ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

N E W S

OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN

ФИЗИКА-МАТЕМАТИКА СЕРИЯСЫ

♦

СЕРИЯ ФИЗИКО-МАТЕМАТИЧЕСКАЯ

♦

PHYSICO-MATHEMATICAL SERIES

1 (317)

ҚАҢТАР – АҚПАН 2018 ж.
ЯНВАРЬ – ФЕВРАЛЬ 2018 г.
JANUARY – FEBRUARY 2018

1963 ЖЫЛДЫҢ ҚАҢТАР АЙЫНАН ШЫҒА БАСТАҒАН
ИЗДАЕТСЯ С ЯНВАРЯ 1963 ГОДА
PUBLISHED SINCE JANUARY 1963

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR

АЛМАТЫ, ҚР ҰҒА
АЛМАТЫ, НАН РК
ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of physico-mathematical scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of physico-mathematical in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of physics and mathematics to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Физика-математика сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Физика-математика сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді физика-математика бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия физико-математическая» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия физико-математическая в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по физике и математике для нашего сообщества.

«ҚР ҰҒА Хабарлары. Физика-математикалық сериясы».

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.)
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5543-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
www:nauka-nanrk.kz / physics-mathematics.kz

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Известия НАН РК. Серия физико-математическая».

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5543-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год.
Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18,
www:nauka-nanrk.kz / physics-mathematics.kz

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Physical-mathematical series.

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5543-Ж, issued 01.06.2006

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
www:nauka-nanrk.kz / physics-mathematics.kz

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
PHYSICO-MATHEMATICAL SERIES
ISSN 1991-346X
Volume 1, Number 317 (2018), 51 – 62

UDC550.837

S. Baydullaev, S. S. Baydullaev

Technical College, Shimkent, Kazakhstan;
Partnership with Limited Responsibility «Kaztransgaz Productions», Shimkent, Kazakhstan.
e-mail: s_baydullaev@mail.ru; ahmet_87@bk.ru

ANALYSIS OF MAGNETOTELLURIC SOUNDING

Abstract: 1. Critical analysis of geophysical method's way of geology on magnetotelluric sounding for the first time in more than 60 years of its existencewas carried out.

2. The analytical conclusions that had never been expressed earlier have been published. As a result of analysis of the notions such as skin-effect, quasi-stationary approximation, impedance, electric induction current, aconduction current, applied to the cosmic variations of magnetic perturbation theory as the basis of the method conclusions have been done that "their application for the purpose of geologic prospecting is not justified".

Keywords: earth interior, geophysics, electrometry, skin-effect, impedance, quasi-stationary approximation, electric induction current, conduction current.

In the middle of the last century, the proposal of the scientists to utilize the space sources of natural electromagnetic waves (NEMW) as a power that seemingly were necessary for geological prospecting for mineral resources would have been not less than offering a miracle. Butto bring that idea to practical implementation it was necessary to prepare its theory, then bring to existence the instruments for registration of NEMW, develop amethodology of the field work and obtaining information and data, the ways of processing and interpretation of the latter.

In the late 50-s of the 20th century, all was ready for this end, and planned works were included in the government production plans of the USSR and work started nationwide.

The registering instruments having been developed, in the process of production works, theabsence of the NEMW that supposed to have period lengths from the initial tens minutes to days and longer in nature. We have been informing the persons responsible for production on that since 1977. But neither before, nor after us (since 1986) no one of experts anywhere and ever produced a sound on the matter. None the less, the geologic prospecting work by the method of magnetotelluric sounding (MTS) is continued till now, and huge funding of our peoples was spent for it in the recent 60 years.

Such a situation (*absence of long period waves*) pushed us from the very beginning to independently seek its causes. As the result of the long lasted and wide-scale analytical studies, in 1985, wearrived to the final conclusionthat there is no long period NEMW in nature. The previous paper covers this matter in details.

The further analysis of the condition (theoretical bases) of MTS method revealed other aspects of the theoretical construction not meeting the reality, too. In the present paper, we publish the results of thecarriedanalysis.

The theory of MTS is based on a number of physical and mathematical categories, i.e. physical laws, phenomena, and conceptions. The following concepts are used in the MTS: ionosphere sources of electromagnetic waves (*EMW*), skin-effect, impedance, Fourier transformation, aconduction current,a displacement current, etc. In the present paper, we define the place of some of MTSthose categories that had not been discussed earlier.

The theorist suggests the used the following beliefs:

1.The variation of the magnetic field originating from ionosphere are natural electromagnetic waves, indeed, otherwise, waves needed for the MTS could be constructed of them;

2.It must be beyond any doubt that those cosmic variations of magnetic field may be used for prospecting the earth interior;

3.displacement currents may not be taken into account in the cosmic electromagnetic wave processes considering them absent in the waves;

4.In the applied quasi-stationary conduction currents feature wave properties and its wave number ($k = \sqrt{i\omega\mu\sigma}$)has its necessary place of application in the method;

5.The Earth may be conditionally considered as a medium that does not feature magnetic properties, or these properties are weak. Then, the wave number is expressed as ($k = \sqrt{i\omega\mu\sigma}\boldsymbol{e^{i\pi/4}}$), respectively.

Below, taking into account all these listed factors for multilayered structure, we remind the shortest essence of the theoretic bases of MTS, the main of magnetotelluric methods [1: p.p. 17-21, 12: p.p. 219-220].

In MTS, the characteristic impedance of the medium to the electromagnetic field (EMF) is found first, i.e. scaled impedance of the material that the medium (*the part of Earth under question*) consists of. For the homogeneous ($h_1 = \infty$, $R_n = 1$)structure impedance: $Z_1(0) = -i\omega/k_1 = \omega\mu_0/k_1$. Taking into account the two last formulae, in-impedance is found:$|Z_1| = (\rho_1/2T)^{1/2}$. Here, $Z_1(0)$ is impedance at the border of atmosphere and the Earth. Further, we term the impedance defined at the Earth surface in-impedance. Resulting from that, $\rho_1 = 2T|Z|^2$, or$\rho_{eff} = \left|Z_{eff}\right|^2/(\omega\mu_0)$[12: p. 220].

