SOME RESULTS OF MAGNETOVARIATIONAL OBSERVATIONS IN THE EAST BULGARIA

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Abstract. The study of the floor structure, particularly in active zones, is primary importance for geodynamics and geochronology. The results of the magnetovariational observations in different parts of the Bulgarian continental offshore and land-based magnetovariational observations in Bulgaria are discussed in this report. The geomagnetic variations in the water were measured by the bottom three-component (H, D, Z) flux-gate magnetometers. As a result electrical conductivity functions in the period range of 10 min to 3-4 h were calculated. Analysis shows very small values of the magnetic field vertical component on the south part of Bulgarian territory and adjacent continental shelf. Magnetic variations at the north Bulgarian shelf differ very strong from these at south. Non-uniform thin-sheet model was applied to invert this data. Both the electromagnetic (EM) measurement data themselves and their joint analysis with the data of other geophysical methods determine the crust conducting zone existence both under south part of the Bulgarian offshore of the Black Sea and under the east part of Rhodope massif. The crust conductivity layer is about 3 km thick, with a resistance of 3 Ωm and conductance approximately of 1000 S. To some Bulgarian hydrogeologists thinking autochthonous in this shear is the thick layer of karst marbles what they describe as a large deep bedding artesian basin with hydrothermal karst and ascending underground flow. Waterproof layer is the plate building by the Rhodope granitoides series. Taking into account results of the EM investigations and the data of other geophysical methods it is possible to speak about an opportunity of existence of conducting astenosphere layer under East Rhodopean and south part of the Bulgarian offshore which begins from 50 km depth. A possible explanation for this phenomenon is that the upper mantle beneath the Aegean region is heated by hot asthenospheric material that penetrates the lithosphere through convection. These results conform to the high values of the heat flow observed here and are in concordance with modern view on the deep structure of the neighbouring regions.

Key words: el.magnetic soundings,conductivity anomalies,coast effect,3-D modeling.

Introduction

Marine electromagnetic methods, in particular geomagnetic depth sounding (GDS), lend to mapping the electrical conductivity structure of the seafloor, particularly in active zones. Physical properties such as porosity, partial melt content and temperature can be concluded from electrical conductivity estimates, and geological structure inferred in turn from contrasts in physical properties, including conductivity itself.

Now electrical methods gained status as a technique for studying tectonics by becoming part of multi-disciplinary programs. In this respect, conducting layers location and temperature - depth distribution are the problem areas of high interest, as they could increase our understanding of the internal processes responsible for the characteristic features of these regions. At construction of complex geophysical models it is important to consider geoelectric data.

This paper presents the results of complex marine и land-based electromagnetic measurements on the Bulgarian continental offshore and in the East part of Bulgaria.
The objective of the study was to get information concerning a sedimentary cover and the deep structure to use it as basic knowledge for further geotectonic and seismological investigations.

Less attention was given to the geoelectrical structure of the upper mantle though traditional marine EM instrumentation makes measurements at long periods (greater than 100-1000 s) and is sensitive to the conductive parts of Earth's mantle. At the same time the considerable changes in the geothermal conditions of the Aegean region suggested the possible existence of a substantial conductivity anomaly in the upper mantle.

The “coast effect” associated with the strong change of the depth of the sea could be expected to play a major role in the behavior of the electromagnetic fields nearby Black Sea continental slope. However it was observed not in all parts of a shelf.

The present work purpose is application of data received during geoelectrical observations for confirmation or denial of above-mentioned hypotheses, namely:

i. Whether there is a buried layer of unconsolidated rocks under the Rhodope zone?

ii. Whether the EM data will be coordinated with a zone of the increased temperatures in the top parts of a mantle, which is found out by other geophysical methods under the Balkan-Aegean territory?

Statement of theory and definitions

The magnetotelluric (MT) method, which employs electric and magnetic components, is traditionally used as main tool of the deep geoelectric. The fact is that as rule magnetotelluric sounding (MTS) curves are substantially distorted by horizontal geoelectric inhomogeneities of shallow and deep nature.

Geomagnetic deep sounding (GDS) and magnetovariational profiling (MVP) methods are based on the magnetic components only. They are useful for detecting lateral conductivity variations and are widely use techniques. The natural way to eliminate non - uniqueness of the MTS data interpretation consists in the combined application of MTS and GDS techniques and, eventually, the development of a general deep EM sounding technique based on simultaneous field recording over a wide frequency band. Magnetovariational profiling gives qualitative information on the strikes of the structures and allows doing deep sounding with the use of the "coast effect". "Coast effect" is frequency - dependent horizontal electric- and vertical magnetic field coastal anomalies. The horizontal electric- and vertical magnetic field components show almost equally large changes near coastlines, and nearby continental slope.

The magneto variation data were analysed using the Transfer Function method (Schmucker, 1970; Gough and Ingham, 1983). This procedure leads to the simple equation, which, for each station and period T, linearly relates the Fourier transforms of the horizontal magnetic variations X, Y, to the vertical one (Z) using two complex transfer functions A and B:

$$Z(T) = AX(T) + BY(T)$$

Lateral differences in transfer function values characterise different geoelectrical properties, while the frequency dependence gives some information on vertical distribution of possible conductive bodies under sea bottom. The transfer functions can be reproduced graphically with two arrows, which represent their real (in-phase) **Cu** and imaginary (quadrature) **Cv** parts.

We fit these data to the class of 1-D, 2-D and 3-D geoelectrical structure. The 3-D interpretation based on non-uniform thin-sheet modelling (Zinger and Fainberg, 1985) was applied for the data interpretation.

Geological and geophysical setting

The following main tectonic units are present in Bulgaria (from north southwards) (Bonchev, 1971), (Fig. 1): (1) The Misa plate is the western part of the Paleozoic platform of southeastern Europe with the epibaikalian basement.

(2) The Alpine orogenic area is the northern portion of the Balkan-Asia Minor orogen. The orogen includes a tectonic zone of the Middle Mountains with widely developed volcanogenic -sedimentary formations and intrusive formations of the Upper Cretaceous folded zones of Stara Planina and Balkan Piedmonts.

