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Vertical Electrical Sounding (VES) survey at the central part of Kos Island, Aegean, Greece

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Introduction

The use of vertical electric soundings (VES) in water exploration has been well established (Keller, Frischknecht, 1966; Koefoed, 1979) and is put into practice very often in Greece, where the hyrdrogeological conditions are such that do not deviate much from the horizontal layer hypothesis.

Kos is a 288 km^2 elongated island, located 10 km from the Turkish coast (fig. 1). It belongs to the group of Dodecanese islands in the Aegean Sea and is one of the easternmost islands of the Aegean volcanic arc (Keller, 1982). A large-scale VES survey was conducted in the central part of the island, namely the basin extending between Vulcania in the southwest and Antimachia in the northeast. The aim of this study was to obtain structural and hydrogeological information and explore the presence and depth of aquifers.

Brief geological and hydrogeological setting

The alpine structure of Kos is complex, comprising several tectonic units (Papanikolaou, Lekkas, 1990; Papanikolaou et al., 1995): metamorphosed carbonates, schists, limestones etc, while the post-Alpine structure is characterized by thick Miocene sedimentation. The dominant neotectonic structure is the Antimachia basin, extending between the Kefalos peninsula and the western slopes of Dikeos Mountain.

The studied area occupies the central part of the island, located in the Antimachia basin, and is covered mainly by Quaternary tuffs and ignimbrites, Pliocene lucastrine and terrestrial deposits (conglomerates and limestone) and alluvial deposits. The main faults that dominate the area are trending WNW/ESE accompanied by several small ones trending NE/SW.

The geophysical research

A total of 30 vertical electric soundings were performed, using the Schlumberger array, with a maximum AB/2 separation of 500 m. The sounding centres were 1 km apart and were situated in 3 profiles, trending NE/SW, while intra-section distance was 1 km. In most cases field data were of high quality, while some exceptions were attributed to field conditions. For the initial interpretation of the sounding data the Zhody algorithm was implemented (Zhody, 1989) and the IPI2WIN software was used for the inversion and main interpretation of VES data (Bobatchev, 1992; Bobatchev et al., 2001). Available geological and hydrological information were incorporated in the modelling and inversion procedure, allowing us to obtain the most robust but also realistic solution. An examples from the Antimachia basin is shown in figure 2. Since the centres of VES measurements are located on a regular grid it is possible to combine the 1-D interpretation results and produce pseudo-2D sections and 3D depth slices.

Parallel to the VES survey, a large-scale magnetic coverage of Kos Island took place, by performing measurements of the Earth's total magnetic field. The data were corrected for diurnal variation using the Penteli Magnetic Observatory data (I.G.M.E.) and a local magnetic anomaly map was compiled. Finally, the in situ magnetic susceptibility was measured in 120 stations, using the Bartington Kappameter apparatus, in order to gather complementary data for the investigated area and evaluate the quality of magnetic measurements.