For multilayered structure, in-impedance is $Z_1(0) = (\omega\mu_0/k_1)R_n$[6: p.150]. Under these conditions, the given formula defines an effective parameter, which has the meaning of seeming impedance. It is marked as ρ_T: $\rho_T = 2\,T\,|Z|^2 = 2\,T\,\left|E_x/H_y\right|^2$. In practical units it is $\rho_T = 0{,}2\,T|Z|^2$, [s.(mv\km.nTl)^2].The impedances that have the same meaning are termed respectively: ρ_1 – impedance of the first layer, and ρ_{eff} – effective specific impedance. Only, impedance here is defined as ratio of electric and magnetic fields (EMF) intensity. Taking into account $R_n$and conditional non-magnetism of multilayered medium $\rho_T^n = \rho_1|R_n|^2$is found. Here, *n*is number of the layer in multilayered structure, [12: p. 220]. For such conditions, the depth of underground conductive layer is found in the field (*practical*) measurement units: $h_1 = \sqrt{10\rho_в T_в}/8{,}9 = 0{,}1592\,T\,Z$, [1: p.p. 26-30]. Here, $\rho_в$and $T_в$are intersection coordinates of prior computed theoretically graphs of these two parameters on a special palette. Sometimes, this latter formula is called an effective depth, too. [Завадская Т.Н. Некоторые свойства кривых МТЗ, Прикладная геофизика, вып.40, 1964; Яковлев Г.Е. и др.,1975г; Анищенко Г.Н., 1963].

When solving the electrometry problems, electric and magnetic fields that are members of Maxwell equation, need to be considered separately. Such problem can be solved to the medium with constant physical parameters. Differential equations emerging at the solution of such problem are termed telegraph equations. The telegraph equations represent theprocess of propagation of EMW within the homogeneous transmission line, through which information is transmitted. The equations are as follows:

$\Delta\boldsymbol{E} - \mu\varepsilon\, d^2\boldsymbol{E}/dt^2 - \mu\sigma\, d\boldsymbol{E}/dt = 0$; $\Delta\boldsymbol{H} - \mu\varepsilon\, d^2\boldsymbol{H}/dt^2 - \mu\sigma\, d\boldsymbol{H}/dt = 0$.

Here in both formulae, the second members are elements of displacement current and the third members are elements of conduction current. As it has been said, as the MTS uses parameters that are considered elements of super long waves, as well as quasi-stationary approximation, displacement currentpresent in the first Maxwell equation is dropped off in its theory. Then, the remaining parts of formulae, if solve themfor one direction of the Laplace operator only, will turn into diffusion formulae:$\Delta\boldsymbol{E} - \mu\sigma\, d\boldsymbol{E}/dt = D\cdot\Delta\boldsymbol{E} - d\boldsymbol{E}/dt = 0$; $\Delta\boldsymbol{H} - \mu\sigma\, d\boldsymbol{H}/dt = D\cdot\Delta\boldsymbol{H} - d\boldsymbol{H}/dt = 0$,–i.e. into the second A. Fick law.Here, $D = 1/\mu\sigma$– diffusion factor. At this quasi stationary approximation to EMF it becomes independent on dielectric permittivityof the medium. Now, if, willing to attach wave meaning to the formulae, to introduce wave numbers into them, then they, in a new form, will turn into Helmholtz equations for standing waves:$\Delta\boldsymbol{E} + k^2\boldsymbol{E} = \boldsymbol{0}$; $\Delta\boldsymbol{H} + k^2\boldsymbol{H} = 0$. Here, for vacuum $k^2 = \omega^2\varepsilon\mu/\mathrm{c}^2$. The wave number for conductive medium is imaginary number: $k^2 = \omega^2\varepsilon^{\kappa}\mu/\mathrm{c}^2$. Such wave equations, where right sites are equal zero, are equations for standing wave, not that for the (*running*) processes of their movement. It means that a wave in the process of its progress must preserve (not loose) its energy, and other processes, filling losses of continuously running EMW.For this to take place, such a wave needs to have unexostable source of power.Thus, the Helmholtz equations for stationaty waves are equations for

standing waves. Their solutions are spatial constant values of the EMF components in the EMW active zone.As one can see, such conditions can be satisfied neither by the wave itself, nor by the cosmic source of NEMW. In addition, we would like to say the coming from the space are not EMW, rather variations of magnetic field.

But the developers of MTS by means of replacing these formulae with formulae of vertically falling (*i.e., along z axis only*) of monochromatic flat EMW on parallel layered media in geology, obtained one dimension differential Helmholtz equations of the second order: $\frac{d^2\boldsymbol{E}_x}{dz^2} = \frac{\varepsilon\mu}{c^2}\frac{d^2\boldsymbol{E}_x}{dt^2} = k_m^2\boldsymbol{E}_x$; $\boldsymbol{H}_y = \frac{k_m^2}{i\omega}\frac{d\boldsymbol{E}_x}{dz}$ (*the latter equation may be obtained from the Maxwell equations*). The both formulae have been derived for the plane waves propagating in the opposite to each other directions in dielectric medium: $E_x = A_m\boldsymbol{e}^{-k_m z} + B_m\boldsymbol{e}^{+k_m z}$; $H_y = -(k_m/i\omega)\left(A_m\boldsymbol{e}^{-k_m z} - B_m\boldsymbol{e}^{+k_m z}\right)$. Here,$A_m$, B_m are presented as constantsconnected with structure parameters and wave frequency, [1: p. 19]. Indeed, they are presented, in MTS, as the amplitudes of wave falling from the space (A_m)and reflected(B_m)waves, and exponents $\boldsymbol{e}^{-k_m z}$ and$\boldsymbol{e}^{+k_m z}$represented as sum (*or standing wave process*) of flat homogeneous waves falling from the space and reflected upwards from internal layers of entrails of the earth.

As a result of their solution, electric component of EMF in a geologic medium is$d\boldsymbol{E}_x/dz = 0$. But when$\sigma \neq 0$ longitudinal electric component of wave $\boldsymbol{E}_x(z) = \boldsymbol{E}_x(0)exp(-t/t_0)$dies out with time [4: p.p. 32-33].

In reality, there are no reflected waves at all.The cause for that is that at quasi-stationary approximation, the EMW subordinates to diffusion equations only, to telegraph or wave ones EMW subordinates to diffusion, but not to telegraph or wave ones, therefore, the name EMW is present here in symbolic terms [6: p. 30-, p.p. 34-35]. As you know, the reflection phenomena is not present in the process of diffusion, it means that there are no reflected waves. For the clarity of problem, let us to consider two cases that correspond MTS. The first oneis the case mentioned by A.A.Kovtun.In this case, as on the Earth surface amplitudes of the folling and reflected waves are equal, total magnitude of the field components is doubled at the surface [1: p.p. 19-24].It means that the reflection factor is 1, thephase shift is absent, the reflected wave is standing one, i.e. waveabsorption in the Earth medium is absent completely.Such situation can take place while the wave is reflected from a medium without penetration. If the wave does not penetrate into the medium in question,then no induction current is generated from the wave.The second cade – only falling wave is present, the reflected wave is not present.This complies with theroutine geologic situation, i.e. the wave is absorbed in the medium completely. Below, we consider versions of the second case to resolve a geologic problem.