(3) The Rhodope massif. The geological unit of the Rhodope massif is of a central position in the Alpine space of the Balkans and the tectonic conception concerning it has always strongly influenced the ideas for the geological and metallogenic development of this Alpine segment as a whole. These conceptions have evolved from strongly fixistic for a pre-Palaeozoic, stable, high - metamorphic internal massif (Kozhukharov, 1984) to mobilistic for a south vergent Alpine zone (Ivanov R., 1984; Ivanov Zh., 1984). Indirect data (thickness of the crust, the great gravimetric transition and diaphthoritic structures of rocks) and direct observations, based on a interpretation of petrographic and structural data obtained by the deep drilling operations in the Rhodope massif are involved to conclusion for the existence of a deep-seated Rhodope Nappe.

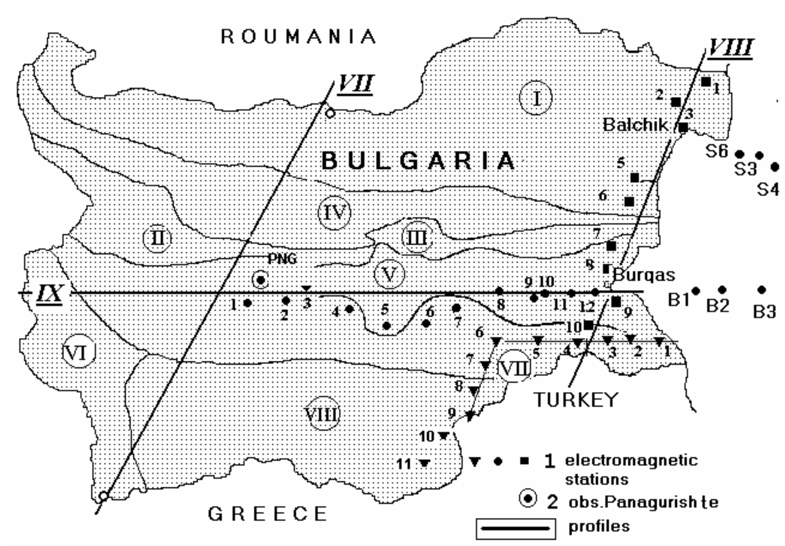

Fig.1 The area of electromagnetic investigations: (1) Marine stations, profiles and observation points in the Bulgarian territory.
Geotectonic provinces: I Misa platform; II West Balkan tectonic zone; III, East Balkan tectonic zone; IV, Balkan Piedmonts; V, Middle Mountains; VI, Kraishtide; VII, Strandzha, VIII, Rhodope massif.

The autochtone is of the Philippi Series (Ph) - low -metamorphic rocks and the allochtone is of the Rhodopean Series (R) - the high metamorphic rocks (Ivanov, 1981).

There are the following arguments for the presence of the Rhodope Nappe:

a) It is abnormally big thickness of the Earth's crust in the Rhodope zone (up to 50 km), which becomes more thin (up to 30 km) to the North in the area of the Misa plate (Dachev, 1988).

b) Determination under West Rhodope of a wave- guide zone in the upper part of the crust at the 5-10 km depths by seismic data. It can be connected to presence of the buried sedimentary rocks of high (4-5 km) thickness. The maximum thickness of the wave-guide is under the Pirin anticlinorium equal 8-9 km and the minimum depth of occurrence of its roof is 2-3 km. Thickness of the wave-guide reduces southwards and northwards from this part. (Dachev and Volvovsky, 1985).

The structure of the crust and upper mantle of zones adjacent to Rhodope massif has been studied by many geophysical methods. Deep seismic sounding was performed in the Aegean Sea (Macris, 1977, 1978). The deep structure of the Aegean region is characterised by low velocities in the upper mantle. The seismological data (Alsan et al., 1975; Spakman et al., 1988; 1993) confirm that the upper mantle beneath the Aegean region is hot, and its density and seismic velocities are lower than normal. It corresponds also with a combined analysis of gravity and seismic data.

The Aegean Sea, south Bulgaria and western Turkey have high heat flow values of more than 2.0 H.F.U (Macris, 1978, Velinov and Boyadjieva, 1981). A possible explanation for this phenomenon is that the upper mantle beneath the Aegean region is heated by hot asthenospheric material that penetrates the lithosphere through convection.

Jacobshagen and Macris (1974) have offered a geophysical model of the Aegean region, explaining the heat flow pattern, velocity field, and tectonic activity of the Hellenic arc. Their model involves a hot lithospheric thermal system that exists beneath the region and originates from an asthenospheric trough; i.e., they assume a large thermal dome (mantle diapir) under the Aegean Sea. This system can be made by relative movements of Europe and Africa and, possibly, by the subduction of oceanic crust beneath the European plate. Result of it is high seismic activity observable in the Aegean zone.

Isotherms 1170 ^{0} C and 1300 ^{0} C are raised up to 85 and 100 km depths respectively within the 120 km thick lithothermal zone below the Aegean Sea, see fig. 2 (Macris, 1978).

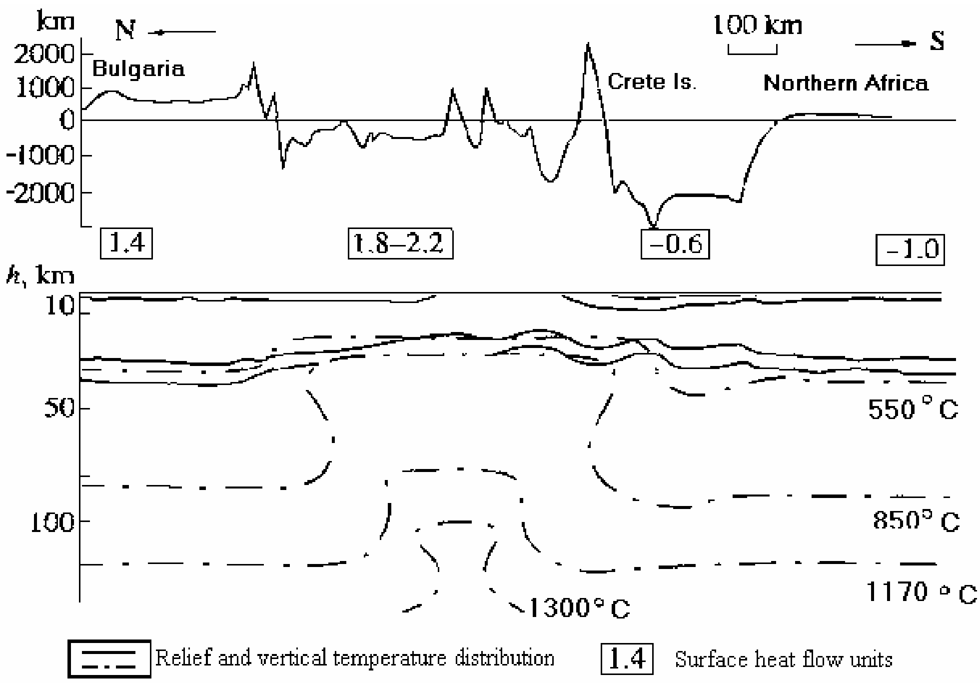

Fig. 2. Geophysical section across Bulgaria and northern Africa (Macris, J., 1978).

