Drilling a Volcano: Scientific Experiment at Alban Hills, Italy

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Abstract

Only a few deep boreholes have been drilled for scientific purposes on active volcanoes in the whole world. Indeed, data collected from deep wells are fundamental to better model geophysical processes. Within the Italian research project INGV-DPC-V3.1 (funded by the Italian Civil Protection Department), we planned to drill a 400m hole with the main goal to define the orientation and magnitude of present stress field in the shallow crust in the Alban Hills. The Alban Hills are considered a quiescent volcanic district, belonging to the Quaternary volcanic belt of the Tyrrhenian coast. They are located in a densely populated area close to Rome, then an eruption would be a real risk, also considering the type of their past activity. Alban Hills have been fully excavated by means of surface or very shallow observations and indirect methods: now we are going to start the first scientific program to investigate them directly at depth. We will perform some hydraulic fracturing tests at different depths in the drilling located in a key area, to compute, for the first time beneath a volcano, the absolute values of stress principal axes and reconstruct the stress path along depth. Analysis on core samples will allow to better understand the geomechanical and palaeomagnetic investigations will constrain the recent volcano-tectonic processes.

We propose to perform some Hydraulic tests (or leak-off) in a 400m borehole to compute the values of stress principal axes. The borehole will allow to characterize the geomechanical behaviour of drilled rocks and to couple these studies with geotechnological and palaeomagnetic investigations to constrain the recent volcano-tectonic processes.

What we are going to do

1. Hydraulic Fracturing Test
   [or extended leak-off tests] to determine active stress orientation and magnitude

2. Downhole Logging
   Borehole Televiseor
   Sonic log
   Gamma ray log
   Magnetic log
   Electric log

Magnetostratigraphy of the sedimentary units
Anisotropy of the Magnetic Susceptibility

To provide information on the Middle Pleistocene strain to be compared with present-day data

Further steps......

4. $^{40}\text{Ar}/^{39}\text{Ar}$ dating of unknown pyroclastic horizons possibly recovered

At the end......

......a seismometer at depth!

Some researchers from INGV (CNT Dpt.) will install a broad-band seismometer at 200-300m that will be connected in real-time with the Italian Seismic network and provide live wave recordings in a densely populated area and where few seismic stations are present.

Introduction to the area

This uplifted area coincides with the zone of recent seismicity

Seismicity and focal mechanisms

This uplifted area coincides with the zone of recent seismicity

Stress field

Only one stress data in the Alban Hills and none stress magnitude

Project DPC-INGV V3.1 "Collli Albani"

Coordinators: P. Scarlato (INGV-RM) and M. Gessa (Univ. Rome)

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Research Unit

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The Alban Hills Volcanic District has been identified as a quiescent volcano only recently and the present project is the first one specifically oriented to the definition of their potential hazard and crisis levels. Main topics:

1. Evolution and present-day state of the magmatic system, including the presence and location of possible magma chambers and the role on magmatic processes on the origin of surface gas output.
2. Genesis and mobility of hazardous gases in ground and surface water bodies, degassing cycles and effects on degassing of anthropic hydrocarbon peridotes.
3. Deep setting of the District and the source of seismicity and regional-scale ground deformation.
4. Dynamics of the District at shallow and surface depth and their interferences with human activities, including local-scale ground deformation, stress field, slope stability, recent eruption processes, crater lake evolution, quiescent mass flows.

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Local tectonics different from regional area

Stress map of Italy

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