o</sup> in the waters of 15 wells
- Measurements of gamma radioactivity by using NaI(Tl) detector in the waters of 15 waters wells to determine K40, Ra226, Bi214 and Tl208
- Measurements of Rn in 2 fumaroles (Crater and Eastern Beach): sampling with closed ZnS (Ag) cells and EDA RD 200
- Sampling of a fumarolic condensate at the Fumarole F5 on the Great Crater.
- Measurements of gamma radioactivity in situ on rock lithotypes of Vulcano island with NaI (Tl) detector and ORTEC Nomad + .

### Ischia:

- Measurements of Rn by EDA RD-200 portable instrument, pH, T ed Hg<sup>o</sup> in the waters of 10 wells
- Measurements of gamma radioactivity by using NaI(Tl) detector in the waters of 10 waters wells to determine K40, Ra226, Bi214 and Tl208

### Somma-Vesuvio

In this area in the first year of this program a gamma radioactivity mapping was carried out by helicopter in cooperation with the Austrian Geological Survey. Maps of total gamma radioactivity, and of the K40, Bi214 (i.e. Ra226), Tl208 (i.e. Th232) have been produced and in the 2<sup>nd</sup> year several profiles E-W and N-S have been carried out with NaI (Tl) detector and ORTEC Nomad + .

- Data processing and interpretation

Collected data are used to define the spatial distribution of geochemical features of underground waters and their temporal variations. The collection of the data started in 1982 in Campi Flegrei Caldera and in 1989 at Vulcano Island. Likewise Ischia and Vesuvius are investigated since 1990.

The last measurements evidentiare some variations that may be correlated to thermodynamical changes in the volcanic systems. Some preliminary data have been presented to international meetings and are under elaboration for publication. Notable is the increase of measured radiogenic isotops (Rn, Ra, <sup>40</sup>K, Tl) at Vulcano.

- RESEARCH PRODUCTS
  - International papers: 2
  - National papers 0
  - Abstract of International Congresses 3
  - Abstract of National Meetings 1

4 Data bases (1 for each volcano)

### PUBLICATIONS LIST (inclusive of papers in prints and accepted)

AVINO R., CAPALDI G., DI MATTEO V., PECE R., PINTO A. (2001) – Radon in active volcanic areas Italy - GNV-Meeting, 9-11 October, 2001, Abstracts, pp. 35-36.

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AVINO R., CAPALDI G., DI MATTEO V. PECE R. Radon and mercury in the groundwaters of Phlegraean fields (southern Italy): temporal and spatial variations. Sub. JVGR



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**RU Responsible: Dario TEDESCO**

Name-Position : Associate Professor

Affiliation : S.U.N.

ACTIVITY REPORT–2nd YEAR

RU PARTICIPANTS

Name - Position	Affiliation	man/month
Dario TEDESCO, Associate Professor		6
Simona CASTALDI Researcher		6
Maurizio MUSELLI, technician	Seconda Università di Napoli	6
Alfonso GUERRA, technician	Dip. Scienze Ambientali	6
Emilio CUOCO, fellowship		6
Giuseppe VERRENGIA, fellowship		6

• 2nd YEAR OBJECTIVES

The objectives planned for the second year, as scheduled in our project calendar submitted the first year have been achieved

• 2nd YEAR RESULTS (max 1 page)

• methodologies

Uncondensable gases (N<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>, CO, Ar, He, Ne, CH<sub>4</sub> and light hydrocarbons) were analysed by gas chromatography, using TCD, ECD and FID detectors. CO<sub>2</sub>, HCl and Sulphur species (SO<sub>2</sub>, H<sub>2</sub>S and S<sup>0</sup>) were determined by titration and ion chromatography. Condensate samples were analysed for SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>, F<sup>-</sup>, Br<sup>-</sup> and NO<sub>3</sub><sup>-</sup> by ion chromatography and B<sup>3+</sup> by colorimetry. Temperature, pH, electrical conductivity, HCO<sub>3</sub><sup>-</sup> (titration with HCl) and NH<sub>4</sub><sup>+</sup> and SiO<sub>2</sub> concentrations were determined in the field using standard methods. Atomic absorption spectrophotometry (AAS), ion-chromatography and spectrophotometric analyses were used to determine cations (except for Al<sup>3+</sup>, which was analysed by colorimetry), anions, and boron, respectively.

Carbon isotopic ratios have been analysed with a Finningan 250 delta mass spectrometer at the Dept. of Earth Sciences of Florence.

Helium, Neon and Argon isotopic analysis have been done on a dedicated rare gases VG 5400 mass spectrometer fitted with a Johnston electron multiplier and pulse counting electronics on the axial collector

Gas samples were also analysed by a quadrupole mass spectrometer.