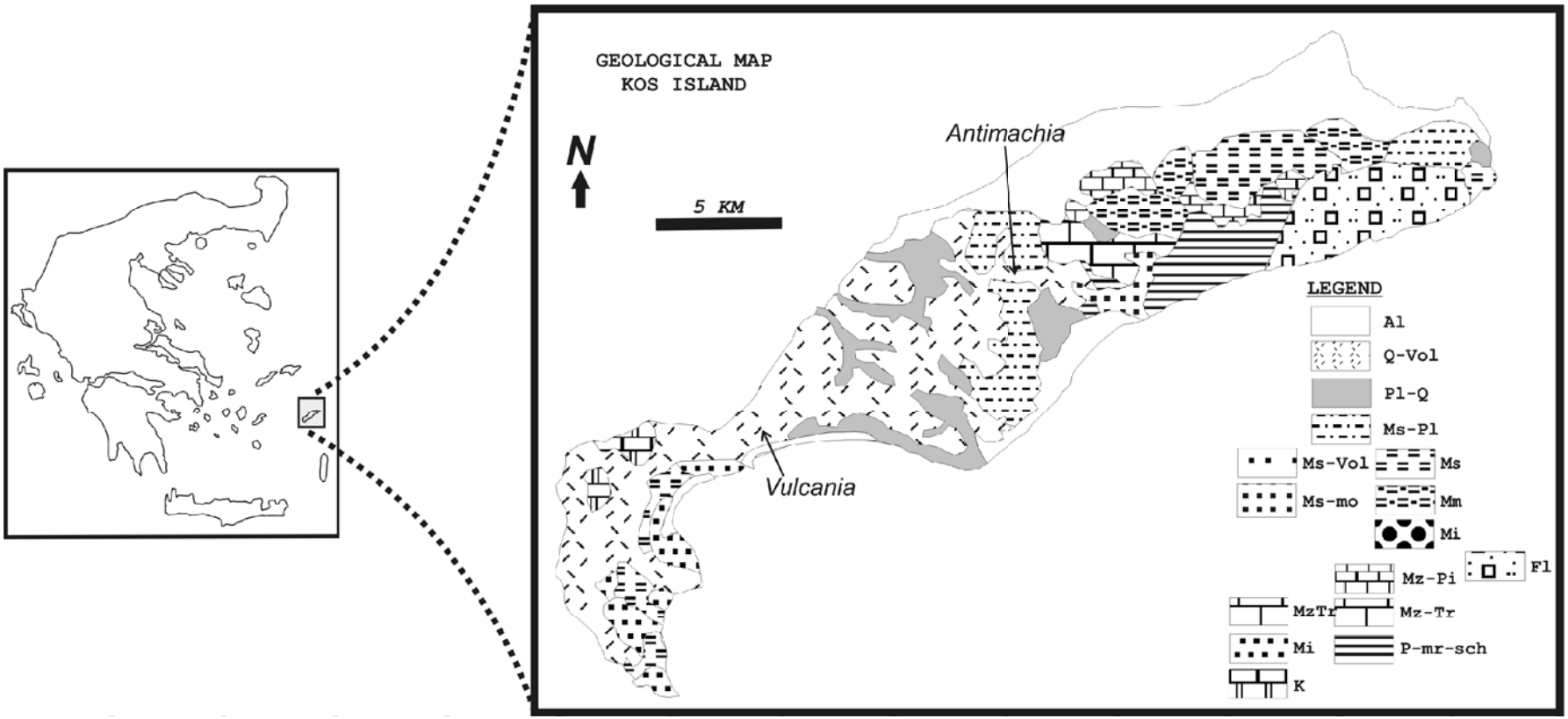

Fig. 1. Location map and schematic geological map of Kos Island (After Papanikolaou, Lekkas, 1990): Al: Alluvial, Q-Vol: Quaternary volcanics, Pl-Q: Pliocene Quaternary sediments, Ms-Pl: Miocene Pliocene sediments, Ms-Vol: U.Miocene volcanics, Ms-mo: Miocene monzonite, Ms: U.Miocene sediments, Mm: M.Miocene sediments, Mi: L.Miocene sediments, Mz-Tr: Mesozoic Triassic carbonates, Mi: L.Miocene molasses, K: Cretaceous marbles, Mz-Pi: Mesozoic pelagic sediments, Mz-Tr: Mesozoic neritic sediments, P-mr-sch: Palaeozoic metamorphics, Fl: Flysch, Eocene

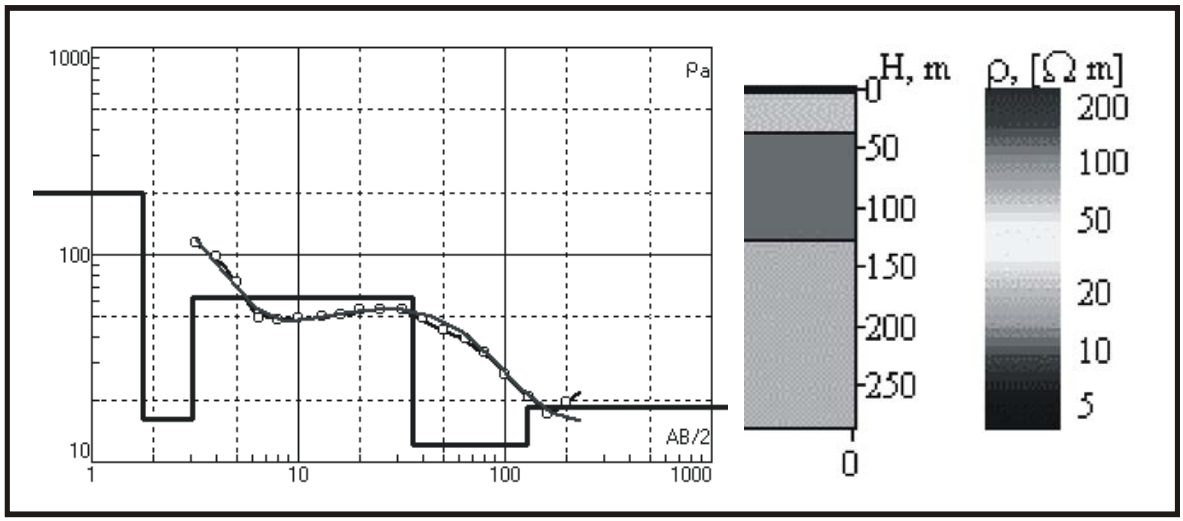

Fig. 2. Interpretation and modelling of VES data from a site in Antimachia basin: Field data (dotted line) and model curve (solid line), along with the apparent resistivity column

Conclusions

The inversion of Schlumberger data provided smooth appearing earth model profiles with sufficient detail for a sound interpretation. By defining the electric behaviour of local geological formations we were able to identify smaller drainage basins, within the Antimachia basin, and locate places with high possibility of sucessful drilling of the aquifer below sea level. The structural geology of Kos Island, known mostly from surface geological data, was enhanced with information about local faults, resulting from the magnetic and electric survey. Moreover, the magnetic measurements supplied information about volcanic rocks, present in many parts of the island, which play an important role in the exploitation of water resources. The results from the interpretation of VES data, combined with the magnetic survey output and available drilling and geological information gave a detailed but also realistic picture of the earth's structure for the studied area. Thus, we were able to indicate appropriate locations and desired depth for future drilling, as well as to propose a strategy for the proper exploitation and pumping of the aquifers over time.

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