Area descriptions, methods and material studied

Magnetotelluric sounding (MTS), geomagnetic deep sounding (GDS) and magnetovariational profiling (MVP) measurements have been made at about 80 points in Bulgaria and at the adjacent Black Sea offshore. The history and results of these investigations on VII и VIII profiles are described partially in (Abramova et al., 1994, 1997).

The location of all profiles and the electromagnetic variations measurement points *on east part* of the territory of Bulgaria and in the Black Sea reported in Fig. 1; the overland stations names and titles are listed in Table 1.

Table1. Station names for profiles.Profiles and stations are numbered according to notations in Fig.1.

IX profile (circles on the fig.1)		VIII profile (squares on the fig.1)		"Connected" profile (inverse triangles on the fig.1)	
№	Station name and title	№	Station name and title	№	Station name and title
1.	Krestevich (KPT)	1.	Balchik (BCH)	1.	Izgrev (IZG)
2.	Gorna Makhala (GML)	2.	Spasov (SP)	2.	Wisitsa (WZC)
3.	Babek (BBK)	3.	Dropla (DP)	3.	Bliznak (BLZ)
4.	Saedinenie (SOE)	4.	Vyglen (VG)	4.	Fakiya (FKA)
5.	Strelets (STR)	5.	Zdravets (ZD)	5.	Bolyarovo (BLR)
6.	Kovachi (KVC)	6.	Golitsa (GOL)	6.	Granitovo (GRT)
7.	Mladovo (MLD)	7.	Debravino (DEB)	7.	Ustrem (UST)
8.	Khanovo (HNV)	8.	Galbets (GL)	8.	Studena (STD)
9.	Alexandrovo (ALD)	9.	Sadievo (SD)	9.	Chernodub (CDB)
10.	Dobrinovo (DBR)	10.	Belila (BL)	10.	Kamil. Dol (KMD)
11.	Orlintsi (ORL)	12.	Livada (LVD)	11.	Pelevun (PLV)
12.	Livada (LVD)				

Profile VIII crosses the main tectonic elements from the north southwards which form the territory of East part of Bulgaria, i.e. Misa plate, Balkan, and, in part, Strandzha. The length of the traverse is about 200 km; 11 electromagnetic stations had been placed on it.

The east part of the profile IX passes on latitude direction along a folded zone of the Middle Mountains up to coast of the Black Sea (Burgas port) и and further in the sea up to 300 m isobaths.

Measurements have been also carried out along a so-called “connected” profile. It adjoins to the profile VIII and crosses area Strandzha and East Rhodope. On this profile 9 points of deep GDS and MTS have been made.

We made sea bottom magnetovariational measurements at fifteen points on the offshore of Bulgaria. Time variations were observed at stations lying approximately along the profile off Kaliakra Cape to southeast up to 300 m isobaths.

The second sea profile continued the traverse IX at the line from Burgas port to east.

It has been made about 10 installations of bottom stations. The data received from them, are incorporated into 3 groups designated here as B1, B2 and B3 (depths of sea 50,100, and 300m accordingly). The sea bottom stations codes, depths and geographical co-ordinates are listed in Table 2.

During the land experiments synchronous measurements by a 5-component station IZMIRAN-5 were carried out. They measured the D (+east), H (+north) and Z (+downward) magnetic field and Ex (+north), Ey (+east) electrical field components. A scale value of magnetic components was 0.4-.8 nT, of electric field - 0.1 μV/m, a time resolution of 0.3 -1 min.

Table 2. Profiles, codes, depth and geographic coordinates of the sea stations

Profile	Code	Latitude	Longitude	Depth, m
Balchik-Black Sea	S2	43° 06´N	28° 46´E	200
Balchik-Black Sea	S4	43° 09´N	28° 43´E	300
Balchik-Black Sea	S5	43° 09´N	28° 45´E	100
Balchik-Black Sea	S6	43° 11´N	28° 29´E	200
Burgas-Black- Sea	B1	42° 26´N	28° 00´E	50
Burgas-Black- Sea	B2	42° 26´N	28° 17´E	100
Burgas-Black- Sea	B3	42° 26´N	28° 37´E	300

Variations in the magnetic field at the sea bottom were measured with three-component bottom flux-gate magnetometer. The flux-gate magnetometers measured the geomagnetic field time variations along three axial directions D (+east), H (+north) and Z (+downward). A scale value of flux-gate magnetometer was as rule about 0.5-1nT, a time resolution of 0.5-1 min and an automatically working period of 8 days. The set at the seabed contained a magnetometer with blocks of compensation, control, orientation, power and a recorder. The scheme of the sea magnetic complex is shown in Fig.3.