• Data acquisition

We had continued to collect monthly at the Solfatara crater, for both chemical and isotopic composition.

Major (H<sub>2</sub>O, CO<sub>2</sub>, H<sub>2</sub>S), minor (N<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub>, CO, Ar, He and Ne) and trace (hydrocarbons) chemical species have been analyzed. Analysis of <sup>3</sup>He/<sup>4</sup>He, <sup>20</sup>Ne/<sup>22</sup>Ne, <sup>21</sup>Ne/<sup>22</sup>Ne, δ<sup>13</sup>C have been performed on gas samples. We have collected gases at the Bocca Grande fumarole and at the Soffione. Measurements of chemical and physical parameters have been also done at the Fangaia. Similarly to Solfatara crater, at Ischia island, two field trips have been conducted and we have collected volcanic gases from fumaroles in several part of the island, waters (hot and cold). Chemical components analysed are the same as for the Solfatara crater fumaroles. Again similarly the same isotopic ratios have been analysed from gases. Anions, cations and metals, plus oxygen and deuterium isotopic composition have been analysed from waters.

Fumaroles (from both crater and beach) and water wells (cold and hydrothermal) at Vulcano island have been collected twice during two different field trips. In addition to gases analysed at Solfatara and Ischia island, at Vulcano crater we have also analysed acid species, such as SO<sub>2</sub>, HCl and HF.

We have collected submarine fluids from fumaroles located between 2 and 30 meters at Campi Flegrei caldera, Ischia island, Vulcano island and Panarea island.

Two field trips on one week each at Campi Flegrei caldera, have been dedicated to install a continuous monitoring stations at the Bocca Grande fumarole. At the same time soil gases have been analysed in one dedicated field trip, CO<sub>2</sub>, CH<sub>4</sub> and trace species have been analysed. Total budgets have been computed.

One soil gas flux campaign, measuring CO<sub>2</sub>, CH<sub>4</sub> and NO<sub>x</sub>, at the Solfatara crater in November 2002.

Two campaigns, at the Solfatara crater and Vulcano island have been done to calibrate, according to Paolo De Natale, the new laser optic instrumentations of INOA. Both campaigns have given promising results.

A specific device have been used at the Solfatara of Pozzuoli to continuously monitor volcanic gases. For the first time, the whole gas phase has been monitored for several days. A Quadrupole Mass Spectrometer coupled with a Gas Chromatograph have been used in the field. He, Ar, H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, H<sub>2</sub>S, CO<sub>2</sub> and H<sub>2</sub>O. It is the first time that such a system is used on an active volcanic area. Data have been compared to those obtained by alkaline solution flasks and analysed later in the laboratory. Instrumentation have been calibrated both, in the laboratory and in the field during chemical analysis.

- Data processing and interpretation

On top of this work, we have used the chemical composition of each geothermal or volcanic area, to compute thermodynamic calculations in order to better understand physical conditions of the source regions giving origin to these fluids. The isotopic composition has helped to understand if source regions have changed with time and if migrations of fluids have occurred during this period of time. Currently all volcanic areas do not show any significant variations compared to the past. A little increase, of some chemical parameters, have been recently noted at the Solfatara crater fluids.

- Others

- RESEARCH PRODUCTS

- International papers: 1
- Abstract of International Congresses 2
- Abstract of National Meetings 1

#### PUBLICATIONS LIST (inclusive of papers in prints and accepted)

TEDESCO D., VASELLI O., TASSI F., 2001. Chemical and isotopic measurements of volcanic and natural fluids in southern Italy. GNV-Meeting, 9-11 October, 2001, Abstracts, p. 39.

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VASELLI O., TASSI F., CUCCOLI F., BELOTTI C., MONTEGROSSI G., TEDESCO D., FACHERI L., 2002. A geochemical and IR Laser System survey at the fumarolic field of the "LA Solfatara" (Phlegrean Fields, Southern Italy). 82<sup>nd</sup> SIMP Congress, 18-20 September, 2002, Cosenza (Italy), 287-288.

VOLTAGGIO M., BRANCA M., TEDESCO D., TUCCIMEI P AND DI PIETRO L. Radium<sup>226</sup> excess during the 1631-1944 activity period of Mt. Vesuvius (Italy): A model of alpha recoil enrichment in a metasomitized mantle and implications on the current state of the magmatic system. *Geochim. Cosmochim. Acta* (accepted for publication).

#### Invited Talk:

- (1) EGS, Nice, April 2002
- (2) Cities on Volcanoes, Hilo Hawaii, July 2003.