The MTS developers borrowed the basic notion of the method, i.e. impedance, from the paper of American scholar G.A.Stretton on the theory of electromagnetism [9]. In this paper, impedance was adjusted for the long lines (*or elements of thealternating electric circuit*), which EMW propagates along.But, ten years prior to that paper by G.A.Stretton, in1938,the expressions for impedance of the surface situating in monochromatic EMW developed for theory of antennas more meeting the goals of electrometry were developed in the papers of another scholar from the USA S.A.Shchelkunov [13;14] or in the paper of M.A.Leontovich, the Soviet scholarof1948[7].Had the MTS developers have proceeded from those latter papers, maybe the solutions and proposed expressions could be different.

Skin-effect

While geologic problems are addressed, the MTS method developers, considering the variations of magnetic field as NEMW coming from the outer space using skin-effect as a tool for deep penetration into entrails of the earthexplained the theory of method as follows: the source of NEMW is located at the height from the Earth surface, more precisely, in ionosphere,approximately at the height of 80-115 Km(*at present the more accurately defined this height is 60 Km at day time and 90 Km at night time*); the depth of its penetration into the entrails of earth depends on the wave frequency. It means, according to the theory, knowing the frequencies of NEMW used in MTS, one can determine electric parameters of all the layers from the Earth surface till the depth of their penetration.The depth of penetration of variations coming from the outer space into the entrails of earth was called skin-depth and described it as follows: $\delta = 10^{-3}\sqrt{2/(\omega\mu_0\sigma)} = \sqrt{10^7\rho T}/2\pi$.

Here we talk about multikilometer waves – hundreds, even thousands of kilometers – depths of entrails of earth for their geological prospecting.The theory reads that receiving sensors of waves located on the Earth surface receive all the NEMW that bear information from those depths. By processing that information, an analyst can find depths of electric conducting layers and their electric parameters.

In reality, the variations ofthe space magnetic field (VSMF) that are registered on the Earth surface are source ones, i.e. just arrived from the space. In order to obtain necessary geologic information, they must have been visited the entrails of earth. The variations, at the place of their fall, losing their energy, is subject to full decay.And science studied penetration of waves (!), not that of variations. It means that generation of secondary (*i.e. reflected in the Earth interior*) wave from VSMF is not possible in the skin-depth. It is not possible not to understand this truth.

But while resolving a geologic problem, the actual depth of bedding and geometry of the underground objects are the main ones.It is not an easy task for electrometry. In this case, thenecessity of synchronic registration of primary (*falling from the space and penetrating into entrails*) VSMF and secondary (*reflected from the underground layers and reached the Earth surface*) ones must be understandable. Unfortunately, magnetic fields do not travel in the underground, as we said above,they do not have ahabit to return.

The reflection factor of EMW is:$R = \left(\mathrm{A}^{ref}/\mathrm{A}^{0}\right)^{2}$,here$\mathrm{A}^{ref}$ and$\mathrm{A}^{0}$are amplitudes of the reflected and falling waves respectively. The ration defining relative index of reflection of two media is equal: $\sin i/\sin r = n_2/n_1 = n_{21}$(*Snellius law*),where:$n_1$ and$n_2$indices of refraction of the first and second media;$i$stands for reflection angle;$r$stands for refraction angle.For reflection of wave,the condition $n_2 > n_1$, i.e.$n_{21} > 1$mustbesatisfied.For the medium with no ferromagnetic properties$n_{21} = \sqrt{\varepsilon_2/\varepsilon_1}$,[11: p.p. 304-305].If the inequality is opposite $n_2 < n_1$, in means refraction of wave on the border.In highly conductive media indices of reflection and refraction are approximately equal.

Any flat EMW remains flat only if it propagates in the medium without absorptions, for instance, in the outer space or atmosphere. And reflection index for low-frequency waves propagating in the medium with absorption is an imaginarynumber: $n(\omega) \approx \sqrt{i\frac{\sigma}{\omega\varepsilon_0}} = \sqrt{\frac{\sigma}{2\omega\varepsilon_0}}(1-i)$. Here its imaginary part is incomparably larger than one, i.e.Im $n(\omega) \approx \sqrt{\frac{\sigma}{2\omega\varepsilon_0}} \gg 1$. Therefore, strong absorption of waves takes place in conducting layers at low frequencies.It means that they do not reflect [7].

Here, it is necessary to specify absolute refraction index, it is$n = c/v$. Here, $c$is speed of EMW in the vacuum, $v$is phase speed of wave in a medium.For such a case (*in dielectric*)$\approx \sqrt{\varepsilon\mu}$ .The last equation in called the Maxwell's equation, some times[8: p. 219].There is no dispersion here, dissipation depends of frequency. For the media with no ferromagnetic properties($\mu \approx 1$), $= \sqrt{\varepsilon}$,[11: p. 304].

In electrometry, in order to ease solution of the problems for complex media(*for instance: anisotropic, linear etc*.), sometimes, sought parameters are replaced by new ones, more efficient for the case.Then, new notions are called in a new fashion:for instance, the specific electric resistance of layers is termed ‘effective resistance’, impedance is termed ‘effective impedance’, depth is called ‘effective depth’ etc.Then,in accordance with the content of new parameters new meanings defining them must be explained.For instance, anew understanding of ‘effective impedance’ is explained –independence on theazimuthal geometry of anisotropic media, as well as for ‘effective depth’ – sum thickness of layers till underground highly conductive bedding rock in the entrails.The new coined notion in electrometry must exactly correspond to thedefinition in the applied electrodynamics. Indeed, ‘effective depth’ in the electrodynamics is the depth where wave energy is intensively absorbed and completely attenuates. How the wave attenuated in the depth and not having come back to surface can yield information on sum thickness of layers till marker? The theory of MTS does not say even a word on that.

For the waves used in MTS, skin-depth has too large magnitude. Therefore, as you feel, the efficient depth must be smaller than skin-depth.It, for theconductive homogeneous medium in the entrails has been calculated as: $h_{eff} = \frac{\lambda}{2\pi\sqrt{2}} = \frac{\delta}{\sqrt{2}} \approx \frac{Z}{-i\omega\mu_0}$. And the effective depth in Niblett transformation$h_{eff} \approx \rho_{\text{к}}$ ·

$\int_0^{h_{eff}} \frac{dh_{eff}}{\rho(h_{eff})}$for the 'Tiknonov-Cangiar' model to resolve geological problem has been adjusted as: $h_{eff} = [\rho_к/(\omega\mu_0)]^{\mathbf{1/2}} = [\rho_к T/(2\pi\mu_0)]^{\mathbf{1/2}}$,[6: p.p. 209-210].