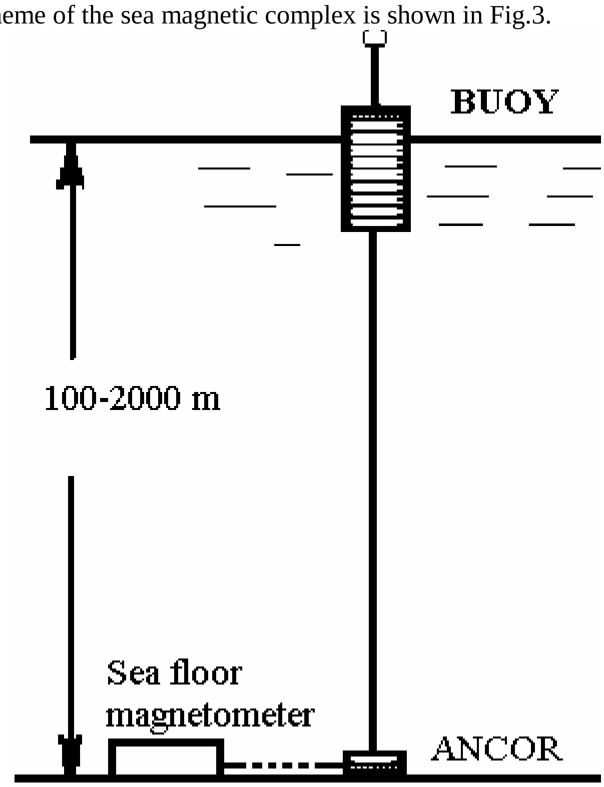

Fig. 3. The scheme of the measurement instruments complex at the bottom of the sea.

Here the result of the magnetic measurements only will be considered.

The analysis of experimental data

As a result of overland and sea observation data processing transfer functions for each point of observation were calculated.

Electromagnetic transfer functions values (components of magnetic tensors, complex induction vectors etc.) have been calculated in a range of the periods from 10 minutes to 3-4 hours (in some points to 24 hours). Magnetic tensors are determined also in ration to a base point in Panagyurishte observatory.

All this complex of parameters was used for the research of conductivity properties of the Earth's crust and mantle in territory of Bulgaria and adjoining water area of the Black Sea shelf.

The ccarried out earlier and modern analysis of experimental data has revealed the following features of electromagnetic field in territory of East Bulgaria:

1. Definition of a sediments effective conductance So on curves of apparent resistivity ρT gives value about 1000 S, including East Rhodope massif and Strandzha zone, folded on a surface by crystal slates and granitoides with very high values of specific resistance. These results are similar to the earlier results received in the Western Bulgaria (Abramova et al., 1997).

2. Presence of the maxima complicated with local minima, on longitudinal curves of apparent resistivity ρT, corresponding in 2-D case to E - polarization, unusually low values of apparent resistivity in Chernodub, Pelevun, Granitovo (ρT about tens and even ones Ώ m) allows to assume an opportunity of presence of well conducting layers in a crust and, probably, conducting asthenospheric layer, similarly placed in the Western Rhodope zone.

3. Amplitudes of vertical components of a magnetic field, and, hence, components of vectors of induction **Cu** and **Cv**, on land and in a southern part of the Bulgarian shelf practically everywhere are small: ratio of vertical components to horizontal Z / H have sizes about 0.1-0.2 and poorly depend on frequency. For these points of observation frequency curves of amplitudes of real and imaginary parts of induction vectors in Livada are typical (fig. 4). It is necessary to note, that it is not typical for behaviour of EM field variations in of Alpides type zones. For example, in the Carpathian significant changes of Z / H are observed (about 1 and more) along the profiles which cross of tectonic structures (Zhdanov et al., 1993).

4. At northeast coast and water area of Black Sea the classical "coast effect " presents. Distinct frequency curves for real and imaginary parts of induction vectors for north shelf part and point Balchik are shown in fig. 5. The maximal values in the point most removed in the sea reach sizes 1.3, approaching coast the size of vectors decreases.

The analysis of frequency curve of induction vectors real and imaginary parts in areas with similar geological-geophysical and bathymetric conditions (a short shelf, abrupt continental slope), shows, that here the character of EM field behaviour is in good consent with the theory. So the real part of induction vector in the most removed in the sea point S4 has two maxima: one is on the period 800-900 s, another - about one hour. The first is apparently caused by the contrast of resistance of the Black Sea water and sediments and borders of the land – sea division, the second, most likely, have the deep nature.

EM field orientation in points along the Black Sea coast in northern part of VIII profile is influenced with contrast of conductivity between the land and Black Sea basin.

5. Unlike a northeaster zone, in southeaster Bulgaria EM field orientation both on land and on a sea part of a profile IX, does not correspond to the superficial structural plan of the basic tectonic elements and means the probable discrepancy of the basic deep geoelectric borders and geological objects in the top floors of an earth's crust. While on profile Balchik - Black sea the classical "coastal effect" is observed, it practically is absent in sea and overland observation in a southern part of the Bulgarian shelf both on sea continuation of IX profile, and on a "connected" profile. It is shown on figs. 4 and 6.

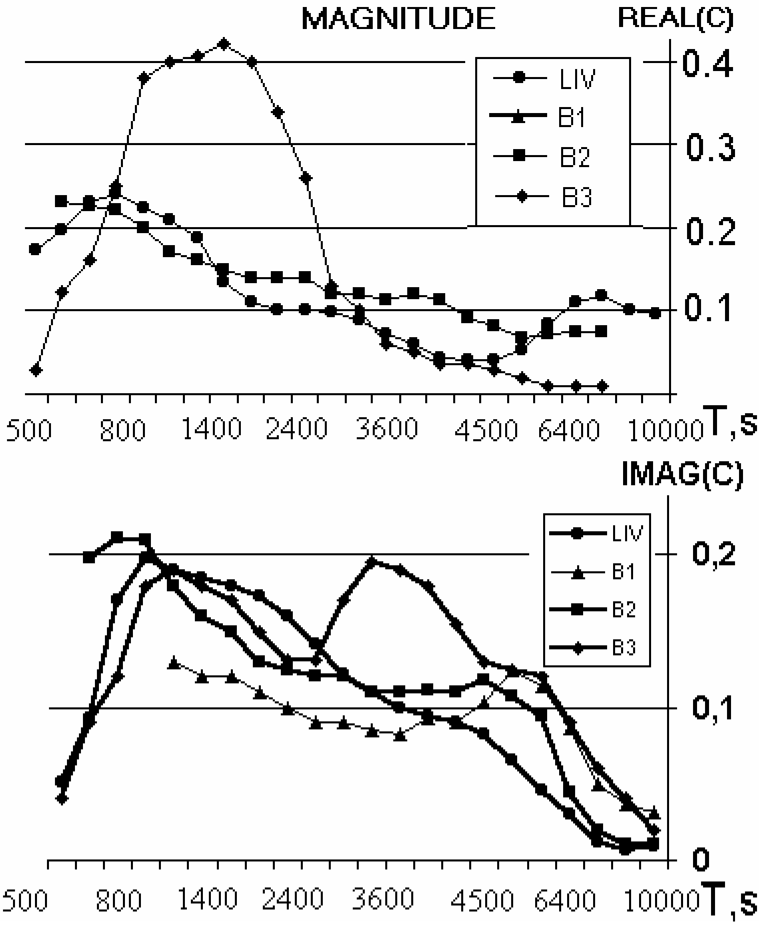

Fig. 4. Frequency characteristics of the real (Cu) and imaginary (Cv) parts of the induction vectors on the Livada (LVD) land-based station and sea bottom stations B1, B2, B3.

