EVALUATION OF ELECTROMAGNETIC RADIATION POWER IN CONNECTIONWITH SEISMIC ACTIVITY IN THE TSKALTSMINDA-UREKI GEOMAGNETIC ANOMALY AREA

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***Summary**: The atmospheric electrical field inversion of analogous circuit model distinguishes a local segment from the unique lithosphere-atmosphere-ionosphere (LAI) system. The reason of the polarity variation of the Earth surfacecan be the generation of telluric current caused by the activity of thermoionized channel activated by seismic processes. The local LAI segment corresponds with an electromagnetic circuit, the characterizing frequency diapason of which is compatible with very low frequency (VLF) telluric electromagnetic radiation [1]. Consequently, we aim to determine in which cases the electromagnetic radiation energy accompanying the telluric current generated in the sea is sufficient for anomalous variation of the electron concentration in the lower ionosphere.*

Key words: *electromagnetic radiation, telluric currents, ionosphere.*

In our opinion, the telluric currents probably generated in the focal zone of earthquakes can serve as such an agent. This assumption is supported by existence of local magnetic anomaly at coastal zone in Tskaltsminda-Ureki resort, the physical properties of which can contribute to the resonant emission of VLF electromagnetic waves generated in the focal zone. It seems that, specific geophysical characteristics of this place add up due to interrelated factors: magnetite-rich sands from western part of the Adjara-Trialeti fold and thrust belt, carried by the Supsa River; seepage of seawater to the coastal area; the polarization effect arising from the movement of a conducting fluid in a magnetized porous rock [2].

Intensity of telluric currents is higher in the sea then on the land. Therefore, the ionospheric effect of the very low frequency (VLF) electromagnetic radiation close to seas and oceans is higher than in the depth of the land [3]. When the focus of an upcoming earthquake is located beneathwater layer, besides the ultra-low frequency (ULF) diapason waves expressed in geomagnetic field pulsations, VLF electromagnetic radiationis probably also generated. In case there is sufficient depth, the high conductivity sea water layer absorbs the VLF waves and conducts only ULF electromagnetic radiation. However, when the telluric current circuit includes a part of a land or shallow, in certain geophysical conditions there is a probability that the spectrum of the VLF radiation is fully manifested. Therefore, total electron concentration (TEC) anomaly may locally take place. It may be caused in the ionosphere by “heating” of lightly ionized medium due to the increase in the magnetic viscosity of the plasma. During the recent years such a phenomenon has been considered as the indicator, which is extremely sensitive to an earthquake preparation process [4]. Such a conclusion is acceptable only in case the activity of the cosmic mechanism causing TEC anomaly is excluded. Therefore, there arises a question: in what circumstances does telluric current have sufficient energy to create local TEC anomaly in the lower ionosphere? It seems that there is a simple answer to this question: in case TEC anomaly appears in the area of a seismic-active zone then the telluric VLF electromagnetic radiation energy has been sufficient for its generation. However, only a qualitative analysis of the problem is not sufficient to prove this assumption andrelevant quantitative assessments are also required. Therefore we used the geophysical characteristics of the local Tskaltsminda-Ureki geomagnetic anomaly.

