

LOCATING GROUNDWATER BEARING FRACTURE ZONE IN PHYLLITE OF ASVESTOCHORI AREA
WITH THE VLF ELECTROMAGNETIC METHOD.

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ABSTRACT

VLF measurements have been used to locate groundwater bearing fracture zone in the phyllite of Asvestochori area, 9 km east of Thessaloniki (Northern Greece).

The VLF measurements indicated a water bearing fracture zone in an almost vertical direction to the strike of s-planes in the phyllite of the investigated area. The VLF anomaly chosen for drilling was a relatively strong anomaly and the following drillhole yielded 23 m³/h.

The VLF is a very useful geophysical method in groundwater prospecting, especially for locating water bearing fracture zones, but also a good knowledge of the geological conditions is essential for the interpretation of the VLF data.

ΕΝΤΟΠΙΣΜΟΣ ΥΔΡΟΦΟΡΟΥ ΡΗΓΜΑΤΟΣ ΣΕ ΦΥΛΛΙΤΗ ΠΕΡΙΟΧΗΣ ΑΣΒΕΣΤΟΧΩΡΙΟΥ ΜΕ ΤΗΝ ΗΛΕΚΤΡΟΜΑΓΝΗΤΙΚΗ ΜΕΘΟΔΟ VLF.

ΣΑΒΒΑΣ ΦΙΛΙΠΠΙΔΗΣ

Βασ. Ηρακλείου 28, 546 24 Θεσσαλονίκη

ΠΕΡΙΛΗΨΗ

Χρησιμοποιήθηκαν μετρήσεις VLF για τον εντοπισμό υδροφόρου ρήγματος σε περιοχή του Ασβεστοχωρίου, 9 χλμ. ανατολικά της Θεσσαλονίκης (Βόρεια Ελλάδα).

Στην περιοχή ερεύνης οι μετρήσεις VLF εντόπισαν υδροφόρο ρήγμα, σχεδόν κάθετα προς την παράταξη των s-επιπέδων του φυλλίτη. Η ανωμαλία VLF που επιλέχθηκε για γεώτρηση ήταν μία σχετικά ισχυρή ανωμαλία και η παροχή της γεώτρησης που ακολούθησε ήταν $23 \mu^3/\omega\text{ρα}$.

Η γεωφυσική μέθοδος VLF είναι πολύ χρήσιμη στην αναζήτηση υπογείου ύδατος και ιδιαίτερα στον εντοπισμό υδροφόρων ρηγμάτων, αλλά η καλή γνώση των γεωλογικών συνθηκών είναι απαραίτητη για την ερμηνεία των δεδομένων του VLF.

INTRODUCTION

The VLF method makes use of the electromagnetic field from radio transmitters in the Very Low Frequency range 10-30 kHz. The VLF radio waves that penetrate the bedrock induce a secondary electromagnetic field around electrical conductors. The VLF instrument measures the inphase and quad-phase components of vertical magnetic field as a percentage of horizontal primary field (i.e. tangent of the tilt angle and the ellipticity of the polarization ellipse). The tilt angle reading is called Real (R) and the ellipticity reading is called Imaginary (Im) or Quadrature (e.g., Coney, 1977; Parasnis, 1979; Olsson, 1980).

The VLF method was successfully used in mineral exploration and geological mapping (e.g., Paal, 1965; 1968; Fraser, 1969; Paterson and Ronka, 1971; Telford et al., 1977). In the last ten years the method has been widely used in groundwater prospecting, especially in Scandinavia (e.g., Mullern and Eriksson, 1982; Arnbom and Andersson, 1982). Arnbom et al., (1984) have tested the method in different geological formations in central and southern Greece. This paper reports on locating groundwater bearing fracture zone in phyllite with the VLF method.

GEOLOGICAL SETTING AND FIELD MEASUREMENTS

The investigated area consists of phyllite and shales (fig. 1). The phyllite is graphite-bearing and shows few intercalations of quartzites. Few chert horizons and lenses of dolerite are intercalated in the shales. According to the Geological map 1:50.000 (I.G.M.R., 1978) the phyllite belongs to the Svoula group of Melissochori-Cholomon Unit, with Trassic-Middle Jurassic age and the shales belong to Aspri Vrissi-Chortiatis Unit, probably Lower-Middle Jurassic in age.

