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SOME REMARKS ABOUT THE THERMAL SPRINGS OF POLYCHNITOS - LESBOS AREA, BASED ON GEOPHYSICAL INVESTIGATION

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ΠΕΡΙΛΗΨΗ

Η εμφάνιση στην περιοχή Πολυχνίτου Λέσβου θερμών πηγών μεγάλης παροχής, που αναβλύζουν από ηφαιστειακά πετρώματα, ήταν αρκετά στοιχεία να διερευνηθεί η περιοχή γεωφυσικώς για γεωθερμική ενέργεια.

Η γεωηλεκτρική διασκόπηση της περιοχής, με την διάταξη Schlumberger, έδειξε ότι τα ηφαιστειακά πετρώματα της περιοχής αυτής παρουσιάζουν μειωμένη ηλεκτρική αντίσταση. Τούτο οφείλεται στην εξαλλοίωση και εμποτισμό των πετρωμάτων αυτών με μεταλλικά νερά, από μεταηφαιστειακή δράση, που κατέστησε τα πετρώματα αυτά περισσότερο αγώγιμα.

Από την γεωηλεκτρική έρευνα διακρίνονται τρεις διαφορετικής αγωγιμότητος ορίζοντες:

1. Οφιόλιθοι με ειδική αντίσταση ρ = 250-600 Ωm.
2. Εξαλλοιωμένοι Οφιόλιθοι και ηφαιστειακά πετρώματα με ρ = 1,5-70 Ωm.
3. Αλλουβιακές αποθέσεις και νεογενή από αργίλους, μάργες κ.ά. με ρ = 6-7,5 Ωm.

Με βάση τα γεωφυσικά στοιχεία, η ζώνη των χαμηλής αντιστάσεως, ρ 10 Ωm, ηφαιστειακών πετρωμάτων, μήκους περίπου 5 km, εκτείνεται ΒΒΔ-ΝΝΑ και φθάνει σε βάθος τουλάχιστον 150 m κάτω από τη στάθμη της θάλασσας. Αυτό δεικνύει την ύπαρξη μιας μεταπτώσεως της αυτής διευθύνσεως, στην οποία πρέπει να αποδοθεί ο σχηματισμός των θερμών πηγών Πολυχνίτου.

Η ζώνη των χαμηλής αντιστάσεως πετρωμάτων σε βάθος 150 m κάτω από τη στάθμη της θάλασσας χωρίζεται σε δύο τμήματα, δια της παρεμβολής μιας άλλης ζώνης μεγαλυτέρας αντιστάσεως ρ 15 Ωm. Αυτό πρέπει να αποδοθεί σε μία μορφολογική επιμήκη εξόγκωση εξαλλοιωμένων οφιολίθων, που πριν την απόθεση των ηφαιστιτών είχαν υποστεί διάβρωση. Έτσι το ελάχιστο πάχος των ηφαιστειακών πετρωμάτων, που εξαλλοιώθησαν από την υδροθερμική δράση, υπολογίζεται, με βάση τα γεωφυσικά δεδομένα, ότι υπερβαίνει τα 150 m.

Επίσης, όλη η περιοχή δυτικώς του χωρίου Πολυχνίτου αποτελείται από αργιλικές προσχώσεις και τόφφους χαμηλής αντιστάσεως, ρ 15 Ωm, το οποίον δεικνύει ότι η περιοχή αυτή ευρίσκεται, επίσης, υπό την επίδραση γεωθερμικού πεδίου.

The thermal waters of Polychnitos - Lesbos area were studied from the geochemical point of view first by De Launay (9) but the first systematic study of these, as also of the other springs of the Lesbos - island, was made by Pertesis (11). He has classified the thermal waters of Polychnitos in the sodium chloride group.

ΠΑΠΑΓΙΑΝΝΟΠΟΥΛΟΥ - ΟΙΚΟΝΟΜΟΥ Α. — Παρατηρήσεις για τις θερμές πηγές Πολυχνίτου Λέσβου με βάση την γεωφυσική έρευνα.