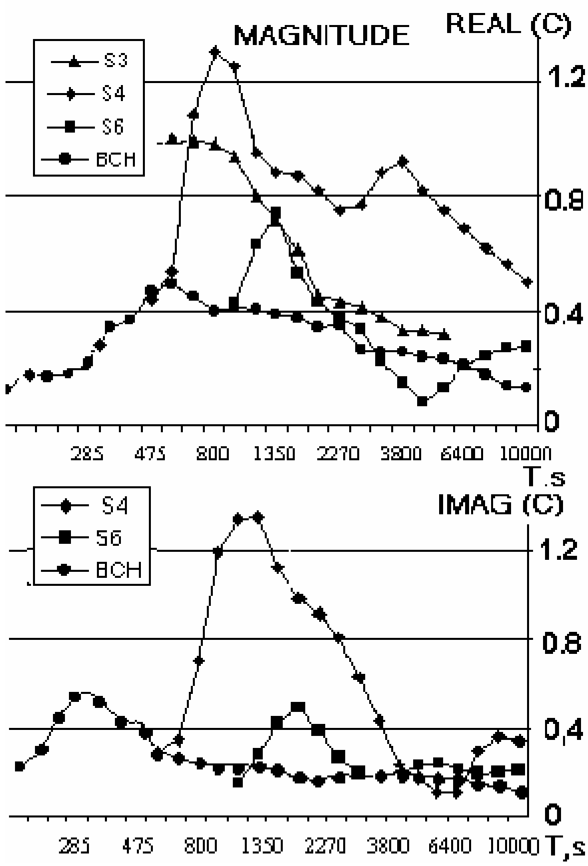

Fig. 5. Frequency characteristics of the real (Cu) and imaginary (Cv) parts of the induction vectors on the Balchik (BCH) land-based station and sea bottom stations S3, S4, S6.

Amplitudes of induction vectors real and imaginary parts are essentially less than in northern part. Fig. 6 shows comparison of frequency curves for northern and southern points of magnetic field sea observation located on identical depths of the sea, 300 m.
A difference in amplitudes of magnetic vectors is essential, in view of the fact, that the distance between northern and southern structures does not exceed 150 km. In the south the influence of a continental slope and the land - sea contrast practically is not felt.

It is known from theoretical modeling calculations, that using value of a maximum of frequency characteristics of induction vectors real parts and having assumed that the maximum is caused only by influence of the land - sea contrast; it is possible to estimate empirically the depth of the sea in the area of measurements.
Frequency characteristics in the observation points located near the sea (Livada, Dobrinovo, etc.) and at sea stations have a maximum on the period about of 30 min that corresponds to the sea depth of 3.5 - 4 km. Actually the depth of the sea in this part of water area is 2 km, so it maybe assumed, that maxima of frequency characteristics are displaced in area of longer periods owing to influence of conductivity of the underlying layers weakening

influence of the land - sea contrast on EM field behaviour. It is not observed on Balchik - Black Sea profile.

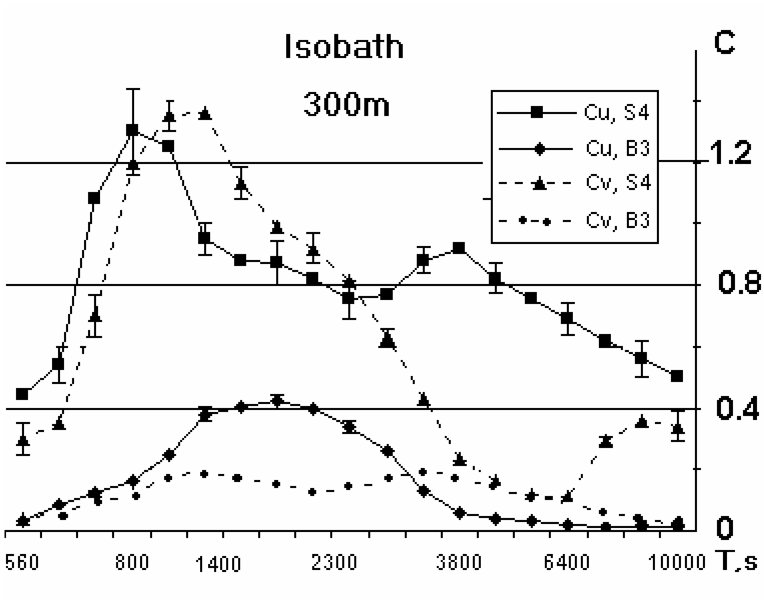

Fig.6 Comparison of the frequency characteristics of the real (Cu) and imaginary (Cv) parts of the induction vectors for the north and south parts of the Bulgarian shelf in the presence of same bathymetry.

Interpretation of the observation data.

It is known that induced in land surrounding water areas EM fields render deforming influence on overland measurements. A degree of this influence on results of EM field measurements was estimated with the help of thin sheet modelling method.

The Bulgarian geophysicists J. Borisova and A. Velev had constructed a map of effective conductance of Bulgaria sedimentary cover on the basis of geological, geophysical exploration evidence. The conductance changed from 400-1000 S in the north of Bulgaria and did not exceed values of 5-10 S in Rhodope massif. The map has been added by values of effective conductance of surrounding territories, when calculations of thin-sheet model were made.

Calculations of the thin-sheet model containing only a superficial film of sediments, have shown, that on Misa plate experimental and theoretical values of magnetic parameters coincide among themselves well enough, see fig.7a. White circles show results of calculations for Balchik.

As to a southern part of researched territory the discrepancy is great: ratio of vertical component of magnetic field variations to horizontal component and sizes of the induction vectors received at calculations are in some times more than received in experiment, fig. 7b. White circles submit results of calculations for p. Livada, white squares- for sea point B3.

