Distribution of elastic parameters in the Earth's core

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Institute of Physics of the Earth, RAS, Moscow, Russia
burmin@ifz.ru

The travel-time curves of refracted and reflected short-longitudinal seismic waves propagating in the Earth's core were constructed by record-sections of seismic vibrations from deep earthquakes recorded by the global network. These travel-time obtained velocity section core, in good agreement with observed data. The velocity curve for the Earth's core is well explain the nature of the so-called «precursors» — vibrations that go in the first arrival in the Earth's surface at epicentral distances of 134—142°. Features velocity section of the outer core is the presence of his bottom of the layer thickness of about 500 km from the high positive velocity gradient and immediately beneath a low-velocity layer thickness of about 200 km (zone F). In the inner core velocity first increases rather strongly to a depth of approximately 5500 km, and then to the center of the Earth varies almost linearly, with a slightly higher gradient than is usual in the standard model.

Density, elastic parameters and viscosity of the Earth's core were obtained on the basis of velocity curve for the longitudinal seismic waves. The density distribution for the new model differs from the distribution obtained in the standard model PREM only in the inner core. Distributions of modulus and shear modulus, depending on the physical processes occurring inside the Earth, may have a different character. In particular, the bulk modulus can have a negative jump at the boundary of the outer and inner core of the Earth, and the shear modulus may be different from zero at the bottom of the outer core. It is concluded that the shear modulus in the bottom of the outer core to fluctuations in the order of 1 Hz should be different from zero, and reach values of $\sim 2\times 10^{12}$ Pa. This conclusion is based on the fact that the gradient of the velocity of longitudinal waves in the lower outer core increases and the assumption that the bulk modulus in the core is a monotonic function. Estimates of the coefficient of shear viscosity for the outer and inner core have been made. These estimates imply that in the outer core directly adjacent to the upper boundary of the outer core viscosity is low, which corresponds to the liquid state of matter in the Earth's core. As we move to the lower boundary of the outer core viscosity increases, and the substance goes into the vitreous state. Low viscosity, apparently, takes place at the bottom of the outer core in zone F.

The methodology of operative prognosis of hydrocarbons by gravity-magnetic and space data

© ***B. Busygin, S. Nikulin, E. Zatsepin, I. Garkusha, 2010***

National Mining University, Dniepropetrovsk, Ukraine
BusyginB@nmu.org.ua

Introduction. Because of constant growth of consumption of hydrocarbonic raw stock and exhaustion of world's reserves of oil and gas the problem of searches of new hydrocarbonic objects becomes more and more important. Nowadays for its decision the seismic survey in various modifications (for example, 3D, etc.) is used. However, possessing high geological efficiency, it demands large economic expenses, especially at field surveying on the big areas. For this reason the approaches based on using of a complex of cheap gravity-magnetic methods and space images of the various physical nature (multispectral, radar, thermal, etc.) received a wide dissemination.

Using the special geoinformation systems and technologies of the integrated analysis of spatial data [Pivnyak et al., 2007; Busygin, Nikulin, 2009], it is possible to implement the preliminary allocation of the sites on which it is expedient to apply detailed seismic survey. Use of such technique will allow to reduce considerably costs without essential loss of the information and to optimize a location of reconnaissance wells.

Investigated area. The proposed technique has been tested on a site in the size 137×130 km by the area more than 17000 km^2, located within the Dnieper—Donetsk cavity (DDC) (Fig. 1). Now the major strategic direction of searches of oil and gas in the territory of DDC are depths over 5 km. By the most reasonable estimations in the range of depths of 5—8 km it is concentrated over 5 billion tons of conditional fuel. At the beginning of 2009 there was discovered a great number of deposits in this region, amongst them — one of the largest in Europe Shebelinskoye gas-condensate deposit with resource of 650 bil. m^3 (exhausted).

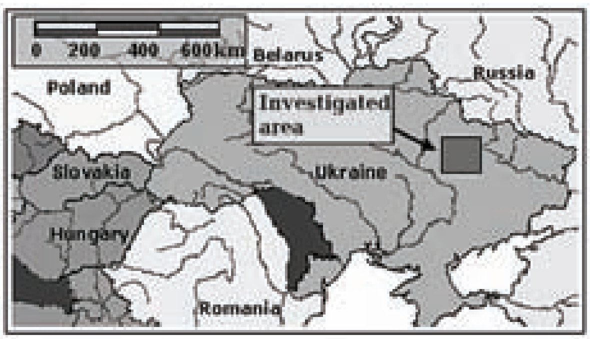

Fig. 1. Area location.

The initial data are presented by gravitational (Δg) and magnetic (Za) surveys on a grid 500×500 m, and the radar image received by SRTM (Shuttle Radar Topography Mission) with the resolution of 90 m. In researches were used 29 known hydrocarbons deposits, presented by gas, gas-condensate, and oil-and-gas objects.