Κατατέθηκε 9.4.84, ανακοινώθηκε 12.5.84.

These waters show a high Li - content, about 6 p.p.m. and a radioactivity 6 Mache unities.

According to this author, two of the five Polychnitos springs show a high discharge of about 700 $m^3/24_h$ and temperatures 76.1⁰ C and 81.4⁰ C, respectively. However, there is another spring with higher temperature, 87.6⁰, but with a lower discharge, only 8.5 $m^3/24_h$. The last spring may be considered as the higher spring of the Continental Europe.

From the geochemical point of view it is of interest to be noted that neither the chemical composition of these springs nor their temperature has been changed in a space of 40 years.

This may be easily explained if we suppose that a considerable quantity of these waters derive from the sea. On the other hand, the constant temperature of these springs in the same space of time, indicates that the geothermal potential in this area must be very high so that it can maintain the spring - temperature in high degrees against the large contribution of sea water in their composition. The fact that the mineral waters of Polychnitos spring from volcanic rocks is an indication that the geothermal potential of this district is associated with the postvolcanic activity of this area.

Of high interest is the statement that the mineral waters of Polychnitos do not contain H_2S. It is supposed (14) that these waters derive from a great depth, where the dominating temperatures are higher than this, which characterizes the H_2S — bearing phase of volcanic fumeroles. Thus, the mineral waters of the high thermal springs of Polychnitos derive from deeper layers than the waters of the other thermal springs of Greece. The contribution of sea water in the composition of these springs is such as they can be characterized as sodium chloride and never as saline springs.

The presence of the high thermal springs at Polychnitos in association with the occurrence of abundant young volcanic rocks in S. Lesbos indicates that this area may be characterized as very interesting from the geothermal point of view. K. Zachos has early (1963) noticed that favourable conditions for geothermal exploration exist in the island of Lesbos. Prager (12) who has studied the Lesbos island from the volcanological point of view, has also noticed the presence of a high geothermal degree in the Polychnitos area. The same author completing the geological work of De Launay and Georgalas has distinguished three phases of volcanic activity in Lesbos. The first with ignimbrites, the second with latites and the third with basalts. Detailed geological studies made later by Hecht, Pe-Piper etc., have point out that the volcanic activity in Lesbos was continuous from Lower Miocene to Pliocene. The main volcanic sequence consists of basalts, andesites and dacites. Acid pyroclastics are found in the flang regions.

For the geothermal exploration of the Polychnitos area was used the resistivity method. This method is been used currently in order to determine geological structure, but also to locate deep geothermal aquifers (13).

The first geoelectrical survey in the Polychnitos area, consisting of 58 Schlumberger soundings, was aimed mainly at defining the thickness of the volcanic rocks situated above ophiolites (3 and 4). On the basis of this survey results it was possible to distinguish three different resistivity layers in this area.

1) Ophiolites at 250 to 600 Ohm. m.

2) Altered ophiolites and volcanic rocks at 1.5 to 70 Ohm. m.

3) Alluvial and Neogene clays and marles at 6 to 7,5 Ohm. m.

The low resistivity values of the altered ophiolites and volcanic rocks may be attributed to the infiltration of mineral waters which show a resistivity ρ 1 Ohm. m, whereas fresh waters show ρ = 17 Ohm. m.

Besides the volcanic rocks of Polychnitos consist (2) of cracked kaolinized pyroclastics, an evidence of the action of the postvolcanic hydrothermal activity.

As volcanic rocks and altered ophiolites have a similar conductivity, it was not possible to obtain reliable informations for the thickness of the volcanics. However, it was possible to define the depth of the non altered ophiolites, i.e., the contact of these rocks with a conductive layer consisting of altered ophiolites and probably of volcanic rocks. By increasing electrode spacing it was obtained to define that volcanic rocks together with altered ophiolites are over than 300 m in thickness.