In our opinion, the basics of thetheoryis the same for all types of waves (*electromagnetic, elastic and others even*).If approach from this point of view is taken, still there are a multitude of not solved problems of resolution of waves and disturbance interference even in the man-made seismic waves that have penetrated the entrails for sure and came back, as well as while extracting useful geologic information from them as well. Seeing that, is it possible to believe in the MTS statements and calculations that with no problems we will obtain desired information using space variations that are not described by wave laws?

The conductive layers in the entrails are absorbing and dispersing always. Any magnetic disturbances getting into such a medium can generate, on its surface, so-calledtelluric surface alternating earth inductive currents.Those currents converting into Joule warmth onlyserveto warmingof that medium.

Unfortunately, there are no harmonically shaped long period EMW of natural origin.The natural sources (*ionospheric ones*) propagate not waves, rather weak magnetic variations of random shape. It is known in the science and practice.In MTS, many situations are not duly taken into consideration,including absorption of EMW by the earth layers. It means that even the most ideal EMW are not suitable for the purposes of deep (*even thousand kilometers deep, with regard of which MTS has ambition*) electrometry.Moreover,it is known, that their ionospheric sources and recording instruments on the Earth surface are located in different moving inertial coordinate systems.Even this circumstance alone is sufficient to reject any trust in this method.

Just because of that study of the Earth interior by means of skin effect, leave it alone, by means of EMW non-existing in the nature is not possible. If even harmonic EMW existed, then utilization of skin effect in prospecting with MTS does not yield any result.Now, let us clarify this. As there are no NEMW in the nature, it is necessary to study thepossibility of using artificial EMW for MTS.Radio waves belong to this type.

In the second half of the 20th century, within the framework of long-term secret project,beginning from the 90-s of the last century, while developing extremelylow-frequency generators of any type, it became clear that it was not possible to achieve the targets.Due to thesecrecy of the research topics, the results of theresearch have not been published.As it is known that for therealization of such venturous ideas enormous financial, material, and intellectual resources of peoples have been spent.

As the results of secret research projects did not support in practice penetration of ELF waves through earth and water (*dekameter waves –3 ÷30 Hz*), are not convincing calculations on possibility of their application in the reality, too (*it is said that for sustaining radio connection with submarines in underwater position as well as underground radio communication!!!*). These papers experimentally established penetration of the longest EMW no more than 20 meters of water depth in a condition not suitable for radio communication.Information on these research works, not supported by documents, are published through the media in a blurred shape [3].Below, based on that information, we provide our conclusions.

For this case, the developers of ELF or ULF (ultra low frequency) generators, with regard of their uncomparable wavelength and ultralow efficiency factor demonstrated absolute e of theuselessness of the task they face in the closed projects as well as for the MTS theory, among all.

In the second half of the last century megameter ELF wave – 82 Hz, λ = 3656 Km, T=0.012 s was developed for operation of the Soviet «ZEVS» system, and 76 Hz, λ = 3944.64 Km for the American system«Seafarer».The lengths of waves those generators produce are comparable with the Earth radius. For them to operate, megawatt power stations were needed. But to register the waves they generated dipole antennas of the length of not shorter than a half of the wave length had been built, and this happened to be anunresolvable problem.Therefore, if at any time in the future it is possible to build generators, they cannot be mobile ones, i.e. to be compact and capable of prospecting interior of the Earth.

As in can be understood from the above, it is not possible to build and use in the reality even more clumsy long period EMW that are considered trivial ones that even feature periods one second to 24 hours and longer.Even there had been ant ideal ionosphere EMW with diurnal period it would be wave lengthwise by 7 million times longer than ELF wave from «ZEVS». And we leave thecalculation of wavelength with aperiod of 24 hours.

Therefore, we remind below how other frequencies of radio waves are created.

The sources of low frequency radio waves which range in the ELF (*dekameter waves – 3 ÷30 Hz*),ULF (*megameter*, *30÷300 Hz*), infralow frequencies (*ILF,hectorkilometer,0,3÷3 KHz*), very low frequencies (*VLF, myriameter, 3÷30 KHz*),and long waves (*LW, kilometer, 30÷300 kHz*),are generators of alternate current.

Generators of ratio frequencies are sources of radio waves with frequencies $3{\cdot}10^5 \div 3{\cdot}10^{12}$Hz, UHF generators, mass radiators, andtube oscillators.

Heated bodies are sources of visible light and infrared waves.

Atoms excited by means of irradiation through thecollision of accelerated charged electrons and photons are sources of X-Rays and ultraviolet rays.

As you see, it so happens that there is no any single method and equipment even for generating of radio waves used in practice.The properties of these EMW with different frequencies are totally different as well. Among those groups, generators of alternate current are the closest to MT sources range wise.

Now, let us tell in more detail about skin effect. The characteristics of skin effect for free electrons can be obtained by means of asolution of kinetic Maxwell equation. Here, while solving these equations it is necessary to be up to establish aconnection between current and EMW.

For thefirst time, the skin effect was revealed by O. Heaviside, and English scholarin 1885-1886 in the form of condensation of alternating electric current in the thin surface layer of a conductor, and in 1886, his compatriot J.Hughes detected it in an experiment.The connection between the frequency of current and thickness of the surface layer where alternating current accumulates in this effect had been established.

Later, a similar case – penetration of EMW to adifferent depth in correspondence with frequency was discussed.The both depths were called skin depth. For the second case, skin effect is a condensation of alternating EMF in the thin surface layer of conductive medium corresponding to its frequency.This layer is termed as skin layer and its gage (δ) is called skin depth. The effect is revealed when current (*induction*), excited by free electrons in a conducting medium, metals, plasma, in ionosphere (*on short waves*), degenerate semiconductor, as well as in other media that feature sufficiently high conductivity.

And here, skin depth depends on frequency (f) of the generating EMW, conductivity (σ) of the medium, dielectric(ε)and magnetic(μ)transmittivity as well as flatness of the medium surface.The effect for cross waves and alternating currents is observed in nearsurface shape. As it is known, the EMW are cross waves only.

