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Possible Sources of Geothermal Energy in the Territory of the Republic of Macedonia

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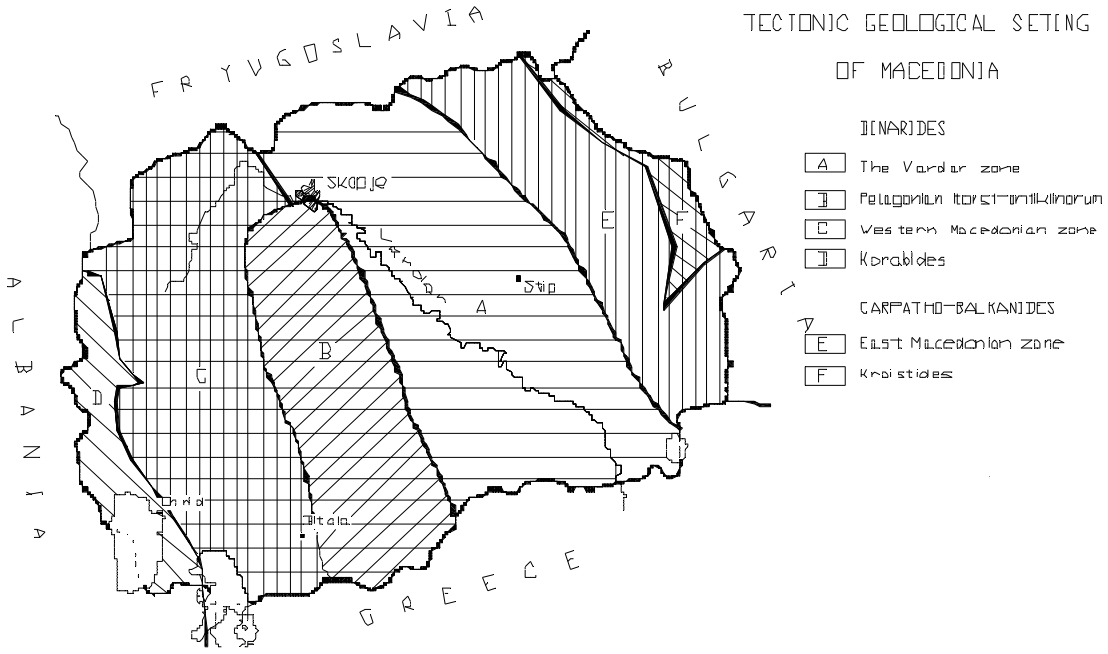

Fig.1. Regional tectonic setting of the territory of the Republic of Macedonia

ABSTRACT

The analyses carried out in order to determine the geothermal potential in the territory of the Republic of Macedonia indicate possible sources of geothermal energy in bodies emanating from young volcanism and areas of greater flux of geothermal energy due to elevated Moho discontinuity as well as environments connected with geothermal conductivity. In that regard, the regional analysis carried out distinguished the area of the Vardar zone and the Serbo-macedonian massif as promising zones of geothermal potential. From that aspect, the area needs detailed investigations in terms of its geophysics, particularly geochemisty in order to better define the geothermal models for the terrain under consideration.

1. INTRODUCTION

According to the regional tectonic setting the territory of the Republic of Macedonia belongs to the Dinaride and the Rodope systems. The Rodope system

includes the Serbo-Macedonian zone (Fig. 1 E), the Krais-htide zone (F), the Pelagonian massif (B) the Western Macedonian zone (C) and the Kora-bides (D). The zones established comprise separate structural-facial units with individual geological evolution (Fig. 1).

Analysis of data available such as the map of Bouguer anomaly, topographic map, cross-sections of deep seismicity as well as data for the speed of neotectonic movements made possible to make the correlation models such as:

M = f(R) where

M is the depth of Moho discontinuity,

R is the relief height

M = F(Dg) where

Dg is Bouguer anomaly

M = f(V)

V is the speed of neotectonic movements. These models and data obtained by deep microsound probes helped to compile he map of Mohorovicic discontinuity (Fig. 2).

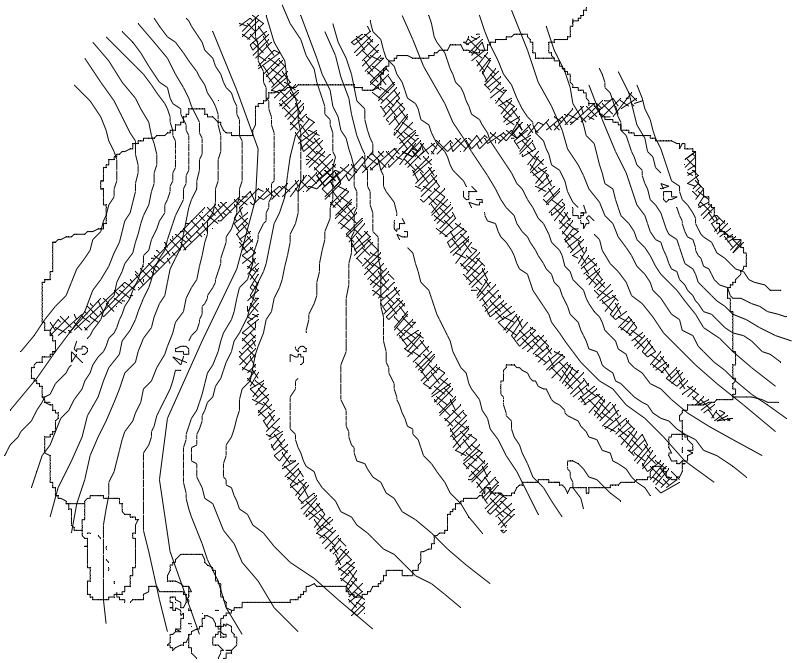

Fig.2. Map of Mohorovicic discontinuity (boundary M) in the Republic of Macedonia

2. BASIC ELEMENTS FOR THE THERMAL FIELD OF MACEDONIA

The presence of a large number of thermal springs in the territory of Macedonia indicates that the area is well endowed with geothermal energy. So far, several sites have been investigated. Sites in the vicinity of Strumica, Kocani, Gevgelija as well as some of minor importance indicated the presence of geother-mal springs of economic interest some of which are in the process of exploitation. Indivi-dual regions were studied in detail because of their economic importance. However, very little has been done in terms of establishing a model for the thermal flux in Macedonia.