The zone with the lowest resistivity, less than ρ = 10 Ohm.m due to the infiltration of hot saline waters, is trending to NNW-SSE. This led us to suppose that the genesis of the thermal springs of Polychnitos may be related to a fault striking NNW-SSE, along which the infiltration of the saline waters was favoured.

As fig 1,2 and 3 show the extent of the low resistivity zone changes with the depth. Also the thickness of this zone varies from the one to the other site, due to the uneven surface of the underlaying ophiolitic rocks, which have been eroded before the deposition of the volcanic rocks. It is of interest to notice that the low resistivity zone maintains uninterrupted in all the studied area up to a depth of 100 m below sea level (see fig 1 and fig 2). Deeper, as fig 3 shows, the low resistivity zone is separated in two parts by intercalation of a zone with higher resistivity, ρ 15 Ohm.m.

The fact, that the contact of both these parts of the low resistivity zone with the intercalated high resistivity zone is irregular, in association with the statement that the resistivity values increase more rapidly towards these contacts led us to suppose that the question here may be a morphological ridge of the ophiolites, due to the erosion of the surrounding parts before the depositition of the volcanic rocks. This view is justified by the recent geological study (7), which proved that the Polychnitos volcanic rocks lay above a Miocene conglomerate containing ophiolitic pebbles, an evidence of a former erosion of the ophiolites in this area. Thereafter, the minimum thickness of the rocks, which are altered by the hydrothermal activity in the Polychnitos area can be estimated at more than 100 m.

