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Distributed optical fiber sensors: an approach for monitoring the thermal gradient at the Campi Flegrei caldera

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The Campi Flegrei caldera is considered among the highest risk volcanic areas in the World. The caldera in which now the western town of Napoli develops and 1 million people lives, hosted more than 60 explosive eruptions in the past 15 ky and at the present is the site of intense hydrothermal, fumarolic and bradyseismic phenomena that also preceded and accompanied the last magmatic unrest in AD 1538 [1]. Therefore, research and monitoring activities are continuously promoted and conducted both at national and international levels in order to understand the working of the volcano, to determine its present structure, to forecast its future evolution and to mitigate the volcanic hazard. The definition of 3D distribution of temperature represents an important goal of scientific studies allowing to identify heat source(s), to determine thermal conductivity and the flow versus advective heat transport, to quantitatively model the thermal state, to interpret data from seismic, aeromagnetic and geochemical surveys. Furthermore, the geothermal gradient measurements through time is fundamental in monitoring an active volcano. It also allows a more realistic interpretation of data from seismic, geodetic gravimetric, magnetic and geochemical monitoring networks by the knowledge of temperatures at depth. Thermal gradient can easily and rapidly measured taking advantage of Brillouin fiber-optics distributed sensors [2,3]. These sensors allow the measurement of temperature and/or strain profiles over distances up to a few kilometers by simply deploying a low cost single-mode optical fiber in the

area of interest. The temperature and strain accuracies are about 1°C and 20 ìå, respectively, while the system allows the acquisition of temperature/strain profiles with a spatial resolution of about 2 meters. We present the first results on temperature profiles measured at the Campi Flegrei caldera. The measurements, carried out along a 90-meters-deep borehole already equipped with a borehole strainmeter, have been performed through a fiber-optics distributed sensor based on stimulated Brillouin scattering. The obtained data are consistent with results of geothermal exploration [4] and indicate that geothermal gradient can be efficiently measured and monitored by the proposed technique.

References 1. A. Parascandola (1947) I fenomeni bradisismici del Serapeo di Pozzuoli. Genovese, Napoli. 2. R. Bernini, A. Minardo, L. Zeni (2004) Accuracy enhancement in Brillouin distributed fiber-optic temperature sensors using signal processing techniques, IEEE Photonics Technology Letters, vol. 16, pp. 1143-1145. 3. A. Minardo, R. Bernini, L. Zeni, L. Thevenaz, F. Briffod (2005) A reconstruction technique for long-range Stimulated Brillouin Scattering distributed fiber-optic sensors: experimental results, Measurement Science and Technology, vol .16, pp. 900-908. 4. AGIP (1987) Geologia e Geofisica Del Sistema Geotermico Dei Campi Flegrei, Servizi Centrali per l'Esplorazione, SERG-MMESG, San Donato.