Research technique. The apparatus of lineament analysis, based on detection and research of lineaments — the linear sites detected on space images and on physical fields, underlie the proposed technique.

For more accurate allocation of lineaments the radar image and geophysical fields were exposed to the operations of images processing – contrasting, histogram alignment, sharpness increase (Fig. 2). The images received as a result of processing, have allowed to allocate more amount of linear elements, including, visually not distinguishable in initial materials. Then using the Canny «optimal detector» [Canny, 1986] on space image and raster

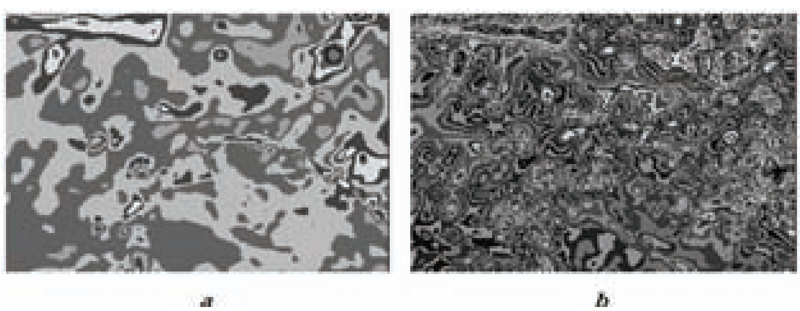

Fig. 2. Fragment of the raster map of magnetic field before (*a*) and after (*b*) operations of images processing (colors of a legend are generated in a random way).

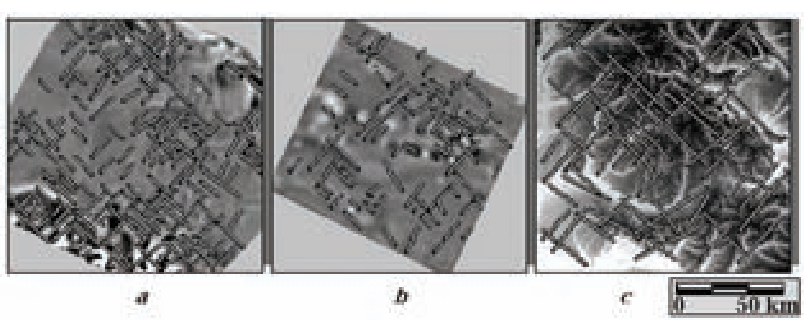

Fig. 3. Orthogonal systems of lineaments with azimuth 45—135º, detected on magnetic (*a*), gravitational (*b*) fields and in a radar image (*c*).

maps of fields the borders of brightness were defined and corresponding maps were built.

The lineaments were allocated using the Hough transformation [Sewisy, 2002] to brightness borders maps. The circle diagram estimation showed that two orthogonal systems of lineaments with azimuth 0—90° and 45—135° are presented on the image. In a Fig. 3 the scheme of lineaments location with azimuths 45 and 135° is presented, and in a Fig. 4 — the density (amount on area unit) of these lineaments, calculated in a sliding window 5000×5000 m, is presented.

The absolute majority of known objects are in conjunction with zones of high density (9 from 28) and with sites of their intersection (8 from 28) or in immediate proximity from them, while no essential relationship between the system of lineaments with azimuths 0—90° is observed (Fig. 5).

Conclusions. Thus, the sites of high lineaments density can be considered as perspective on detection of oil and gas objects and to be recommended for analysis by seismic prospecting of various modifications.

The relationship between location of oil and gas objects and zones of the high lineaments density indicate to the possibility of use the relatively cheap geophysical (gravitational and magnetic), and also space methods for preliminary allocation of promising sites.

Fig. 4. Lineaments distribution with azimuth 45 and 135º.

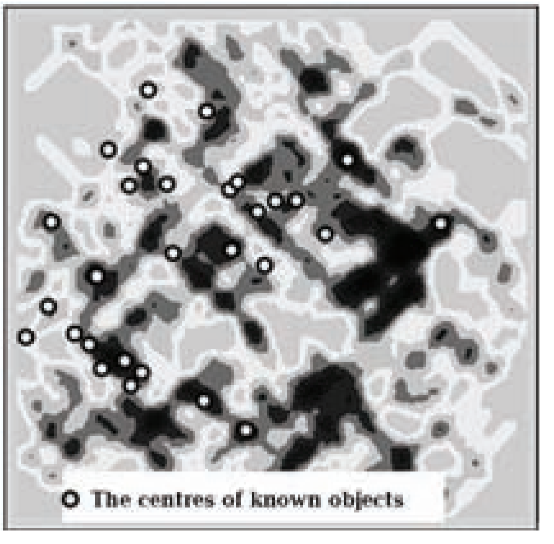

Fig. 5. Lineaments density map (more dark colour corresponds to more density).

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