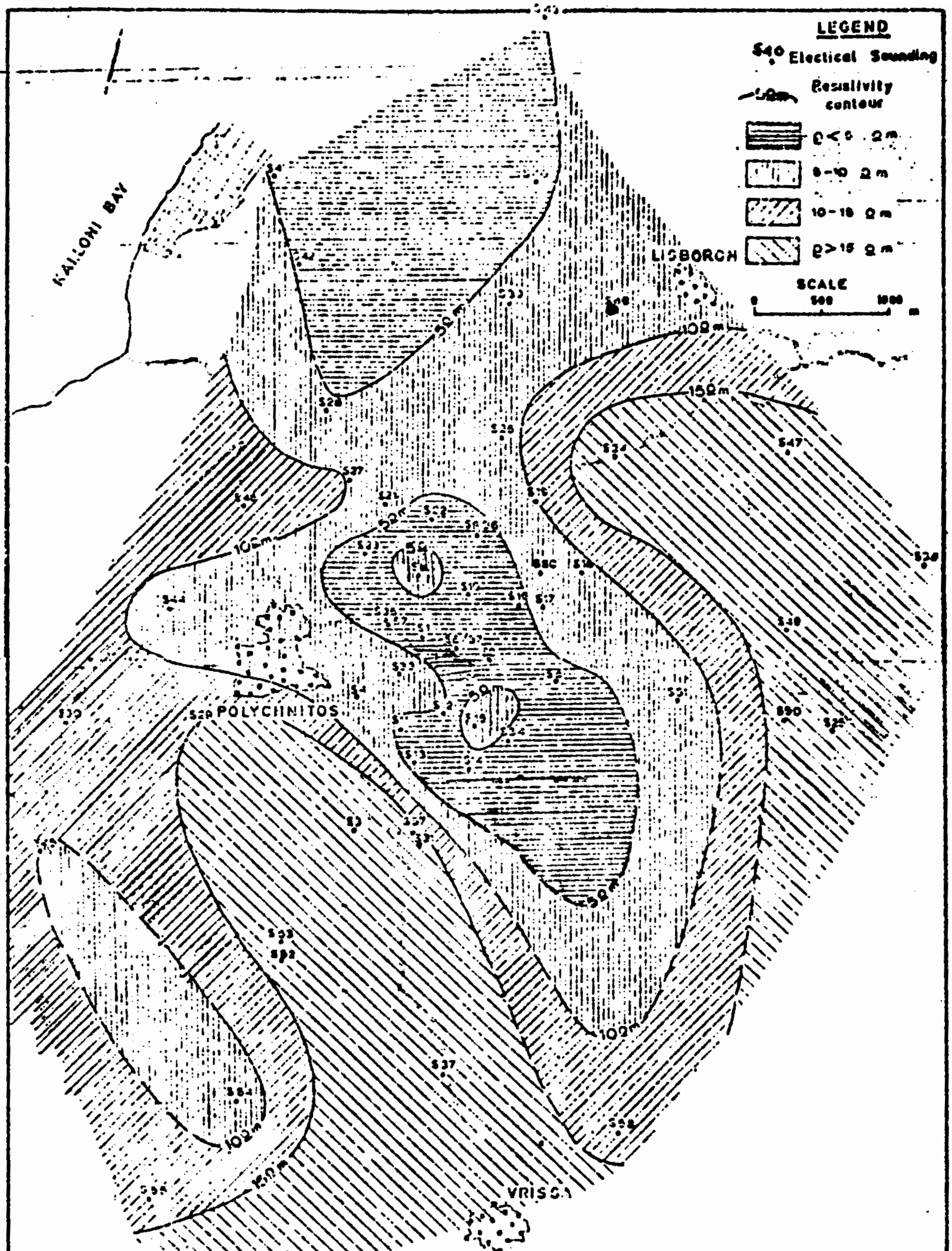

Fig. 1. Horizontal distribution of resistivity at the sea level.

