Sub-project V3_3 - Ischia

Responsibles:

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The island of Ischia is the emerged top of a large volcanic complex rising more than 1,000 m above sea floor at the north-western corner of the Gulf of Naples. It is an active volcanic field composed of volcanic rocks, landslide deposits, and subordinate terrigenous sediments, reflecting a complex history of alternating constructive and destructive phases due to the interplay among tectonism, volcanism, volcano-tectonism, erosion and sedimentation. The volcanic system is still active, as testified by the intense volcanic activity in historical times, widespread fumaroles and thermal springs, and by seismic activity. Volcanism at Ischia began prior to 150 ka B.P. and continued, with centuries to millennia of quiescence, until the last eruption occurred in 1302 A.D. Recent studies have demonstrated that during the time interval between 74 and 55 ka B.P. there was a dramatic change in the structural setting of both magmatic system and volcanic edifice. This time interval, previously regarded as a mainly quiescent period, bore witness to a complex volcanic activity with the largest eruptions recorded on the island. This period culminated with the caldera-forming Mt. Epomeo Green Tuff eruption (55 ka,) which was followed by block resurgence of the caldera floor, at least since 33 ka. Resurgence dynamics influenced the later volcanic activity determining the conditions for magma ascent mainly within the eastern portion of the island and along pre-existing regional faults. During the last period of activity, started 10 ka B.P., volcanism was mainly concentrated at ca. 5 ka and in the past 2.9 ka. In the past 5 ka, reactivation of faults and related volcanic activity, are accompanied by emplacement of deposits generated by surface gravitational movements. These deposits preceded and followed the emplacement of volcanic rocks, testifying that slope instability conditions were induced by reactivation of vertical movements, which also generated faults and fractures that fed volcanism. Furthermore, the availability of large amount of loose material, rapidly accumulated along the slopes during eruptions, predisposed the conditions for landslide generation.

Volcanic hazards assessment and long-term forecasting of a future eruption at Ischia have to be the prime objectives of future researches on the island. Although variable researches have been carried out on the island in the last decades, they have never been finalised to volcanic hazards assessment. Therefore it is necessary to formulate a multidisciplinary and coordinated project with the aim of finalising the available data and filling the knowledge gaps. Still a large amount of information necessary for formulating a comprehensive hypothesis on the behaviour of the volcano and its magmatic feeding system, is lacking. The structure of the volcano and its underlying lithosphere needs to be better defined through combination of structural and geophysical data. As only one third of the volcano is above sea level, data from marine geology and geophysics investigations are needed. This is true also for the definition of the geomorphic characteristics of the entire volcano. According to the present knowledge, the portion of the volcanic and deformation history of the volcano, most useful for volcanic hazards assessment, is related to the past 10 ka. But, as previously mentioned, the knowledge of the intense volcanism and deformation (74 - 55 ka), which has likely affected the later behaviour of the volcanic system, is quite poor. Therefore, in order to understand the present state of the volcano, it is necessary to investigate its volcanic, magmatic and deformation history over the past 74 ka. Through these investigations, the sequence of events and its timing should be defined. The behaviour and structure of the magmatic system should be assessed as well, also in terms of physical and chemical parameters, rheological

properties and glass structure. The diffuse occurrence of hot-water springs and fumaroles testifies the existence of active geothermal and hydrothermal systems. Investigation of these systems and definition of their physico-chemical characteristics are important pieces of information for hazards assessment. Another hazard on the island, closely related to volcanism, is the occurrence of surface gravitational movements which generate landslides deposits at variable scale. This implies that investigations need to be carried out also on these deposits, in order to have a more complete picture of the geological hazards on the island. The present knowledge of Ischia eruption precursors is very poor. Therefore, in order to construct a dataset necessary for a future definition of the alert levels, it is useful to collect geological, historical and archaeological data on the precursors of the Ischia eruptions.

The project is subdivided in 5 Tasks, each articulated in Work-Packages.

Task 1. Structure and geomorphology

WP 1.1: Lithospheric structure

Deliverables:

1. Structural setting of the lithosphere beneath the volcano, with particular reference to location and size of the magmatic system.