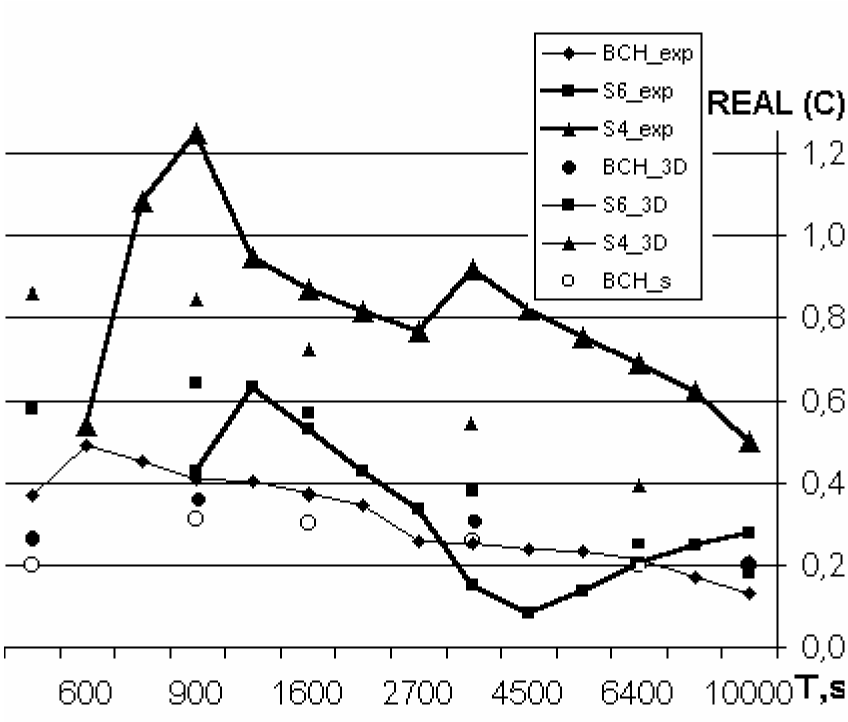

Fig.7a Comparison between observed and computed transfer functions of the magnetic field for stations located on Balchik-Sea profile. Symbols for the curves: "exp"- observed transfer functions; the thin-sheet numerical modeling: "s" computed transfer functions for model without conducting layer in the crust, "3D" - computed transfer functions for model included of sediments, the conducting layer in the crust and the upper mantle parameters.

These results are illustrated also in figs. 8 a and 8 b on which map of induction vectors amplitudes distribution for the period 3600 s, received experimentally, 8a, and calculated for the thin-sheet model including superficial sedimentary layer for the same period, 8b, are shown. If in experimental maps the higher values of amplitudes of the induction vectors are observed only in northern part of studied territory, on calculated maps they are observed in regular intervals for northern and southern parts of the sea and the land.

It means that in territory of East Bulgaria, the same as in western part, the lateral contrasts in distribution of effective conductance of a sedimentary layer from the north to the south are not observed, and it can be supposed that there is the existence of the buried under Rhodope sedimentary layer. Evidently this result corresponds to the assumption about buried sediment rocks existence under the highly crystalline metamorphic rock complex and granitoides *or* a different source of high electrical conductivity.

To solve the problems of three-dimensional 3-D modelling, the experimental, the multifrequency EM data and results of their 1-D inversion were used.
The first step in constructing geoelectric models of the lithosphere was to synthesize *a priori* information in the form of the subsurface conductivity distribution and regional deep 1-D conductivity structures. Results of prospecting MT and GDS soundings and results of the analysis of other geophysical and geological data were used to estimate the subsurface conductivity.

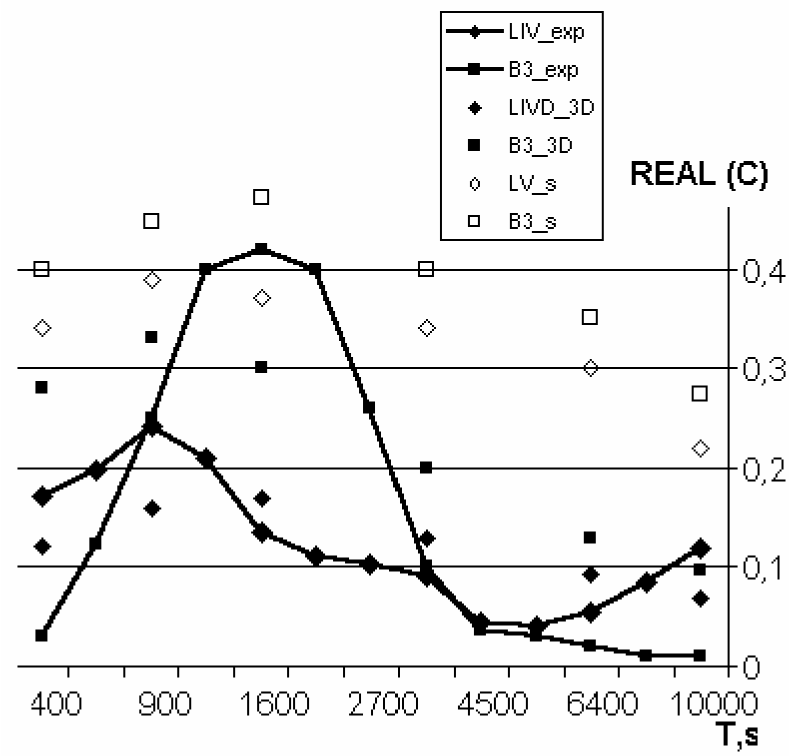

Fig.7b Comparison between observed and computed transfer functions of the magnetic field for stations located on Livada-Sea profile. Symbols are similar specified on Fig.7a.

We considered also geological arguments concerning the overall structure and geodynamic history of this region.

Here we eliminate to estimate the influence of buried under Rhodope crust conducting layer on the induced in the Earth currents. These estimations have been received as a result of construction and calculations of the model, which consists of several geoelectric layers.
Maps of the conductance distribution of the sedimentary heterogeneous cover So, and bedding under Rhodope area conducting crust layer are put in a basis of 3 D geoelectrical model.

For the region of Alpides type of the geological history we have included in the cross-section the upper mantle layer with increased conductivity.