The VLF transmission stations used in this investigation were FUO (15,1 kHz, Bordeaux, France) and JXZ (16,4 kHz, Helgeland, Norway). The VLF-Survey lines P1 and P2 have been performed using the FUO station in N20E direction, while the P3, P4, P5 and P6 using the JXZ station in N80E direction. The horizontal distance between the measured points in all survey lines was 20 meters.

RESULTS AND INTERPRETATION

The VLF anomalies of all Survey lines are presented in fig. 2. The present anomalies define two VLF-zones, VLF-zone 1 and 2 (fig. 1). The VLF-zone 1 has

a direction of N12W and is almost vertical to the strike of s-planes of the bedrock. The VLF-zone 2 is located on the boundary of the two rocks (upthrust).

The strength of an anomaly is expressed by the amplitude of the secondary field as a percentage of the amplitude of the primary field. The R-double amplitude for the anomalies defining VLF-zone 1 are varying from 15 to 40% while for VLF-zone 2 from 10 to 21%. The amplitude of an anomaly is dependent, among other factors, on the difference between the electrical conductivity of the conductor and the surrounding bedrock. It is important to note that different types of rocks have different electrical conductivity values and that the water flow can vary in the different sections of the same fracture zone (Mullern and Eriksson, 1982).

The arithmetic signs of R and Im components are opposite across a good conductor and the same across a poor conductor. This relation between R and Im is better in the anomalies defining the VLF-zone 1 than in those defining the VLF-zone 2 (fig. 2). From some of the anomalies defining the VLF-zone 1 it is possible to estimate approximately the depth to the top of the conductor as well as the dipping of the conductor (Olsson, 1980). The VLF-zone 1 (water bearing fracture zone) probably has a dipping to the east and the top of the conductor maybe around 20 meters below ground level.

The strongest anomaly P5 was chosen for drilling. The R-double amplitude of this anomaly is 40%. The following drillhole (fig. 1) to a depth of 98 meters, yielded 23 m³/h.

The VLF is a very useful geophysical method for locating water bearing fracture zones in the bedrock. However, it is important to combine the VLF measurements with geological and hydrogeological surveys in order to obtain better interpretations of the VLF data. The results of this investigation clearly demonstrate the necessity of combining VLF geophysics and geology.

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FIGURE CAPTIONS

Fig. 1: The geology and VLF survey lines of the investigated area.

Fig. 2: VLF anomalies of the investigated area. P1 and P2 using FU0 transmission station, P3-P6 using JXZ transmission station.