WP 1.2: Structural setting and geomorphology of the volcano, including its submerged portion

Deliverables:

1. Structural map of the volcano

WP 1.3: Stratigraphy, transport and deposition mechanisms, and volumes of surface gravitational movement deposits

Deliverables:

1. Stratigraphic sequence and physical characteristics of the surface gravitational movement deposits

WP 1.4: Quantitative Geomorphic Analysis of the entire volcano, both emerged and submerged portions

Deliverables:

1. morphological dataset based on high spatial resolution data (DEM, DTM, Remotely Sensed Imagery)
2. digital thematic maps;
3. 3D visualization;
4. GIS database.

Task 2. Volcanology and geochronology

WP 2.1: Definition of the stratigraphic sequence of the volcanic deposits, integrated with that of the non-volcanic rocks, areal distribution, density, volume of extruded magma, and eruption vent/vent area for each eruption.

Deliverables:

1. Stratigraphic sequence of the exposed deposits

2. Maps of the areal distribution of the deposits of effusive eruptions and pyroclastic currents
3. Isopachs and isoplets maps for fallout deposits
4. Frequency maps for lava domes and flows, and pyroclastic current and fallout deposits
5. Frequency maps of load on the ground by fallout deposits

WP 2.2: Age determination of the volcanic and deformation events, and surface gravitation movements

Deliverables:

1. Chronogram of the volcanic, deformation and surface gravitational movement events
2. Maps of the active vents through time

WP 2.3: Eruption dynamics and transport mechanisms of effusive and explosive eruptions

Deliverables:

1. Physical parameters of the volcanic eruptions

WP 2.4: Eruption precursors

Deliverables:

1. Geological, historical and archaeological dataset
2. Definition of the background level using the monitoring network data

Task 3. Evolution, structure and present state of the magmatic feeding system

WP 3.1: Definition of magma genesis and evolution, and relation with eruption dynamics.
Deliverables: 1 - Modelling of the mantle source characteristics of the Ischia magmas.

WP 3.2: Determination of the physical and chemical parameters, volatiles content, structure and rheological behaviour of the erupted magmas
Deliverables: 1 - Magma chamber processes before and during eruptions of variable magnitude and occurred in variable structural conditions; 2 – physical and chemical parameters, and rheological properties of the erupted magmas; 3 – kind and amount of volatiles in the magmatic reservoir/s; 4 - experimental determination of glass structure and distribution of hydrous species; 5 - relations among magma structure, physical and chemical parameters, and eruption dynamics; 6 - timing of large magma chamber processes;.

Task 4. Hydrogeological setting and geothermal system

WP 4.1: Definition of a baseline level for groundwater composition (major, minor and trace ionic species, dissolved gases, isotope composition of water and dissolved gases) in the present quiescent state of activity

Deliverables:

1. Geochemical maps of the spatial distribution of major, minor and trace species and dissolved gases in the groundwater system
2. Assessment of the budget of volatiles (CO_2, He) transported by the groundwater system

3. Identification of hydrogeochemical precursors of volcanic unrests

WP 4.2: Geochemical, petrological and geophysical assessment of the physical-chemical properties (temperature, depth, pressure, lateral extension, volume, composition of the fluids) of the hydrothermal system.

Deliverables:

1. Graphical two-three dimensional representations for the geometry of the deep-seated hydrothermal reservoirs
2. Estimate of the probability of pressurization events of the hydrothermal reservoir and consequent phreatic explosions
3. Identification of geochemical precursors for phreatic events

Task 5: Volcanic and related hazards assessment

WP 5.1: Definition of the areas at variable probability of opening of a new vent

Deliverables:

1. Probability hazard map for opening of a new vent

WP 5.2: Probability definition of the expected volcanic events at variable scale

Deliverables:

1. Eruption scenarios

WP 5.3: Physical modelling and numerical simulation of the expected volcanic events

Deliverables:

1. Modelling of eruption column and fallout deposits
2. Modelling of pyroclastic currents
3. Physical parameters of the expected hazardous phenomena needed for vulnerability evaluation, such as load on the ground for tephra fallout and dynamic pressure for pyroclastic currents

WP 5.4: Zoning of the territory in relation to the expected volcanic hazards

Deliverables:

1. Probability tephra fallout hazard map
2. Probability pyroclastic currents hazard map

WP 5.5: Definition of the expected surface gravitational movements at variable scale

Deliverables:

1. Classification and volume estimation of landslides deposits

WP 5.6: Zoning of the territory in relation to the expected surface gravitational movements

Deliverables:

1. Surface gravitational movements hazard map.