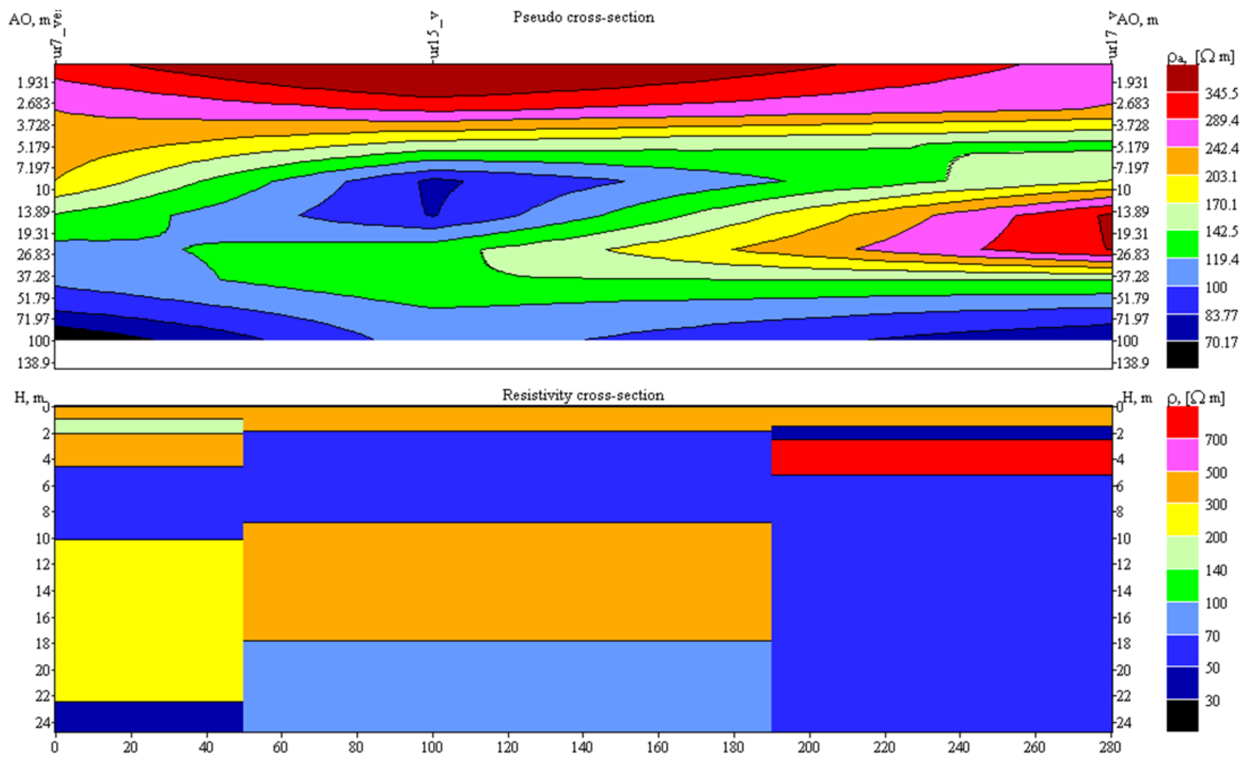

Fig.1 a,b. Deep transverse cross-section for central part of Tskaltsminda-Ureki geomagnetic anomaly.

For example, Fig. 1a, b shows a typical transverse cross section of the central part of the geomagnetic anomaly (conditional center "Magnetite" N-41 58 979; E-41 45 570). Apparent (a) and imaginary images (b) show a variety of specific electrical resistivity (ρ), which is likely to be reflected in the intensity of the telular currents [2]. It should be noted that for more persuasion we consider it is necessary to built a deeper cross section, although this will probably only be possible along the longitudinal direction.

Tskaltsminda-Ureki geomagnetic anomaly dipole model. Let us imagine, that in the depth of the see, quite close to the geomagnetic anomaly, there appeared a generator of free polarization charges – a thermoionized channel connected to the upcoming earthquake focus. Thus, in the geomagnetic anomaly area estimatedto a first approximation by electric and magnetic dipolemoments, a telluric current source was activated. Let us assume that the telluric current circuit, besides the sea, includes the land as well, namely covers an anomaly area, which can be identified with the inhomogeneous system of polarization charges characterized with a certain charge relaxation time interval. Quasi-neutrality requires to satisfy condition $\tau << T$, where T is telluric current variation time, which is in the relaxation time interval of free and bound polarized charges, $\tau = \frac{L}{c}$ is the time characteristic of electromagnetic signal distribution, $L$is longitudinal linear measure of the system and c is light speed.

Generally, electromagnetic radiation power W of a charge system is determined by multi-pole moments. Let us assumethat the telluric current circuit is closed in the charge system area. It simplifies to assess the energy effect of the electromagnetic radiation of the system, especially far from the system. In this case the electromagnetic radiation power (ohmage loss) of the model system and consequently, the geo-electric anomalyon the ionosphere level is determined by dipole electric and magnetic moments [5]. Their role in the magnetic effect is depended on the radiation emission frequency and wave length, namely, in the high frequency approximation the power of the electromagnetic radiation of the quasi-neutral system of charges is mainly determined by electrical dipole moment $\boldsymbol{P^e}$ **. P**

$$W^e = \frac{\omega^4}{12\pi}\mu\sqrt{\varepsilon\mu}\left|\boldsymbol{P}^e\right|^2 , \quad (1)$$

ω is frequency of electromagnetic radiation, ε and μ are dielectric and magnetic constants of the medium.