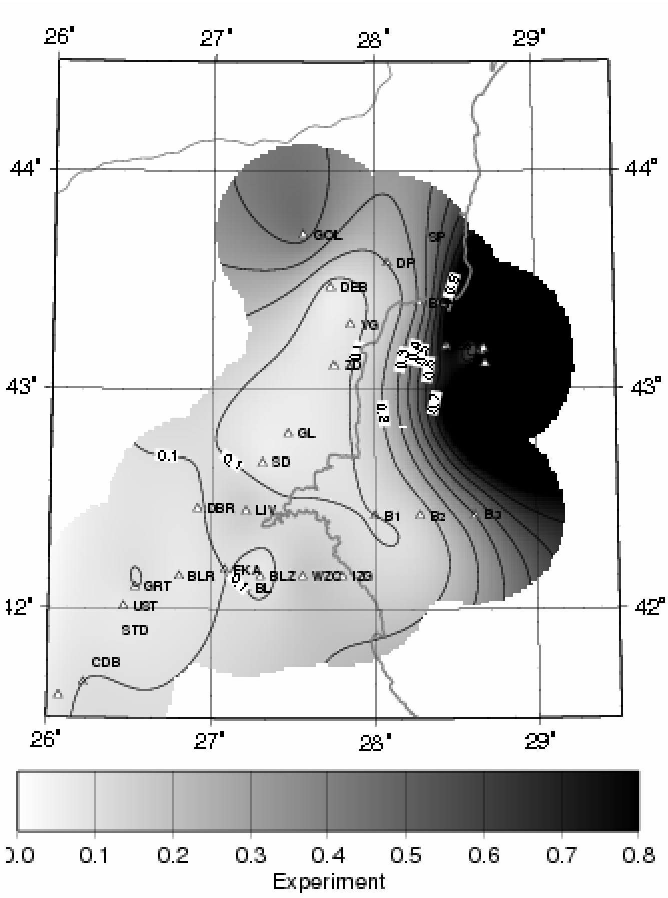

Fig. 8a. The map of real parts of induction vectors distribution in East Bulgaria (observed data).

As a base for the upper mantle part of the initial model it was used the geophysical model proposed by J. Macris (1978). This model of the crust and upper mantle of the Aegean-Balkan region was developed by geophysical information considering available from the area of this zone: the results of the deep seismic soundings, the gravity, the magnetic and the seismicity. In the geoelectrical sense the features of this model point to the high conductivity zone existence what rises to the depth about 50-80 km (so-called "asthenospheric diapir") and the presence of the conducting crust layer under the Rhodope zone, see Fig. 2. The resistance values of the asthenospheric conductor were calculated from the relationships that determine the temperature of partial melting of upper-mantle material and conductivity (Van'yan, 1997).

The thin-sheet method developed by Ed. Fainberg for an interpretation of the EM data allows carrying out correct calculations of EM fields above a cross section including laterally inhomogeneous S-sheets placed at some depths inside a layered medium.

E. B. Fainberg carried out calculations of thin-sheet modelling of fields developed by him and Zinger, (Zinger and Fainberg, 1985) for 5 periods of variations: 400 s, 900 s, 1800 s, 3600 s and 5400 s.

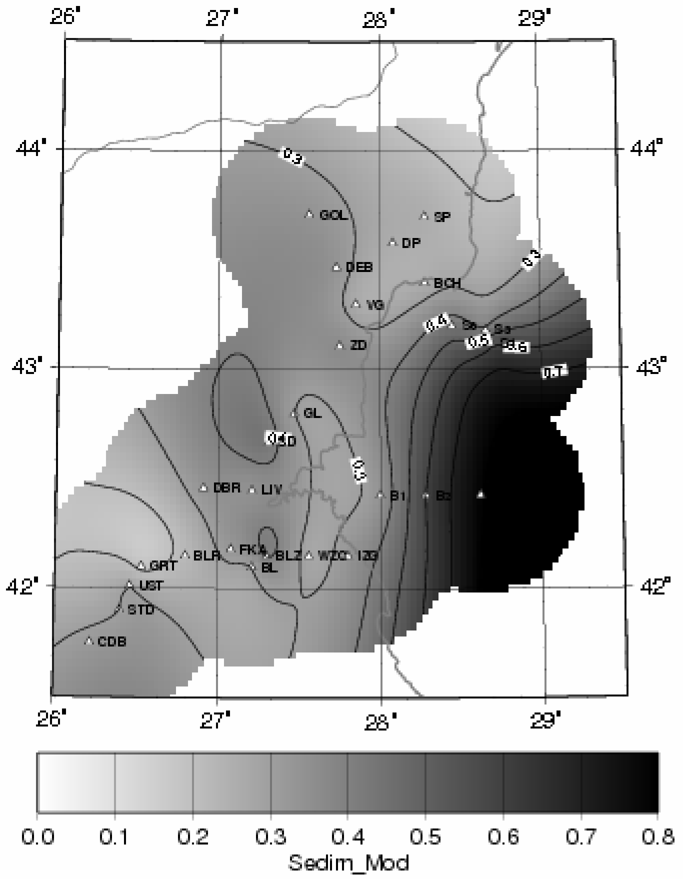

Fig. 8b. The map of real parts of induction vectors distribution in East Bulgaria (model without conducting layer in the crust).

Series of models has been calculated at different values of total conductivity of crust layer at presence and absence of conducting asthenospheric layer.

Results of calculations have shown, that containing to the model the conducting layer in a crust, we receive the good agreement of the experimental and calculated data.

Presence or absence of asthenospheric conductor does not render an essential influence on behaviour of calculated fields.

Fig. 8c illustrates the distribution of induction vector amplitudes for the period 3600 s obtained by this model. It is visible, that sizes of vectors in a southern part of a shelf and in East Rhodope are essentially closer to experimentally received, than in the model containing only a film of superficial sediments.

