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Investigation of the deep crustal structure and magmatic activity at the NW Hellenic Volcanic Arc with 3-D aeromagnetic inversion and seimotectonic analysis.

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We report the results of a joint analysis of geophysical (aeromagnetic) and seismotectonic data, applied to the investigation of the deep structure, magmatic activity and geothermal potential of the north-western stretches of the Hellenic Volcanic Arc (HVA). The HVA is usually considered to be a single arcuate entity stretching from Sousaki (near Corinth) at the NW, to Nisyros Island at the SE. However, different types of and their ages indicate the presence of two different volcanic groups. Our study focuses on the northern part of the west (older) volcanic group and includes the Crommyonian (Sousaki) volcanic field at the west end of Megaris peninsula (east margin on the contemporary Corinth Rift), the Aegina and Methana volcanic complex at the Saronic Gulf, where typical Quaternary calc-alkaline volcanics predominate, and the Argolid peninsula to the south and south-west. In addition to the rocks associated with Quaternary volcanism, the study area includes a series of Mesozoic ultramafic (ophiolitic) outcrops at the Megaris peninsula, to the north and north-east of the Crommyonian volcanic field, as well as throughout the Argolid.

A major deep structural and tectonic feature of the study area, and one with profound influence on crustal deformation and the evolution of rapidly deforming extensional structures like the Corinth Rift and the Saronic Gulf, is the local geometry and dynamics of the African oceanic crust subducting beneath the Aegean plate. Locally, the subducting slab has a NNW strike and ENE plunge, with the dip angle changing rapidly (steepening) approx. beneath the Argolid.

The aeromagnetic data was extracted from the recently (re)compiled aeromagnetic map of Greece (Chailas et al, 2010) and was inverted with the UBC-GIF magnetic inversion suite (Li and Oldenburg, 1996). The inversion included rigorous geological constraints introduced by means of numerous in-situ magnetic susceptibility measurements. The inversion has imaged several isolated structures of relatively high magnetic susceptibility (>0.035), which all dip to the NNE and do not exceed the depth of 2km; these have all been identified with outcropping ophiolitic bodies. With particular reference to the Argolid, the results also indicate the existence of extensive and massive deep magnetized domains at depths > 4km, with susceptibilities of the order of 0.02. The latter include a rather conspicuous volume beneath the Methana volcanic complex, at depths between 4 and 8km. Because the modeled susceptibility values are generally consistent with the values expected for hot (200°C – 500°C) calc-alcaline igneous rocks, this feature was interpreted to comprise a magma chamber. By analogy to the Methana chamber, all such massive structures were attributed to recent magmatic intrusions (plutons). The pervasive presence of the intrusive igneous rocks beneath the Argolid indicates a rather extensive complex of magmatic activity associated with the western volcano group of the HVA. Particular attention is due to one such elongate and deep reaching “pluton”, which develops in a NNW direction (approx. 330°) along the axis of the Argolic Gulf, to the south of the Argolid peninsula; this is situated almost directly above the local inflection (steepening) of the subducting slab and is almost exactly aligned with to it.

The sub-crustal stress field due to the subducting slab has been determined by Rondogianni et al (2011) and has been re-appraised in the frame of the present analysis using the method of Michael (1984, 1987). It turns out to be extensional and NE-SW oriented, with the azimuth/dip of the maximum principal axis (compression) being approx. 230°/57° and the same for thee minimum principal axis (extension) being 59°/33°. With such a field, deformation is expected to associate with steeply dipping dislocation surfaces parallel to approx. 325° and to be primarily extensional, with a non-trivial left-lateral heave.

An analogous analysis was conducted for the crustal stress field on the basis of all well constrained focal

mechanisms of crustal earthquakes known to have occurred in the study area; the method of Michael (1984, 1987) was implemented as well. The results have shown that the crustal stress field is mainly extensional and NNE-SSW oriented, with the azimuth/dip of compression being approx. 48°/71° and the same for extension being 207°/17°. This will produce extension perpendicular "faults" dipping to the south and having a small left-lateral horizontal heave.

The sub-crustal and crustal stress fields are different for reasons obviously related to the differences in the conditions and influences exerted on the two domains. However, they are not, and cannot be dissociated! Sparing details, it can be simply pointed out that while the sub-crustal field pulls to the NE with a significant heave to the NW, the crustal field pulls to the SW. In consequence, low rate spreading in an ENE-WSW direction is expected, perpendicular to the strike of the slab, which should maximize along the inflection (steepening) of the slab. This may be a plausible explanation for the formation of the Argolic Gulf and the intrusions observed along its axis. Moreover, because the interaction of the subcrustal and crustal stress field results in a complex segmentation of the crust, their coupling also appears to facilitate and control the widespread and pervasive plutonic and volcanic magmatism of the study area and the Argolid in particular.

Finally, it is proposed that the recent plutonic magmatism and intermediate heat flow density (50-70 mW/m2) at South Argolid also suggest the possibility of geothermal resources in the form of an enhanced geothermal system (hot dry rock).

References

Chailas, S., Tzanis, A., Kranis, H. and Karmis, P., 2010, Bull. Geol. Soc. Greece, 43 (4), 1919- 1929.
Li, Y. and Oldenburg, D.W., 1996, Geophysics, 61, 394-408.
Michael, A.J., 1984, J. Geophys. Res., 89, 11517-11526.
Michael, A.J., 1987, J. Geophys. Res., 92, 357-368.
Rontogianni, S., Konstantinou, K. et al., 2011, Earth Planets Space, 63, 139–144,