The regional geothermal characteristics of the territory of Macedonia were established by latest geophysical investigations and are fairly consistent with those postulated. The map for the density of thermal flux (containing some approximations), shows data for the temperature and density of thermal flux corrected for temperature equilibrium. Nevertheless, thermographic correction has not been given.

It has been determined that underground temperature increases from the west (the border with Albania) to the east reaching its maximum in the Vardar zone and the Serbo-Macedonian zone, gradually decreasing towards the area of the Macedonian – Bulgarian border (Fig. 3). The typical geothermal regions shown in the figure indicate that temperature of about 20oC prevails at depth of H=1000 (m) in the Dinarides, and temperature of about 70o C prevails at the same depth in the Serbo-Macedonian massif. Data do

not refer to local anomalies which close their maximum values at small regions. The boundaries of regions with equal density of total flux are approximate. It can be inferred that the zones of maximum values of density for the thermal flux in the Serbo-Macedonian and the Vardar zones are identical in earth's crust of smaller thickness, whereas lower values for thermal flux are obtained in area of increased thickness of earth's crust (Korabides).

From the above, it can be inferred that the major, but not the only, cause for the anomalous geothermal field is the spreading of the astenosphere implying that the anomalous temperature field is reciprocal to the thickness of the earth's crust.

At the same time, however, these areas represent unstable zones affected by frequent distortions and formation of deep dislocations cross-cutting the earth's crust. Geomagnetic investigations indicated that penetration of magmas either to the earth's surface or close to it took place along these deep faults. In this manner, these several hundred kilometers long deep faults most probably served as pathways for convective heat.

This manner of heating the geological formations is also supported by the fact that the largest natural sources in the territory of the Republic of Macedonia are located in regions of Tertiary magmatic activity. The increased temperature of granites in the Serbo-Macedonian massif and the Vardar zone can be related with the decomposition of radio-active elements in granitic plutons.

Table 1.Temperature zones in the territory of Macedonia

Zone	Tectonic unit	low temperaturtes:
	Korabides	< 50 mW/m2
Western Macedonia		medium temperatures:
Western-Masedonian zone		50-80 mW/m2
	Korabides	High temperatures
Vardar zone		> 80 mW/m2
Serbo-Macedonian zone	Eastern Macedonia	

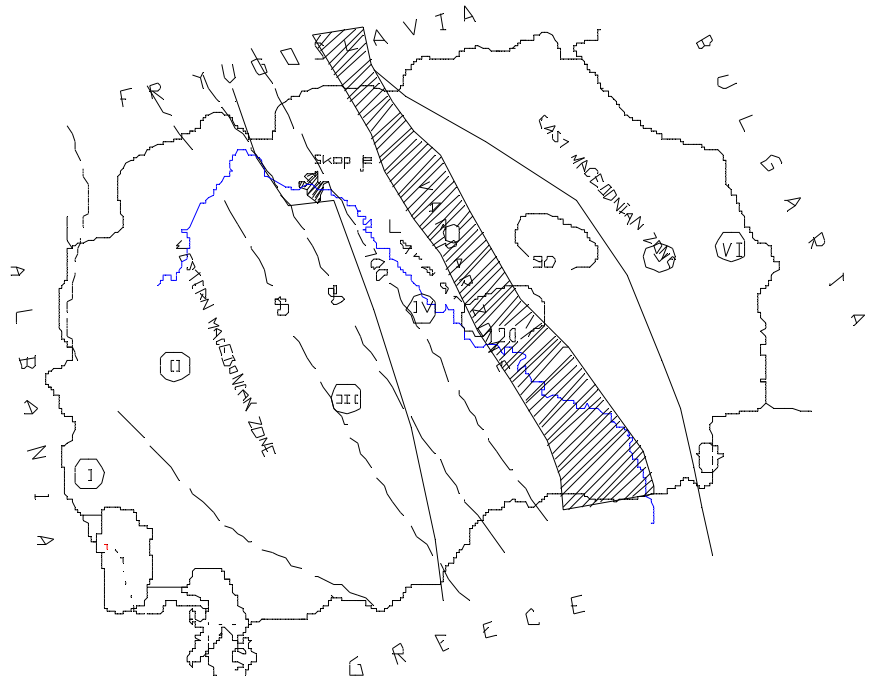

Fig.3. Map of the thermal flux for the territory of the Republic of Macedonia [mW/m2]

3. CONCLUSION

The territory of Eastern Macedonia and the Vardar zone are possible sources of geothermal springs because of the elevated Moho-discontinuity, increased geothermal flux as well as the young volcanism which is strongly pronounced in

both zones.

The Western-Macedonian zone and the Pelagon are less promising geothermal sources.

Future geothermal investigations should be conducted in the area of the Vardar zone, particularly the area of Eastern Macedonia.

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