

RECENT RESEARCH OF GEOPHYSICAL PARAMETERS OF THE LITHOSPHERE OF EAST-EUROPEAN PLATFORM

Analysis of anomalies of electric conductivity in tectonically stable regions showed that within the ancient platforms that were previously attributed to aseismic, rarely, but the catastrophic earthquakes with high intensity occur. Accepting the assumption that the places of concentration of epicentres of earthquakes often line up along the areas of axial parts of regional anomalies of conductivity we believe that in these cases they can have general nature of origin. Such earthquakes, mainly, correlate with the areas of active deep tectonic faults, suture zones, boundary deflections and sections of platforms adjacent to them.

Keywords: conductivity anomaly, deep fluid, earthquake.

Introduction

In the course of geophysical investigations of the last decades a widespread presence of seismic and geoelectric inhomogeneities in the consolidated crust of continents was established. The main role in formations of these inhomogeneities is played by fluids and deep fluid systems.

According to data seismic tomography and Depth Seismic Sounding the fluid flows correspond to subvertical column velocity with alternating of high and low velocities. The last is associated with the processes of stretching and compression density differentiation medium for passing fluid flow. These processes form the structures that are fixed as electroconductive layers.

Relationship between geophysical anomalies and seismic activity

It is known that in the territories of Stable Continental Regions more than 1300 earthquakes occurred with magnitudes $M \geq 4.5$ [Schulte, Mooney, 2005]. The magnitude of interplate earthquakes can reach $M=6.5 - 7.8$ and the earthquakes can be not less powerful than the ones in rift or intraplate zones (www.isc.ac.uk).

Source for earthquakes of the East-European platform were found practically everywhere with the magnitude of the quakes reaching $M=3.0 - 4.0$, rarely $M=5.0-5.8$ [Сафронов, 2003]. Within boundaries of stable structures of the Ukrainian Shield, Volyn-Podolsk plate and Dnieper-Donetsk basin in Ukraine the manifestations of local earthquakes with a large spread of magnitudes $M= 2.0-3.8$ are known [Kendzera, Omelchenko, 2009; Starostenko et al., 2012].

A common characteristic of many shields, such as Ukrainian, Baltic, Canadian, Indian, Anabar and Aldan, is the presence of a layer with slower velocity in the upper crust at the depth of 4-17 km. In most cases this waveguide is a region of concentration of epicenters of upper crust earthquakes [Korhonen, Porkka, 1981; Luosto, Hyvonen, 2001; Трипольский, Шаров, 2004].

Majority of the earthquakes on the platforms are related to fracture zones that became active during Neogene-Quaternary period and that separate massive lithostratigraphic rock formations [Сафронов, 2003].

In addition, the earthquakes can also be related to riftogenic zones and zone of cross points of active crust structures of one direction.

The development of representation of the seismic process as a result of processes of deformation and stress in monolithic environment is not the only cause of the formation zone of seismic fireplace. Axiomatics of M.A.Sadovsky [Sadovsky and Pisarenko, 1991] changed of these presentations, changing to opened, dissipative, self-organizing hierarchically block environments. Presently approach [Gufeld et al., 1998; Гусев, Гуфельд, 2006] to earthquake predictions is based on that the lithosphere deformation is characteristic feature both for seismically active and aseismic areas. There are also effects of migration of sources of weak earthquakes along different structural displacement [Гуфельд, 2007], which externally display processes of propagation of long period waves of volumetric deformation. All this specifies that the geological environment constantly is in a metastable condition; it is possible that there is an additional mechanism of pumping of environment by elastic energy. It characterizes the environment as dissipative structure.

In connection with that, more and more attention is attracted to studies of a role played by deep fluids and processes of degasification of the Earth [Летников, 2001]. Analyses are based on processes of interactions between ascending flows of hydrogen and helium and the solid lithosphere. A consequence of such processes is gas porosity that controls many parameters of the medium and the oscillation regime of the three-dimensional state of stresses of the block structures, which impacts the dynamics of block movements. The endogenous activity of the lithosphere and its instability are controlled by degassing of light gases [Gufeld et al., 2011]. Evidently, great masses of material are involved in the deformation processes, from upper mantle to upper crust.

Let us consider the structure of anomalous electric conductivity in the consolidated Earth crust of European continent.

In accordance with the present analysis, it can be concluded that there are indeed qualitative dependencies between deep anomalies of high electrical conductivity in the Earth crust and epicenters of seismic events in passive regions of the globe.