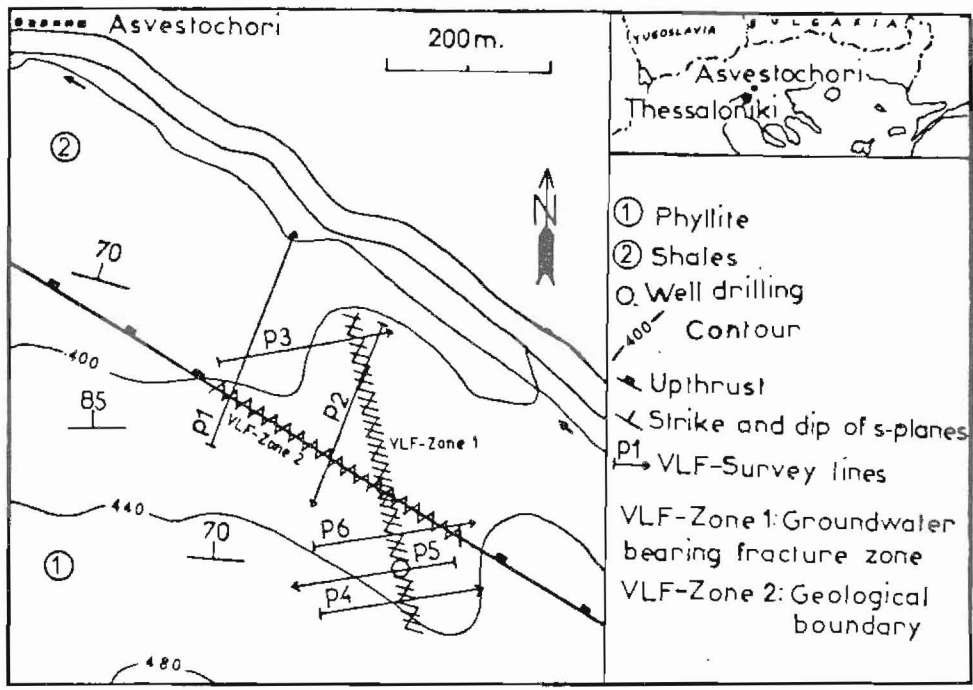


Fig. 1

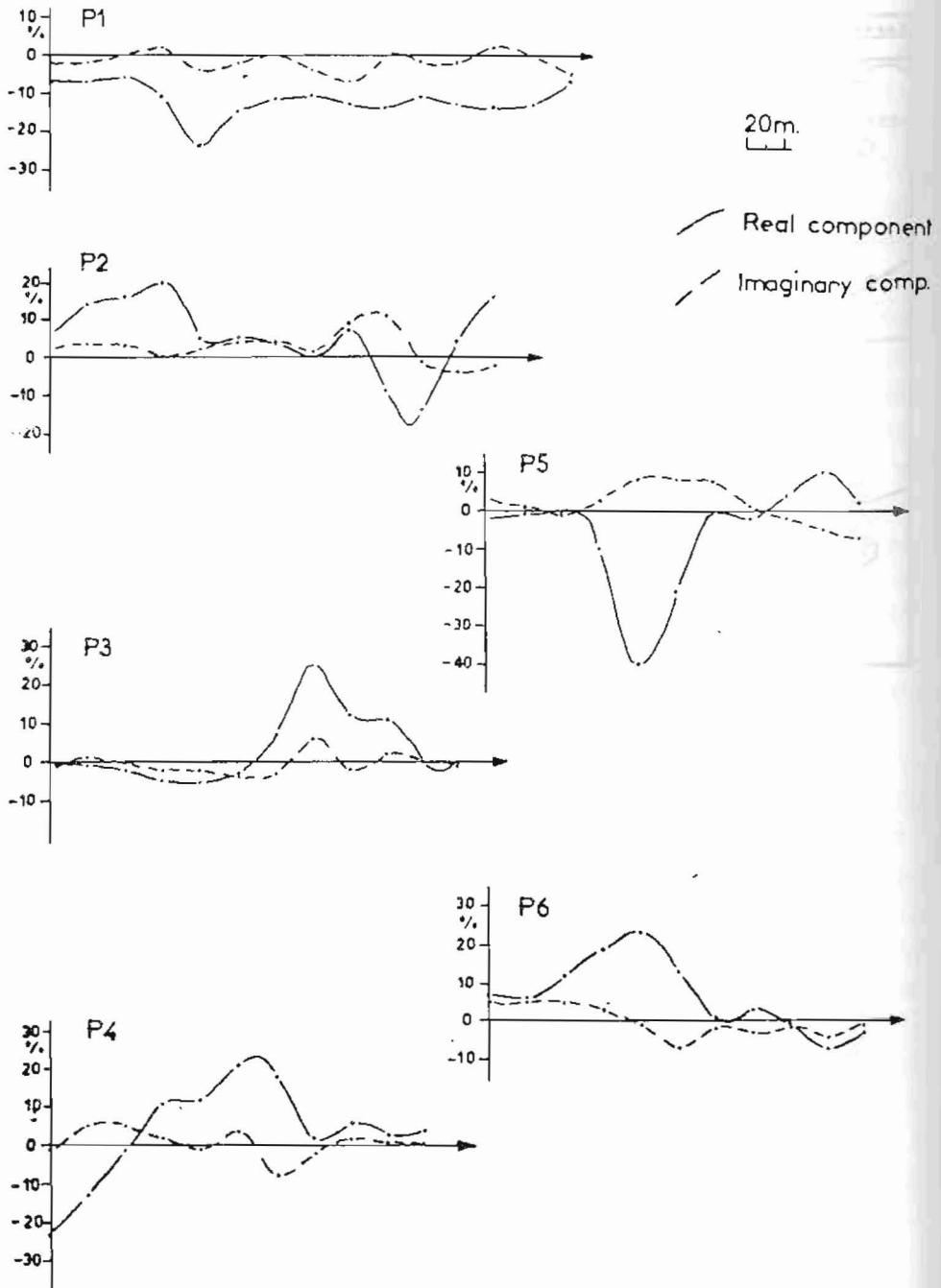


Fig. 2

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