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High resolution imaging of the Methana volcanic complex, Greece, with magnetotelluric and aeromagnetic data

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The Methana calc-alkaline volcanic complex is located off the NE coast of Argolis Peninsula (Peloponnesus, Greece) at the NW terminus of the Hellenic Volcanic Arc (HVA). It consists of approximately 32 domes, with the most recent eruptive episodes dated to 258 BCE and 1700 CE. Herein, we report the results an attempt to investigate the volcano's interior with joint interpretation of Magnetotelluric and Aeromagnetic data.

The aeromagnetic data was inverted with the UBC-GIF 3D magnetic inversion suite, constrained by several in-situ susceptibility measurements. At depths to 2 km, the inversion resolves individual intrusions corresponding to known phases of volcanic activity (domes), with susceptibilities >0.1. At depths greater than 4.5 km, a more weakly magnetized domain is detected ($\sim$0.025); its ceiling is well resolved; its floor cannot be placed with certainty but extends to at least 7 km. The depths are comparable to those of magma chambers. Based on the palaeomagnetic analysis of nearby volcanic rocks, it may be safely suggested that its temperature should not be higher than 550-600°C, but also not considerably lower. It may comprise a magma chamber, inasmuch as it compares well with the temperatures and locations of known magma chambers along the HVA. Finally, there's exists evidence of the location of the vents through which the extrusive activity has taken place.

A Magnetotelluric survey comprising 14 stations was conducted IN 1992, as part of a geothermal project. Herein, this data is reevaluated with modern analysis methods and re-interpreted with 2D inversion. The results indicate the presence of conductors at depths of 1500-2500 m beneath the centre of the Peninsula, extensive horizontal conductors at, or just below sea level and conductive protrusions above sea level.

The joint interpretation of the susceptibility and geoelectric images is based on the premise that they both are generated by hydrothermal circulation which depresses resistivity and destroys susceptibility via chemical alteration: the coincidence of low resistivity and susceptibility domains would indicate geothermal reservoirs and circulation conduits.

It turns out that the sea-level conductor coincides with practically naught susceptibilities, confirming the pervasive intrusion of sea water. The conductive protrusions also coincide with very low susceptibilities and defunct hydrothermal manifestations at the surface, also indicating the location of past, vigorous hydrothermal venting. Finally, two discrete volumes of low to intermediate susceptibility and low resistivity are detected at depths of approx. 2 km. These are thought to represent geothermal reservoirs, an interpretation corroborated by the presence of thermal springs and hydrothermal alterations directly above them, at the surface.

Evidence of faulting is also relatively abundant in the spatial configuration of the impedance tensor, in the interpreted geoelectric profiles and in low susceptibility lineaments, all interrelated and associated with past or present hydrothermal activity and thermal springs.

Overall, our analysis has provided detailed images of the volcano's interior, useful information on its geothermal potential and valuable insight into its structure and function, albeit based on a limited but carefully analyzed data set.