Concrete assessments of (1) formula requires determination ofthe equivalent electric dipole value. However, this task is rather difficult as far as it depends on number of parameters: polarization charge density, the electric conductivity and geomagnetic anomaly measures of the medium. However, there are circumstances enabling to simplify this problem.According to the model, in the geomagnetic anomaly area there are necessary physical conditions for conducting the telluric current generated in the upcoming earthquake focus. Consequently, a telluric current circuit element or independent loop is localized here. According to the structure and measures of the geomagnetic anomaly the role of the currentin the radiation loss of the system, compared to the polarization effect, may significantly increase, i.e., the magnetic dipole factor may become commensurable with or even more than the electric dipole factor. In this case the power of the electromagnetic radiation of the system depends on the wave number determined by the latitudinal linear measure l of the system: $k = \frac{2\pi}{l}$

$$W^{m} = \frac{k^{4}}{12\pi}\sqrt{\frac{\mu}{\varepsilon}}\left|\boldsymbol{P}^{m}\right|^{(2)}. \tag{2}$$

The geomagnetic anomaly of Tskaltsminda-Ureki contains great quantity of magnetite. Therefore, by indirect assessment, compared to vacuum, the relativity of the constants characteristic of the medium may increase by at least one order: $\sqrt{\frac{\mu}{\varepsilon}} \approx \sqrt{10^3}\sqrt{\frac{\mu_0}{\varepsilon_0}}$ ≈3800 Ohm. Determination of the P^m magnetic moment, like electric moment, is difficult. However, we can imagine the magnetic dipole approximating the anomaly as the sum of the elementary dipoles. Therefore, we should virtually imagine thatin the geomagnetic anomaly area the circuit of the telluric current generated in the sea is a spoolof current, the separate coil radius r_0 of which is much less than the latitudinal linear measure of the geoelectrical anomaly. Each coil magnetic moment $m = \pi r_0^2 I_0$, where I_0 is periodically variable telluric current amplitude. In this case (2) expression is simplified and gains classical form $W = 0.5\Omega I_0^2$ where Ω is ohmage.

$$W^{m} = 5000\pi^{6}(r_0/l)^{4} I_0^2 \quad . \tag{3}$$

In order to assess the total $Q = \sum W^m$ power of the electromagnetic radiation characteristic of the model magnetic dipole we may use the geophysical parameters of the Tskaltsminda-Ureki anomaly. According to the electrical sighting data the value characteristic of the telluric current density amplitude is I_0≈0.01A, while the relativity of the latitudinal and longitudinal linear measures is $r_0/l)$≈0.3 [4]. Consequently, the power of the electromagnetic radiation corresponding the virtual coil is ($4*10^4$)Ohms*(10^{-4})A^2≈4 Watt.

Conclusion. It is known that in order to make influence on the upper ionosphere 4.5-9 MHz frequency is needed, which requires nominal conductor power of 750 watt [6]. Consequently, in order to have effective influence on the plasma medium at the lower ionosphere level (D, E-layers), in the VLF diapason, minimum ≈25-100 kilowatt power is required. Magnetic anomaly we can imagine as a virtual vertically oriented antenna. By physical analogy, in case of G = 100 amplification coefficient value, such radiation can emit an antenna of approximately 10 megawatts of capacity that fully covers the entire space [7]. On the basis of physical analogy we can assume that within the limits of the above described model, for the local perturbation of the ionosphere medium from the Tskaltsminda-Ureki geomagnetic anomaly area, which can be considered as the seismic activity increase indicator, a L≈15 km long virtual current spool will be sufficient. As far as the radiation power of each coil is $W^m \approx 4\ watt$ e.g., when the coil number is n=1.5*104 then the total power of the electromagnetic radiation corresponding the total magnetic moment of the spool is $Q \approx 60$ kW. The electromagnetic process will be impulsive, while the leader in in frequency spectrum will probably be the VLF diapason frequency, which is characteristic of the electromagnetic circuit corresponding to the local segment of the LAI system [1].

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