In order to obtain thedesired result in non-ideal (*absorbing, dissipating, dispersing etc.*)media, energy loss connected with condition and content of the medium must be taken into account, as the amount of energy spent by the wave may be insufficient for useful work to be produced by the wave in the interior. For this purpose,absorbance index may be calculated according to the formula$\kappa = \frac{\omega}{\mathrm{c}}\sqrt{\frac{-\varepsilon+\sqrt{\varepsilon^2+(60\lambda\sigma)^2}}{2}}$, wher: ωstands for circular frequency; c is length velocity; λstands forthe wave length; $\sigma$is electric conductivity of the medium; εstands for dielectric permittivity of the medium (*dielectrical constant*). If$\kappa = 1$, then energy of EMW is subject to complete absorption in the Earth [7].

The energy (W) of EMF in a volume unit of themedium is equal to sum of the energy of field in vacuum and energy of medium charges movement in the wave field. And heat(Q) emitted in a unit of time is equal to work of forth of friction.The formula to find magnitude of heat is as follows: $\mathrm{Q} = \frac{\omega\varepsilon''|\mathbf{E}_0|^2}{8\pi}$, where: $\varepsilon'' = \frac{4\pi N e^2 \nu\omega}{m\left[\left(\omega_0^2-\omega^2\right)^2+\omega^2\nu^2\right]}$– is imaginary component of the complex dielectric permittivity; $N$is

volume concentration of micto particles in the medium in question; $m$stands for the mass of electron; e is elementary charge; ν stands for frequency of collisions of the charge with micro particles.

Unfortunately, it is not possible to express energy through dielectric permittivity. When$\nu = 0$, $\varepsilon'' = 0$, and$Q = 0$,as well (*i.e. such a situation correspond to the outer space*),in other words, for a case, when, as a result of wave process the wave travels through the medium without delay, its energy is found via the following formula:$\boldsymbol{W}_E = \frac{|\mathbf{E_0}|^2}{16\pi}\frac{d(\omega\varepsilon)}{d\omega}$. Here you will see that EMW cannot penetrate in the Earth interior, [4: p.p. 94-97].

At low frequencies, when the dispersion frequency may be neglected and $\varepsilon_0$not be taken into account,skin depth will be equal: $\delta = \frac{c}{\sqrt{2\pi\omega\sigma_0}} = \frac{c}{n\omega}$, where$n = \sqrt{2\pi\sigma_0/\omega}$– refraction factor comparable with the wave's phase velocity.

Now let us itemize our conclusion to what depth the EMW can penetrate depending on the physical(*including accountof* μ) properties of the medium. Therefore we introduce tangent of the loss angle: $tg\ \delta = 4\pi\sigma/(\omega\varepsilon)$. For strongly decadent wave($tg\delta \gg 1$):$\approx \varkappa = \sqrt{(\mu\varepsilon/2)tg\delta} = \sqrt{2\pi\mu\sigma/\omega}$.We see from that that magnitude of loss and phase velocity depend on frequency as well (*dispersion phenomenon*).But in this case the wave process does not come to being, as the wave fades on very short distances: $\delta = c/(\omega\varkappa) = \lambda/(2\pi\varkappa) = \lambda/\left(2\pi\sqrt{2\pi\mu\sigma/\omega}\right) = \lambda/\left(2\pi\sqrt{\mu\sigma T}\right) = \frac{c}{2\pi}\sqrt{T/(\mu\sigma)}$, [4: p. 34].

In good conductors, absorbance index ($\varkappa$*–speed of wave amplitude decrease in the direction of propagation*) and refraction index(n *– determining phase velocity*) are approximately equal$\approx n \gg 1$. Thus, the depth of penetration of EMW into conducting medium (*thickness of skin layer*) must be shorter than the wave length: $\delta \ll \lambda$,[4: p. 35].

Now,for the ideal radio waves in the terrestrial conditions, we find through formulae$\delta = c/\sqrt{2\pi\omega\mu\sigma} = c/\left(2\pi\sqrt{\mu\,\sigma/T}\right)$the physical parameters resulting from skin phenomenon, [2: p. 308]:

If T=1s, μ=1, σ=10^3S/m, thenδ =1,510 Km, h_{eff}*=1,067.7 Km;*
If T=1s, μ=1, σ=10^0S/m,thenδ =47,728 Km, h_{eff}*=33,749 Km;*
IfT=1s, μ=1, σ=10^{-3}S/m, thenδ =94,866км, h_{eff}*=67,079 Km;*

Such an EMW for MTS exists neither in nature, not in technology. Had it even existed, as you see the depth of its penetration, it is of no use for addressing geological problems?

For the ZEVS wave frequency$f$ = 82 Hz, if:

μ=1, σ=10^3S/m, thenδ =167Km; h_{eff}*=1,273 Km;*
μ=1, σ=10^0S/m, thenδ = 5,270 Km; h_{eff}*=3,726.8 Km;*
μ=1, σ=10^{-3}S/m,thenδ =166,667 Km; h_{eff}*= 117,850 Km*.

ZEVS generator producing such wave cannot be used for addressing geological problems.Therefore,let us consider similar case for the radio waves with higher frequencies.If:

f =300 Hz, μ=1, σ=10^3S/m, thenδ =87.14 Km; h_{eff}*=61,62 Km;*
f =300 Hz, μ=1, σ=10^0S/m, тогда δ =2,756 Km;h_{eff}*= 1.948 Km;*

f =3 KHz, μ=1, σ=10^3S/m, thenδ =27.5738Km; h_{eff}*=19.5 Km;*
f =3 KHz, μ=1, σ=10^0S/m,thenδ =871.39 Km;h_{eff}*=616.2 Km;*

f =30 KHz, μ=1, σ=10^3S/m, thenδ =8.7139 Km;h_{eff}*=6.16 Km;*
f =300 KHz, μ=1, σ=10^3S/m,thenδ =2.757 Km;h_{eff}*=1.94 Km*.

As one can see, ifat these conditions, formulae for finding the skin depth and effective depth are good for application, thenfor electrometry, it happens,it is possible theoretically possible to use radio waves for which generators are already available.

In compliance with the theory, the most remote sources of radio waves are applied for this end.The cause of that is quasistationary approximation, i.e. in necessity of many fold longer wavelength as compared to the distance to its source.This case corresponds to the condition of radiating far field region. Then$|k_1|r$>>1,orr/δ> 3-5, where: $k_1$stands for wave number of homogeneous medium; $r$is distance from ionospheric source of EMW to receiving MT station on the Earth surface.Only when this condition is

satisfied, i.e. at this distance necessary EMW will have time to take shape till the point of registration on the Earth surface.This condition corresponds to the following case: at the height of NEMW source $r = 60 \div 90$Km, for the condition to be satisfied,ifwe take$\rho_к = 1000$ [$\Omega * м$], thenskin depth must be within the range of$\delta = 18 \div 30$Km.This basically corresponds to the frequency range 1÷3 KHz, and the frequency,in compliance with the medium conductivity, may increase till 300 KHz.

