

The campi flegrei deep drilling project: initial results from gas monitoring site surveys and drilling mud gas monitoring during the 500 m pilot hole drilling

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Situated in the Campanian region (Italy), the Phlegraean Volcanic District is a densely populated active volcanic area, including the Campi Flegrei caldera, the islands of Procida and Ischia, and a number of submerged volcanoes. The understanding of mechanisms for volcanic unrest and eruptions of large calderas is crucial to mitigate volcanic hazards and to evaluate the influence of volcanic activity on the global environment. The Campi Flegrei Deep Drilling Project (CFDDP) was born to tackle these questions by scientific drilling of a 500 m pilot hole and a 3-4 km deep main hole.

The drilling of a pilot hole was successfully executed in late summer 2012 and late fall 2012, interrupted by three months of operational stop. In the first phase, a 12 ¼inch hole was drilled to 222 m below ground level. In the second phase, the hole was deepened to 434 m (8 ¼inch borehole diameter) and finally reached a depth of 501 m with 6 inch diameter. The hole was logged and cased at the end of each phase with exception of the lowermost 80 meter, where a slotted liner was installed to permit fluid flow from the formation into the well for future fluid and gas monitoring. Cuttings were separated from the drilling mud at the shale shakers, analysed in a field laboratory and sampled for further measurements. Two core runs at 438 m and 500 m yield only poor recovery.

On-line gas monitoring was carried out to gain new insights into the evolution of the fluid regime (drilling mud gas monitoring) and to understand the interplay between deep circulating fluids and volcanic/seismic processes. The only formation-derived gas extracted from the drilling mud during pilot hole drilling was CO₂ with concentrations lower than 0.1%. Preliminary data evaluation suggests that CO₂ concentrations vary with different lithology. The low gas concentrations identified by scientific mud gas monitoring and by commercial mud logging are most likely caused by heavy drilling mud that impedes the flow of gas from the formation into the drilling mud. In the future, water and gas will be sampled from the pilot hole by a modified U-tube technique.

Prior to drilling, two long-term gas monitoring site surveys were executed from January-Mai 2009 and from May-July 2012 at a Pisciarelli fumarole field at the eastern outer flank of the Solfatara volcano, 3.2 km away from the CFDDP drill site. The average composition (air-corrected) of fumarolic gas is as follows: CO₂ (98.4 vol.%), H₂S (0.24 vol.%), N₂ (1.13 vol.%), CH₄ (65 ppmv), H₂ (0.089 vol.%), and He (7.3 ppmv). Long-term and diurnal variations in the gas composition have been identified. Stable isotope and noble gas isotope analysis are planned on all types of gas samples.