SUBMERIDIONAL AND SUBLATITUDINAL FAULTS IN THE STRUCTURE OF THE LITHOSPHERE IN PRIAMURYE

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The fault zones determined at the surface by using geological methods cannot be solely considered the indicators of tectonic faulting and break of the crust and the lithosphere (Tyapkin et al., 1982). To study tectonic fault zones and hidden faults, the lineaments obtained from various data are used that show either directly or indirectly the features of the geological structure. Under lineaments we imply extensive linear structures of the relief, geophysical anomaly axes and narrow zones of abnormal values of the geophysical field gradients. Linearly arranged earthquake foci are considered as seismic lineaments.

The hidden faults and tectonic fault zones may occupy rather large areas. They control block division and destruction of the lithosphere at different depths. The areas of increased fracturing and low rock density or, on the contrary, areas of high rock density due to intrusion of dense intrusive rocks, exert the influence on the distribution of ore deposits and control the hydrocarbon trap locations in the sedimentary basins. The epicentral fields of earthquakes correlate closely with the spatial locations of hidden faults or their intersection areas. The investigation of increased faulting and fracturing zones and hidden faults is important for different aspects of tectonic development in the Priamurye area. Earthquakes may group into seismolineaments of the submeridional (SM) and sublatitudinal (SL) directions that are not consistent with the geological faults (Geodynamics…, 2006). The sketch maps of fault tectonics that have been compiled for the study area by different authors in recent years are mainly dominated by the north-east trending faults, which is caused by high activity of faults of the Tan-Lu fault system during the Mesozoic-Cenozoic. The faults oriented in this direction play a major role for the zonality of metallogenic belts controlled both by deep faults and lineament-type structures (Radkevich et al., 1990). For the major portion of the study area, the regional SM- and SL- oriented faults are determined by using geological methods in separate cases only. These faults are ancient; they experienced multiple activations during their history (Zabrodin et al., 2015). Their complex and multistage formation causes the need of their comprehensive study. Numerous lineaments have previously been obtained for the entire of the region based on the analysis of the relief only. A comprehensive analysis of the relief using the geophysical fields allowed for distinguishing only few lineaments that correlate with the faults.

The lineaments of the relief and statistical characteristics of the distribution of linear elements in the area were searched for based on the Digital Elevation Model (DEM) SRTM-03, (Shuttle Radar Topography Mission Survey) using the WinLESSA program technique. The lineament maps, rose charts, elongation lines of the rose charts, density maps of elementary linear elements, etc., have been constructed. To construct lineaments based on the analysis of the geophysical field, we used the gravity and magnetic field maps, scale of 1: 1000 000. Using the program COSKAD-3D, the field decomposition into the regional and local components and tracing of the anomaly axes were performed. The schemes showing the axes of the regional gravity and magnetic field anomalies and the axes of the local gravity field component of the first-rank have been constructed. The lineaments (anomaly axes) that give the information about the locations of rather large linear areas of tectonic faults occurred at deep horizons of the lithosphere have also been obtained. The anomalies associated with the deepest - regional gravity field component are dominated by SL and SM orientations. The north-eastern strike dominates in the orientation of the local gravity field anomalies of the first rank that are smaller in size than the regional anomalies. In some cases, the anomalies of this component are SM- and SL-oriented. The regional magnetic field anomalies are differently oriented. The SM- and SL-oriented anomalies are also well displayed.

The axial lines of linear zones with increased values of the modulus of the horizontal and full gravity gradient are considered as the major lineaments. The computation of the modules of the horizontal and full gradients of the initial gravity field has shown that the patterns of the anomalies of the horizontal and full gravity gradients are similar, but we used the full gravity gradient anomalies because they have better linear elongation.

The areas of abnormal Vp/Vs ratio values may correlate with fault tectonics of the region. For the Priamurye area, the abnormal Vp/Vs ratio values were obtained during processing of the data of earthquakes occurred in 1982-1984 (Nagornykh et al., 1989). The dominating earthquake occurrence depth is up to 25 km, that is, the crustal velocity characteristics have been obtained within the similar depth range. The decreased or increased values of this parameter may indicate the abnormally fractured and fluid-saturated zones that show geodynamically unstable crustal areas.

The seismological data have also been used. Linearly arranged earthquake foci (seismolineaments) can suggest a major deep fault. In this connection, the earthquakes with magnitude M≥3 were plotted on the sketch map of lineaments.