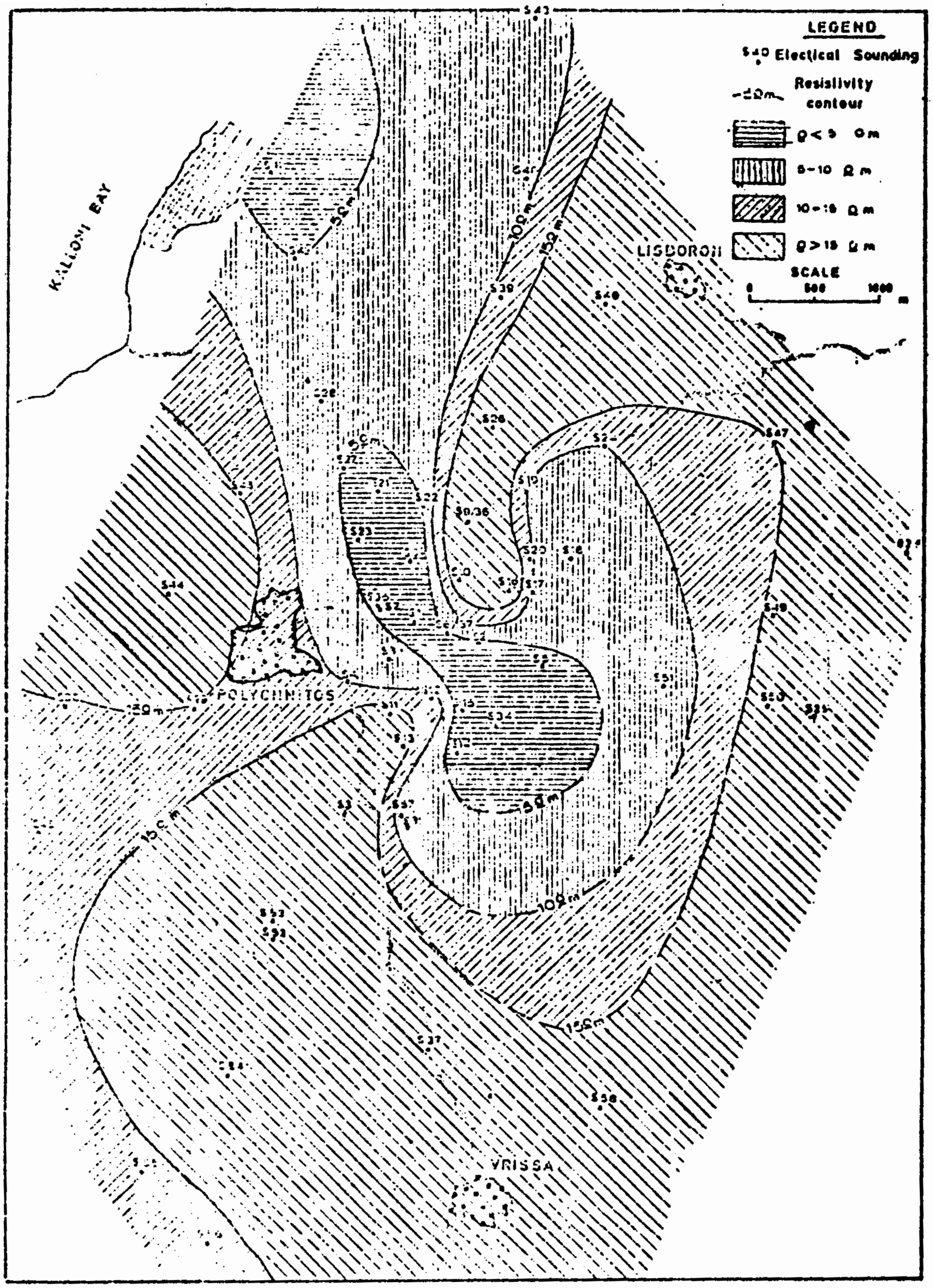

Fig. 2. Horizontal distribution of resistivity 100 m below sea level.