That said, it willbe usedelectric induction current instead conductivity current, i.e. abandon quasistationary approximation.Moreover,in the theory employed,the power of the wave source is not taken into account as in quasistationary approximation the wave does not have wave properties. Through "waves" with to wave properties, it is not possible to reveal physical properties of the medium in question.

Indeed, anelectric induction current is just alternating electric current in conducting medium and/or alternating electric field in atmosphere(*as well as in ionosphere*). Ifdisregard this, thenconductivity current remains only. In this case, MT theory will forfeit all the rights to use the laws of wave process including all the consequences it entails (*i.e.wave equation, wave number, skin effect, skin depth,effective depth, impedance etc*.).At the harmonic changes of electric field amplitude of electric induction current density in dielectrics exceeds the amplitude of conductivity current density. In compliance with definition of electric induction current density the following condition is satisfied in dielectrics: $\omega\varepsilon E > \sigma E$, or$\omega\varepsilon/\sigma > 1$.The meaning here–the medium resists travelling of the electromagnetic field through it in compliance with its frequency (*in direct ratio*).This resistance may be called reactance. Thus, depending on the wave frequency the same matter may appear as both dielectric and conductor.It corresponds to boundary condition of near-field zone, i.e. $|k_1|r << 1$, or$r/\delta < 0.5$,where$\delta \cong 503{,}29\sqrt{\rho_к T}$is thickness of skin layer in homogeneous earth.Thereat, components of electric field depend on electric conductivity of earth but do not depend on frequency of the field, and the magnetic component does not depend on anything. It means that EMF is similar to the field of direct current, and skin effect does not work thereat.Therefore, for such a case, it is not possible to use such a field generated by the conductivity current.

According to the boundary condition, for the MTS method that uses radio waves within the depths range$\delta = 120 \div 180$Km, the wave frequency may decrease to 3 KHz. It meanssuch cases must be experimentally checked mandatorily.Under refusal from thequasi-stationary field and taking into account electric induction current actual depth of study will fall down up to 1000 times.

Ifwe take into consideration such data and approach from the assumption of linearity of medium for ordinary waves in the MT-method almost whole geologic medium happen to be linear.Therefore, in its initial theory, it will be appropriate in the formula of wave number to not include conductivity current but include the electric induction current [5].

But in the practice, attempts to apply radio waves never stopped. The first effective attempt was undertaken by Sweden in 2001. In the University of Uppsala, a generator was developed emitting EMW in the frequency range of 1 KHz÷ 10 KHz. This controlled source of EMW was developed for MTS.Therefore, this method was called "radio MTS" (*RMTS*). At present sophisticated version of the method is being developed under name RMT-K.EMW of the frequency range is 1 KHz÷ 1 MHz.The depth of study at such high frequencies does not exceed 50-60 meters, 100 m the largest. This is the depth that allows opportunity to check results of the method.At present, as we have mentioned above, the method of RMT-K is appliedupon introduction electric induction current into the theory instead of conductivity current. Ifhere the results obtained are real ones and experimentally corroborated, thenthis method is worth respect [10]. From the very beginning,the work on MT methods had to be started from the situations available for corroboration. Nothing lasts forever in this world. As time passes, the MT methods merits and their types as well change beyond recognition. We have achieved this at the minimum cost.

Impedance

The term *impedance* was coined by the British scholars O. B. Heaviside and O. Lodge.The US scholar S. Schelkunoff introduced the notion of field impedance in 1938.On the skin effect, there are notions of impedance of the alternating current electric circuit impedance and impedance of conductive surface in the monochromatic EMF (*field impedance and surface impedance*).

The complex (*full*) resistance of element of electric circuit $|Z| = \sqrt{\mathcal{R}^2 + X^2}$ is termed as module of its impedance,where$\mathcal{R}$is active resistance (*to direct current*),and$X$is reactive one (*to alternating current*), i.e. frequency depending and imaginary resistance.Here impedance is measured by unit of electric resistance *om* in the international system SI, and in the Gauss (SGC) system it does not have unit of measure. In SGC, impedance is a proportionality factor between **E**and**H**components of field, and does not have any physical meaning. Butifwe want to recognize it in SGC as resistance of medium, thenit will featureunit ofreverse speed.Nonetheless, such a definition would be not quite correct. Therefore, to solve geological problems, first we will consider impedance as reactive (*inductive*) resistance of medium to the current excited in one by monochromatic EMF. Therefore, we take impedance effectively describing ordinary absorption of the wave energy in conductors, as approximate connecting factor between tangential component **E**and**H**of the harmonic flat EMFat the boundary «vacuum-metal»:

$\boldsymbol{E}_2 = Z \cdot \boldsymbol{H}_2 = \sqrt{\frac{\mu_2}{\varepsilon_2}}[\boldsymbol{H_2 \nu}]$, [SI], where$\boldsymbol{\nu}$ – unitary vector, vertically (*along normal line*) falling on the division border.Here, EMW moves according to right-hand rule. At such conditions, according to Leontovich boundary conditions, refraction index (n) on the boundary must satisfy the following requirements: $|n_2| \gg n_1$, $\delta \ll L$, where: $n_2$is refraction index of the conducting layer; $n_1$is refraction index of empty space; δstands for skin depth; Lstands for the thickness of conducting layer.Here, one talk about transition of EMW from vacuum in metal (*in our case – from the outer space in the Earth*).Here, along the movement direction of wave, the atmosphere is considered the first, and the Earth surface is the second layer [7].Ifthe boundary surface curvature $R^{\text{к}} \gg \delta$, thenLeontovich boundary conditions are effective,[5]. Indeed, impedance may be calculated for any surface with known electric parameters($i.e. \varepsilon_n, \mu_n, \sigma_n$). Impedance calculated this way on the boundary surface«aer-metal» is termed surface impedance. The physical meaning of impedance does not change. In the case in question, impedance matches characteristic impedance(*resistance*) of the second medium, extending like homogeneous long metal.At not so high frequencies, for the medium with flat surface and high conductivity, we obtain the following: $Z = (1 + i)\sqrt{\frac{\mu\omega}{8\pi\sigma}}$, whereσstands for specific conductivity with regard of direct current.S.Schelkunoff was pioneer to publish this solution in 1938,[13;14]. Later, in 1948, Leontovich found the most precise expressionfor impedance obtained for homogeneous metallic conductor with the flat surface[7]. Impedance of the empty space is calculated by the formula$Z=E_x/H_y=120\pi$ [Ω], and it is sometimes called characteristic impedance of vacuum.According to the MTS, for hight electric conductivity,the equivalent formula of the specific electric resistance of layer in the SI will look as follows: $\rho_{\text{к}} = 0{,}2\ T\ Z^2$,[Ω*м]. The both correspond to the above original. But the matter is different. This Leontovich boundary condition is called impedance condition in the applied electrodynamics, besides, it can used when the structure of field in the second conducting medium is known in advance only. In the case of concrete problems, the equivalent boundary conditions are approximate only and have conditions of applicability on their own. While solving them,these conditions must be many times and very accurately checked again and again in advance.