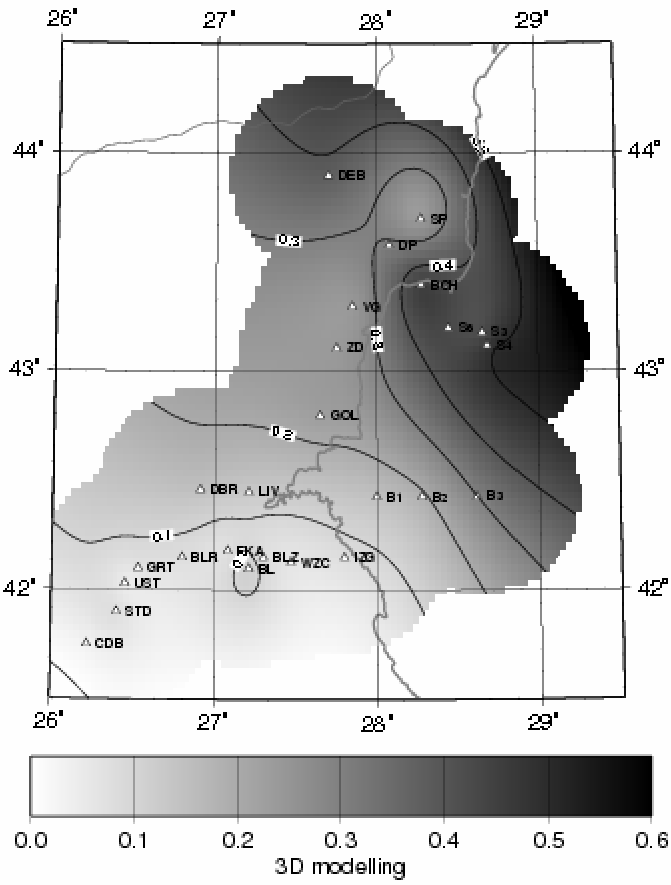

Fig. 8c. The map of real parts of induction vectors distribution in East Bulgaria (model included of sediments and the conducting layer in the crust).

From some number of the counted models as the most adequate to experimental data, the model containing the following elements is accepted.

1. Sedimentary cover. In northern part, in the territory of Romania and Bulgaria (Misa plate) the total conductance So has sizes of 400-1500 S. Further to the south there is practically non-conducting plate of Balkan and Rhodope Nappe. The sedimentary layer includes a water layer Black and Aegean seas, surrounding studied territory.
2. A non-conducting crust with ρ = 1000 Ωm, and capacity from 50 up to 25 km. in various parts of Bulgaria.
3. The deep-seated crust conducting layer. Thickness of a layer is about 3 km., specific resistance ρ ~ 3 Ω m and total conductance Sa approximately of 1000 S.
4. A deep section of the cratonic platform type in the north.
5. A deep section in the south, including the top mantle with the conducting layer beginning with depth of about 50 km, with conductance Sa ~3000 S. A conducting layer

thinning to Misa plate in the north and under Aegean sea in the south, not reaching Crete Island.

Discussion and conclusions

Some conclusions about the reasons of "atypical" behavior of an electromagnetic field in this area:

1. It is possible to speak definitely about the presence of a buried crust conductivity layer under east part of Rhodope massif and south offshore of the Black Sea. Both the electromagnetic measurement data themselves and their joint analysis with the data of other geophysical methods determine the crust conducting zone inn this area.

Very low (about first tens of Ώm) values of apparent resistance in points Pelevun, Chernodub etc., located in East Rhodope, and practically full absence of vertical component Hz testify the presence of well conducting layers under the East Rhodope crystalline basement and the Black Sea offshore.

A source and the reason of unique geoelectric anomaly of the south Bulgaria can be Rhodope artesian basin. Bulgarian geologists Rosen Ivanov and Ivan Stanev have offered the original paleo-hydrogeological method (Ivanov, R., and Stanev, 1982).

This method is based on research of the hydrothermal system in an active volcanism area. Their metallogenic model, based on the formation of thermo -elision systems during the Tertiary, was proposed to explain specific features of the magmatism and ore mineralization and its relations. The model explains quite adequately the conductivity anomaly nature discovered under the Rhodopean zone. To their thinking autochthonous in this shear is the thick layer of karsts marbles what hydrogeologists describe as a large deep bedding artesian basin with hydrothermal karst and ascending underground flow. Waterproof layer is a plate constructed by the Rhodope granitoides series.

The opportunity of using geoelectric data for the forecast, mapping and estimations of stocks of hydrothermal waters in a complex with other methods is not excluded.

2. Qualitative analysis of the electromagnetic measurements data in the conjunction with other geophysical data speaks about an opportunity of conducting asthenospheric layer existence under Aegean area and Alpide territory. It confirms a hypothesis of "mantle diapir" and it will be in agreement with the high values of the heat flow, which are observable in Aegean zone and in Southern Bulgaria (Velinov and Boyadjieva, 1981). A possible explanation for this phenomenon is that the upper mantle beneath the Aegean region is heated by hot asthenospheric material that penetrates the lithosphere through convection.

Acknowledgements. Author thanks colleagues Al. Velev, Iv. Stanev, V. Shneyer, Yu. Abramov and S. Korotaev for helpful teamwork during long time, Ed. Fainberg - for modelling calculations. The author also recollects with deep grief of Bulgarian colleagues Khr. Dachev and R. Ivanov, and Russian, Leo Van’yan, who have left us forever.

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Някои резултати от магнитовариационни изследвания в Източна България

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В статията са представени резултати от магнитовариационни изследвания в различни части на българското крайбрежие и на територията на страната. Геомагнитните вариации в морето са регистрирани с три- компонентен дънен флуксгейт магнитометър. Изчислени са функциите на електропроводността, като са използвани вариациите с периоди от 3 минути до 3-4 часа. Анализът на данните показва ниска стойност на вертикалната компонента на геомагнитните вариации в Южна България и в областта на съседния континентален шелф. Геомагнитните вариации в северния континентален шелф са много по-различни от тези в южния.

За интерпретация на данните е използван нееднороден модел с въвеждане на тънки слоеве. Съвместните електро- и магнитни измервания и актуалният анализ на данни от други геофизични методи показва съществуването на електропроводима зона, разположена под южното черноморско крайбрежие и под Източните Родопи. Проводимите слоеве в земната кора са с дебелина около 3 км и имат специфично електрично съпротивление от порядъка на 3Ωm и съответно специфична електропроводимост от порядъка на 1000 S. Тези резултати се съгласуват добре с хипотези на някои български хидрогеолози за хидрогеоложките условия в тази част на българската територия.