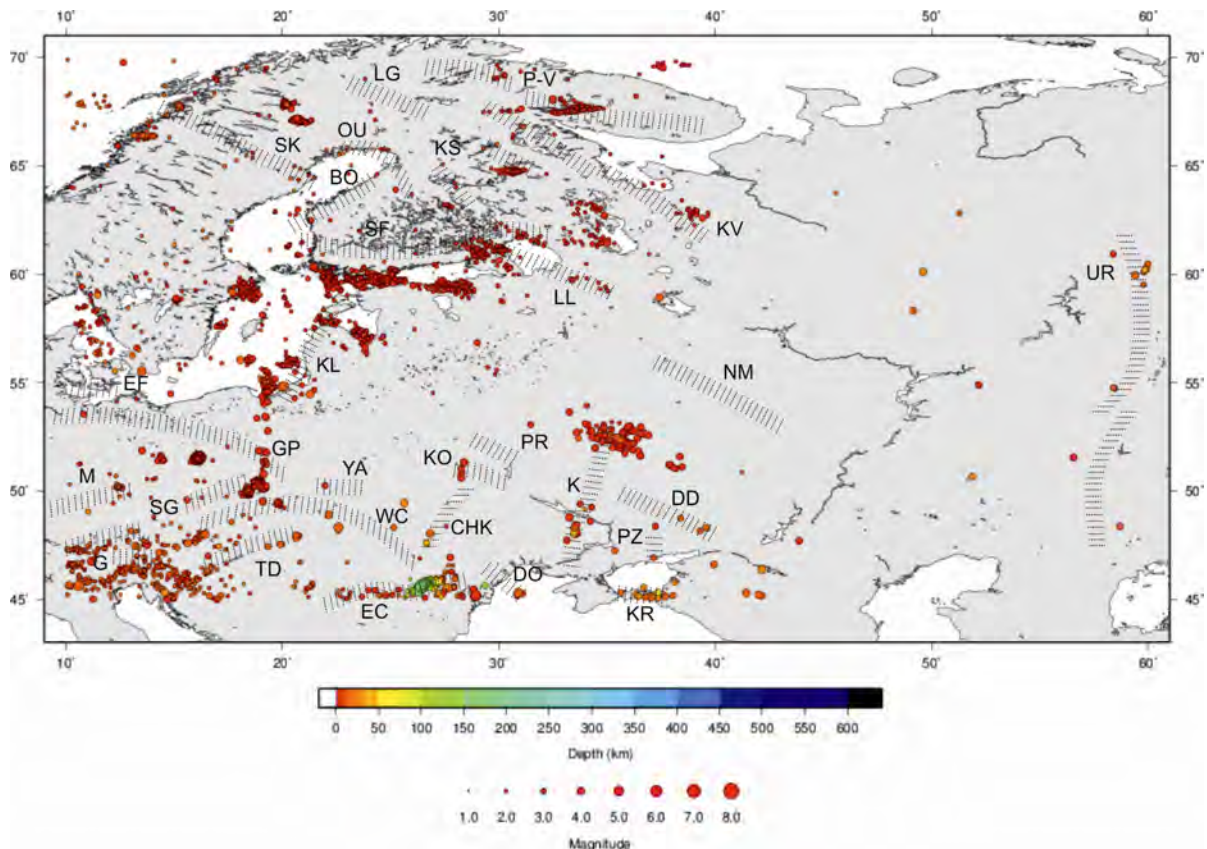


Fig. 1. Scheme of earthquake epicenters (according to the www.isc.ac.uk of the period from 2008 to 2012 years with $M=2-4$) and regional anomalies of conductivity in the crust of the East-European platform: BO – Bothnian; DD – Donels-Dniepr; PZ – Peryazovyan; EC – Eastern Carpathian; DO – Dobrogea; G – Gail river; M – Moldanubian; EF-Trad European Fault; GP – German-Polish; KL – Klaipeda; K – Kirovograd; KS – Kainuu Schist Belt; KV – Kittila-Vetrenny; SK – Skelleftea-Storavan; LL – Lab Ladoga; LG – Lapland Granulite Bell; P-V – Polmek-Pechenga-Imandra-Varzuga; NM – Near-Moscow; OU – Oulu; SF – Southern Finland; SG – Southern German; TD – Transdanubian; UR – Urals; WC – Western Carpathian; KO – Korosten; CHK – Chernovtsy-Korosten; YA – Jaworowsk; PR – Pripyat; KR – Crimea [Burakhovich et al. 2001, Kulik 2004, Kulik and Burakhovich 2006]. Shading corresponds to high conductivity layers.

Conclusions

In the ancient platforms the areas of concentration of epicenters of seismic events are often lined up along zones of anomalies of electric conductivity. One can suggest that their close spatial correlation is due to the common nature of their formation. At the same time the absence of such correlation in other parts of the ancient platforms tells us that nature of this correlation is not fully understood and requires further studies.

As a result we obtained, that some of these anomalies are extended on thousands kilometers along regional and interregional high conductivity structures and can be the result of geodynamic processes. The similar correlation is observed at both American continents, Australia and within the European continent.

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СОВРЕМЕННЫЕ ИССЛЕДОВАНИЯ ГЕОФИЗИЧЕСКИХ ПАРАМЕТРОВ ЛИТОСФЕРЫ ВОСТОЧНОЕВРОПЕЙСКОЙ ПЛАТФОРМЫ

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Анализ аномалий высокой электропроводности тектонически стабильных регионов показал, что на древних платформах, которые ранее относили к асейсмичным, редко, но происходят катастрофические землетрясения с высокой интенсивностью. Выдвинуто предположение, что места концентрации эпицентров землетрясений часто выстраиваются вдоль зон осевых частей региональных аномалий электропроводности и в этих случаях они могут иметь общую природу происхождения. Землетрясения такого рода, в основном, коррелируют с зонами активных глубинных тектонических разломов, шовными зонами, краевыми прогибами и участками платформ прилегающих к ним.

Ключевые слова: аномалии электропроводности, глубинные флюиды, землетрясения.

СУЧАСНІ ДОСЛІДЖЕННЯ ГЕОФІЗИЧНИХ ПАРАМЕТРІВ ЛІТОСФЕРИ СХІДНОЄВРОПЕЙСЬКОЇ ПЛАТФОРМИ

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Аналіз аномалій високої електропровідності тектонічно стабільних регіонів показав, що на древніх платформах, які раніше відносили до асейсмічних, рідко, але відбуваються катастрофічні землетруси з високою інтенсивністю. Висунуто припущення, що місця концентрації епіцентрів землетрусів часто вишиковуються уздовж зон осьових частин регіональних аномалій електропровідності і в цих випадках вони можуть мати спільну природу походження. Землетруси такого роду, в основному, корелюють з зонами активних глибинних тектонічних розломів, шовними зонами, крайовими прогинами і ділянками платформ, які до них прилягають.

Ключові слова: аномалії електропровідності, глибинні флюїди, землетруси.