The meaning of the Leontovich boundary conditions: it is possible to find impedance on the boundary with the first medium (*the empty space*) through physical parameters of the second conducting medium. In the MTS, in contrary to the said, an attempt has been undertaken to find electric parameters of the second internal medium(*the Earth*) through found impedance outside (*on the Earth surface*).The field impedance in question has been introduced by S.Schelkunoff and Leontovich for use in the theory of antennas.It means,knowing in advance electric properties of the antenna material, it was important to derive necessary information through themagnitude of energy proper to the transmitted radio signal and the part of it absorbed by theantenna.The EMW energy had not lost,the field impedance would have themeaning of the real value.Thenit can be considered wave resistance.But, while solving geological problems, loss of own energy of EMW happens to be unlimited.

In geology, ifnot for specification of the lower boundaries (*geometry*)of the layer coming out to the daily surface, для нахождения его физических свойств, there is no need to carry out electrometry

work.Here,the sought parameters are the physical parameters and geometry of the objects inside the Earth. The simplestcut of the Earth is cut with horizontal layer. Therefore, we consider application of the method of themetallic antenna in the empty space using impedance for solution of problems notappropriate way for searching underground objects in the interior, their physical parameters, and geometry.In the case of metallic antenna, there are two media – the empty space and metal, but in geology, there are the empty space (*atmosphere*) and the set of infinitely absorbing earth layers.Here, the most important is balance between energy of EMW and volume of absorbing medium, i.e. for the first case – with limited volume of the antenna material, and for the second case –with unlimited volume of the Earth layers. Finding such a balance, by means of measurement, of energy of refracted radio waves and limitedvolume of the antenna material is solved problem in the theory of antennas. Given the infinite volume of geological layers, there is no any possibility of finding such a balance.

In the conditions of MTS, which corresponds to falling of the wave along normal, the set of three, i.e. $\mathbf{E}_{x,y}, \mathbf{H}_{x,y}$ and the Poynting vector on positive direction to the Earth interior along vertical z axis forms the right-hand screw.As impedance appearing at the intromission of the wave into the medium is the full resistance of the medium, at its zero value such a medium has ideal conductivity and strong absorption. Then, when there is such an absorbing layer on the bottom, н $\mathbf{E}_{x,y}= 0$ on the surface of the medium. The reflection index found by the amplitudes of fields and expressed through impedance $\left(Z^{(2)} - Z^{(1)}\right)/\left(Z^{(2)} + Z^{(1)}\right) =$ Гcorresponds to such a situation.This Fresnel formula.It mean that the energy of EMW is fully absorbed by the underlie Earth layers that are infinite volume.

For estimation of electric situation in the geologic object in question, such a phenomenon($\mathbf{E}_{x,y}= 0$) can serve as asign for approximate estimation of electric conductivity of underlie layer.Ifthe conductivity in this layer is high but finite, theninsignificant tangent component $\mathbf{E}_{x,y}$ appears on the surface of discontinuity.Exactly this strength determines power flow inside the conductor spent for its heating.

Ifthe current is connected with the medium conductivity and $\boldsymbol{J} = \boldsymbol{J}_{np}$, then, to calculate the power of heat lost, the following formula may be used$p_T = \boldsymbol{J}_{np}\boldsymbol{E} = \sigma|\boldsymbol{E}|^2$. This is Joule–Lenz lawin a differential form,where$\boldsymbol{J}_{np}$stands for conductivity current, andσstands for the medium conductivity. The above mentioned is known in technology.

For the plane wave, let us find relation between magnitudes of electric and magnetic fields strength on the boundary «air-Earth».For this end, using the second Maxwell equation($rot\boldsymbol{H} = \frac{4\pi\sigma}{c}\boldsymbol{E}$),exponential law of electric wave$E = E_0 exp\,(\pm\boldsymbol{\kappa}z)$in the direction of falling on the Earth along normal(z) and characteristic depth of the skin layer($\delta = c/\sqrt{2\pi\omega\mu\sigma}$), let us compose the equation $\boldsymbol{E} = (1+i)\frac{c}{4\pi\sigma\delta}\boldsymbol{H} \times \boldsymbol{m}$.From that, we find impedance$Z = (1+i)\,c/4\pi\sigma\delta = (1+i)\sqrt{\mu\omega/8\pi\sigma}$. This formula gives the full expression for the surface impedance(*for the day time surface of the Earth*). Here,$\boldsymbol{m}$is unitary vector, $\boldsymbol{\kappa}$is the wave vector directed along the axis (z) of the wave fall, $c$is the light velocity,σstands for the static conductivity of the strongly conductive medium at low frequencies, [2: p. 308].

For plane waves in homogeneous isotropic medium$\boldsymbol{E} = -\sqrt{\mu/\varepsilon}[\boldsymbol{Hm}]$and impedance corresponding to one is equal$Z_0 = \sqrt{\mu/\varepsilon}$. This relation is true for any point of the medium including the surface. Here vectors ***E, H,m***a right orthogonal trey of vectors. This relation is termed impedance of the medium and considered the Leontovich boundary condition,[4: p. 33].

For the cases of normal and abnormal (*except* δ) skin-effect, the surface impedance (Z) has the most precise quantitative meaning. At the normal skin effect for low frequencies, impedance is equal$Z = 2\pi\omega/c^2\sigma_0$and decreases along with temperature(T^o) as $\sigma_0$increases.

In order to resolve the problem correctly through this relation, components of electromagnetic field**E**(t) and**H**(t) must be measured directly in the Earth interior, i.e. in the medium in question, at the depth, by instantaneous values (*i.e. not by the wave amplitudes or variations*). Only thenimpedance corresponds to its definition. Had we were able to carry out such measurements, thenthere would be no need for electrometry with the MTS method.

Mathematicaltechniqueshave been derived to find the bedding depth of interior layers of the Earth

and their electric parameters. In geophysics, such operations are called theinterpretation of the processed data of field materials.