At the first stage, the location of the axes of the full gravity gradient anomalies, the regional and local SL- and SM- oriented anomalies of the gravity field, the abnormal Vp/Vs ratio values and the distribution of M≥3 earthquake epicenters have been analyzed. Thus, the information about the faults that occur in the deep layers of the lithosphere has been obtained. Tectonic fault zones of two ranks were distinguished. The first-rank fault zones differ from the second-rank ones in the extent and clearer manifestation in the gravity and magnetic fields, and the fault features. At the subsequent stage, the distinguished deep zones were compared to the axes of the regional magnetic anomalies, the sources of which are located within the crust, as suggested by several researchers. At the final stage, a comparison has been made with the main features of the relief which prove the disturbance of the surface layers by SL- and SM-oriented faults. All the information about the lineaments was collected in the project ArcGis 10.2, where the layer with the fault network obtained from the geological data was also complemented.

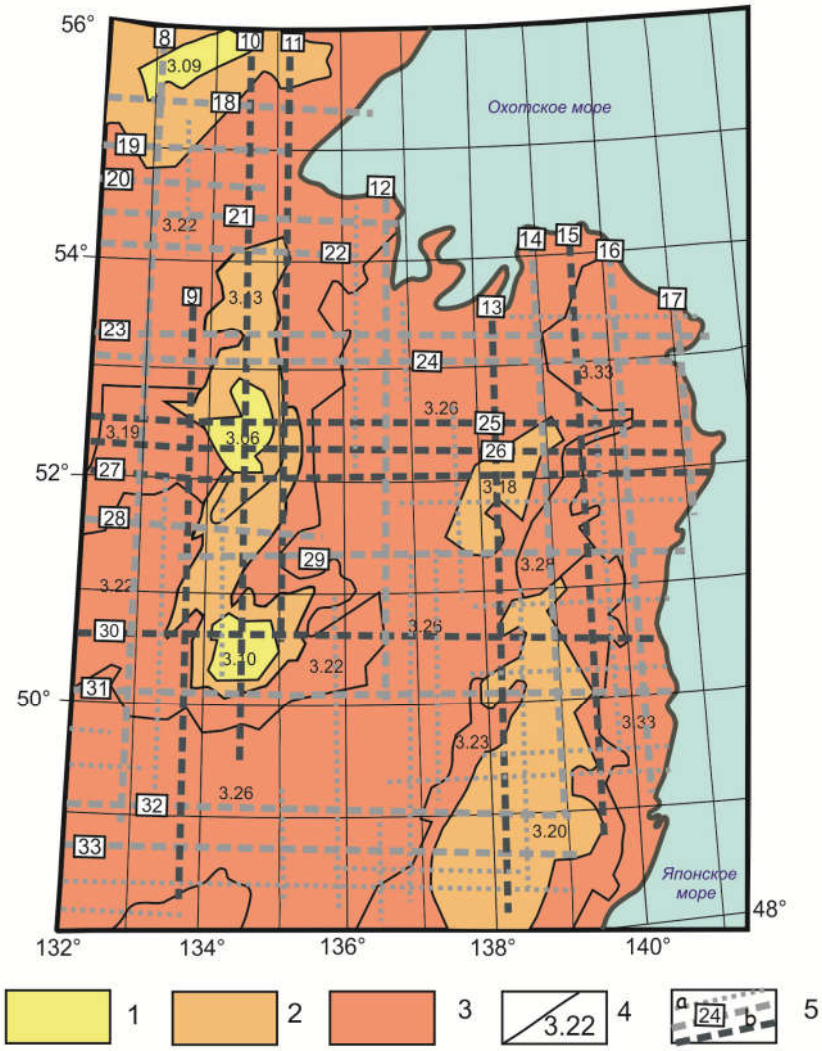

Fig.1 Control of density inhomogeneities by distinguished hidden faults at a depth of 60 km, according to Romanovskii et al., 1992. 1 - the least rock density zones; 2 - moderate rock density zones; 3 - zones of relatively high density; 4- boundaries of density inhomogeneities and density values, g/cm^3; 5 - supposed tectonic faulting zones. Figures in the boxes denote the numbers of tectonic faulting zones.

Based on a set of the geophysical indications and the analysis of the relief, a dense network of extensive linear tectonic submeridionally and sublatitudinally striking fault zones was revealed. It demonstrates a higher degree of faulting within the crust of the region as compared to the geological faults displayed at the surface. In separate segments, tectonic fault zones may correlate with the regional faults revealed at the surface, but these zones are more extensive from geophysical data. The coincidence of the

segments with the geological faults can be considered as objective evidence of tectonic fault discrimination. Along the entire study area, some of tectonic submeridional fault zones have not been established from the geological data (Fig.1). They have been determined only from the analysis of the relief and derived from the geophysical data.

The correlation between linearly arranged earthquake epicenters and the gravity anomaly axes, gravity gradients and zones of the abnormal Vp/Vs ratio values allow us to reliably reveal hidden SM- and SL-oriented faults.

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