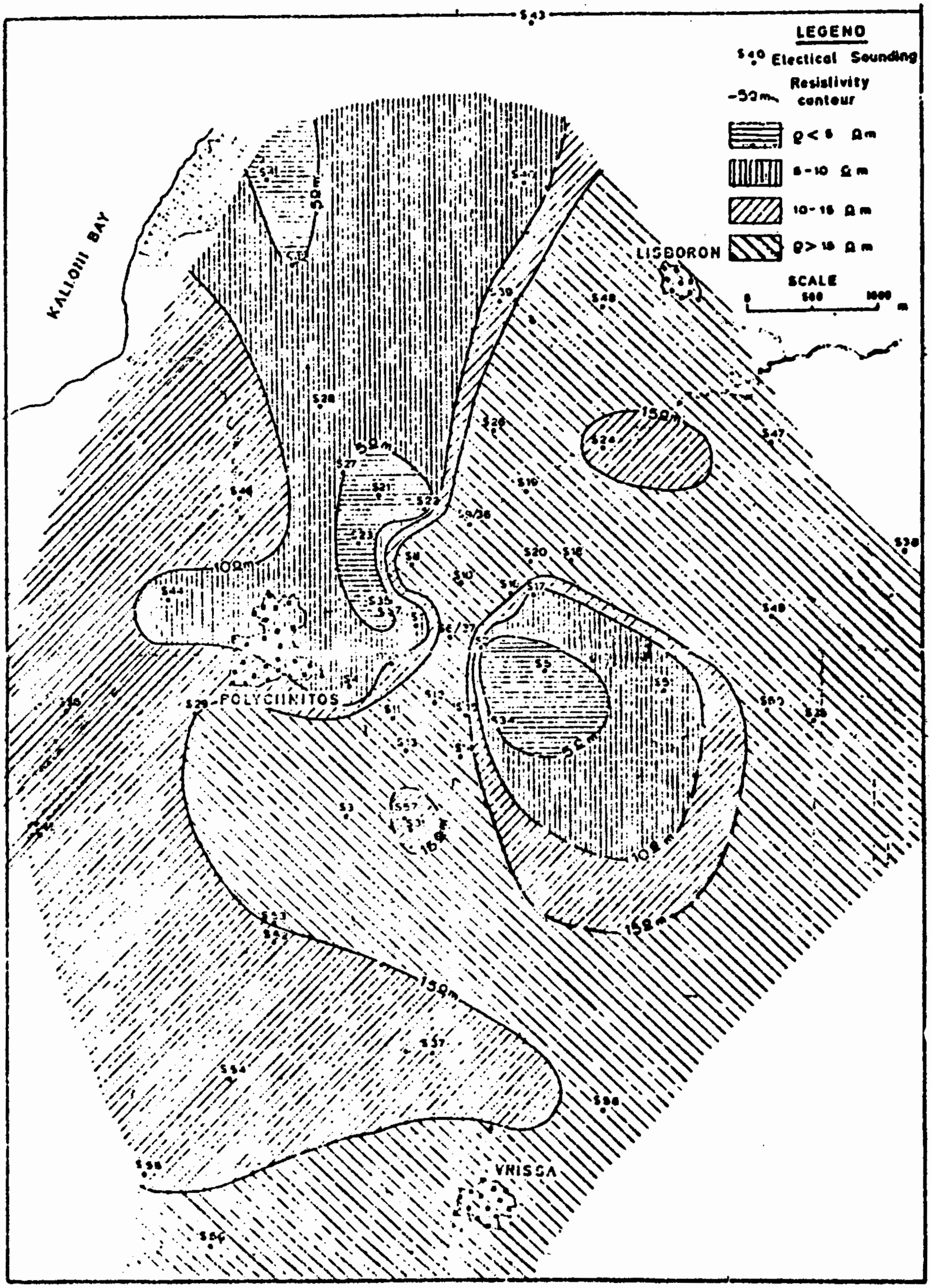

Fig. 3. Horizontal distribution of resistivity 150 m below sea level.

REFERENCES

1. CAMELI G. M., MOUTON J. and TORO B. 1976. — Contribution of geophysical surveying in the discovery of Cesano geothermal field. (Northern Latium - Centrale Italy) Inter. Cong. of Thermal Waters, Geothermal Energy and Vulcanism of the Mediterranean Area, Athens, October 1976. Proceedings V. 1, 130-144.
2. CHORIANOPOULOU P. 1982. — Report about the petrological and mineralogical study of altered rocks of the Lesbos island. Inst. Geol, Min. Res. Athens (In Greek).
3. ECONOMOU P. 1971. — Geoelectrical surveys in Polychnitos - Lesbos - Area 1st paper I.G.S.R - Report (In Greek).
4. ECONOMOU P. 1972. — Geoelectrical surveys in Polychnitos - Lesbos - Area 2nd paper I.G.S.R - Report (In Greek).
5. GEORGALAS G. 1949. — Contribution à la connaissance des roches éruptives de l'île de Mételin, Bull. Volc. II, v. IX, 31-63.
6. HECHT J. 1971. — Geological map of Greece, Polychnitos sheet I.G.M.R.
7. KATSIKATSOS G., MATARAGAS D., MIGIROS G. and TRIANTAPHYLLIS E. 1982. — Geological study of Lesbos Island I.G.M.R.
8. KELEPERTSIS A. 1978. — Geochemistry of high K-andesites from Polichnitos Area (Lesbos island, Greece) Prakt Acad. Athens 52, 497-511.
9. DE LAUNAY L. 1898. — La géologie des îles Mételin (Lesbos), Lemnos et Thasos. Ann. des Mines, Paris.
10. PE-PIPPER G. 1979. — The Cenozoic volcanic rocks of the island of Lesbos (Greece) Diss. Univ. Patras (In Greek).
11. PERTESIS M. 1932. — Les eaux minérales de l'île de Lesbos Publ. du Service géol de Gréce No 20, Athens (In Greek).
12. PRAGER M. 1966. — Présentation d' une esquisse géologique des terrains volcaniques de l'île de Lesbos - Grèce (note préliminaire) Ann. Géol. Pays Hell v. XVI, 512-527.
13. TEN DAM A. and KOROTCHANSKY A. N. 1976. — Geothermal exploration methods Int. Congr. Thermal Waters etc. Athens V. 1, 482-494.
14. VOREADIS G. 1957. — The minerals waters of Greece from the geological point of view (In Greek).
15. ZACHOS K. 1963. — The geothermal energy and possibility of its evaluation In Greece. Technika Chronika, General Edition, v. 242. 82-91 (In Greek).