Given the above, any new method offered, prior to introduction to practice, must be submitted to comprehensive theoretical examination to the council of scholars in the field,experimental testing,in the prior studied testing ground,in natural conditions*(full-scale modeling*),and only approval of the usefulness by the experts it may be approved for utilization in production.

Study of interior electric currents of the Earth and magnetic fields by means of full-scale only will give accelerated, explosive growth and invaluable contribution to the development of the fundamental and applied research (*including solution of the geology as well as seismology problems*).Therefore, we believe that such studies will develop the theory of electrodynamics of complex mediaand advance it immensely.Such multidisciplinary full-scale studies must be carried out in thecomplex along with drilling ultra-deep wells.

As in is known, in ultradeep well in the Kola Peninsula (*Murmansk oblast*), where drilling was completed in late 1982 at the depth of more than 12 Km, MT variations were registered only once at the depth of 6 Km. As we know, thenit happened «the Kola well management guarding it even stronger than a spaceshipby a narrow margin agreed to lower the probe of MT instrument to the depth of 6 Km only».Now, the data registered by the instruments developed for that purpose especially in the early 2000-s,filled the ranks of «archive valuables». By present, both the Kola ultradeep well and its dedicated site are annihilated and the special instruments lowered in the well as about to be annihilated.

To develop such equipment for well studies and their application at the Kola well, we put together and proposed special research project, in 1990. At that time, the leaders of research academic institutions that possessed power and influence did not give full play to the project.If our proposals had introduced at that time, all that problems would have been studied and resolved 28 years ago, already.

We would like to believe that natural earth electric currents exist at all levels of depth. It can be checked and proven by the interior observation in deep wells. But the causes for such current to come existence may be various. For the time being, the science tells that in the Earth interior, stray voltage, man-caused, electrochemical, thermoelectric, convection currents, and other types of electric currents are present, besides the Earth currents.For all that,only the results of real interior observation in the deep well may provide exhaustive answers to almost all these questions. But even at presence of any type of the above electric currents and EMW, the matter of their utilization for electrometry or any other purpose is open and exceeding efforts of scholars are needed.

REFERENCES

[1] Berdichevskij M. N., Jelektricheskaja razvedka metodom magnitotelluricheskogo profilirovanija, Moskva. Nedra, **1968**.

[2] Bredov M.M., Rumjancev V. V., Toptygin I. N., Klassicheskaja jelektrodinamika, Moskva, Nauka, **1985** g.

[3] Vikipedija, internet.

[4] Vinogradova M.B., Rudenko, A.P.Suhorukov, Teorija voln, Moskva, Nauka, **1990** g.

[5] Grigor'ev A. D., Jelektrodinamika i tehnika SVCh, Moskva, Vysshaja shkola, **1990** g.

[6] Zhdanov M. S., Jelektrorazvedka, M., «Nedra», **1986** g.

[7] Leontovich M.A. O priblizhennyh granichnyh uslovijah dlja jelektromagnitnogo polja na poverhnosti horosho provodjashhih tel. Sb. «Issledovanija po rasprostraneniju radiovoln», izd. AN SSSR, vyp. 2, **1948**.

[8] Ovchinnikov I. K., Teorija polja, Moskva, Nedra, **1979** g.

[9] Strjetton Dzh. A., Teorija jelektromagnetizma, OGIZ, **1948** g.

[10] Shlykov A. A., dissertacija na temu: «Interpretacija dannyh metoda radiomagnitotellurchsekih zondirovanij s kontroliruemym istochnikom», S-Peterburgskij GU, **2015** g.

[11] Javorskij B.M., A.A.Detlaf, Spravochnik po fizike, M., Nauka, **1980**.

[12] Jakubovskij Ju.V., Jelektrorazvedka, M., «Nedra», **1973**.

[13] «Electromagnetic Waves in Conducting Tubes», Phys. Rev. 52, 1078-1078, November **1937**,

[14] «On Diffraction and Radiation of Electromagnetic Waves», Phys. Rev. 56, 308, **1939**.

УДК 550.837

С. Байдуллаев, С. С. Байдуллаев.

Техникалық колледж, Шымкент, Қазақстан;
"Қазтрансгаз өнімдері" ЖШС, Шымкент, Қазақстан

МАГНИТОТЕЛЛУРЛЫҚ ЗОНДЫЛАУ ӘДІСІНІҢ ЖАҒДАЙЫН ТАЛДАУ

Аннотация. 1. Жер қойнауын геологияның геофизикалық барлауындағы магнитотеллурлық зондылау әдісіне, оның 60 жылдан астам тарихындағы өмірінде, алғаш рет талдамалық сын жарияланууда.

2. Мақалада ілгері айтылмаған талдау қорытындылары жарияланууда. Нәтижеде, магнитотеллурлық зондылау әдісінің негізі ретінде ғарыштық электромагниттік ауытқуларға қолданылған скин-құбылыс, квазистационарлық жанасу, импеданс, жылжымалы тоқ, өткізгіш тоқ түсініктері талқыланып, олар геологиялық барлау мақсатында орынсыз қолданылған деген қорытындылар шығарылған.

Түйін сөздер: жер қойнауы, геофизика, электробарлау, скин-құбылыс, импеданс, квазистационарлық жанасу, жылжымалы тоқ, өткізгіш тоқ.

С. Байдуллаев, С. С. Байдуллаев

Технический колледж, Шымкент, Казахстан;
ТОО «Продукции Казтрансгаза», Шымкент, Казахстан.

АНАЛИЗ СОСТОЯНИЯ МЕТОДА МАГНИТОТЕЛЛУРИЧЕСКОГО ЗОНДИРОВАНИЯ

Аннотация: 1. Впервые публикуется критический анализ состояния геофизического метода геологии по магнитотеллурическому зондированию, за период более чем 60-летней истории его существования.

2. В статьи публикуются ранее не высказанные аналитические заключения. В результате анализа понятий, таких как скин-эффект, квазистационарное приближение, импеданс, ток смещения, ток проводимости, применённые к космическим вариациям магнитных возмущений как основы метода, сделаны выводы о том, что они для цели геологической разведки использованы неправомерно.

Ключевые слова: недра земли, геофизика, электрометрия, скин-эффект, импеданс, квазистационарное приближение, ток смещения, ток проводимости.

МАЗМҰНЫ

* * *

СОДЕРЖАНИЕ

* * *

CONTENTS

* * *

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

www:nauka-nanrk.kz

http://www.physics-mathematics.kz

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Редакторы *М. С. Ахметова, Т.А. Апендиев, Д.С. Аленов*
Верстка на компьютере *А.М. Кульгинбаевой*

Подписано в печать 15.02.2018.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
9 п.л. Тираж 300. Заказ 1.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-18, 272-13-19