

## Deep deformations of the East European platform Earth's crust: causes and effects

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**Abstract** Object of research is deformation of the deep layers and the Moho surface the East European platform is identified on the basis of structural analysis thickness of the deep layers of the Earth's crust and of the Moho surface. Initial data - geological and geophysical materials of the lithosphere of the East European platform, the thickness of the lower, middle, and upper layers of the Earth's crust and the newest structures. Research methods are structural-geodynamic and comparative- tectonic, which allow us to assess the spatial and temporal variability of deep and near-surface deformations. Results. Active centers and relatively passive deformations associated are combined into geodynamic regions, the boundaries of which are zones of structural disagreement. Geodynamic regions are divided into main and secondary. The first is expressed by stable and long-term development, the second - are shown in separate layers of the Earth's crust. It is established that the protrusions of the mantle lithosphere cause a reduction in the thickness of the layers of the Earth's crust and the formation of the newest trough. The sinking of the mantle lithosphere affects the increase in power in the lower and upper layers and the formation of newest uplifts. The intermediate layer is considered as a compensation layer. Thinning and thick parts of the individual layers lead to the formation of the newest local trough and uplifts. Thus, the conformal and disconform correlation of deformations of deep layers and the newest structures is a characteristic property of the structure of the platform lithosphere. The sources of deep deformations are extra-platform regional areas of recent tectogenesis and intraplatform local active centers - protrusions and trough of the mantle lithosphere, abnormal thickening and thinning of the Earth's crust layers.

**Keywords** Deformation of deep layers, thickening and thinning of layers, geodynamic zoning, tectonic lamination of the Earth's crust, newest structures, discordance and conformality of deformations.

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### References

- Atlas «Opornye geologo-geofizicheskie profili Rossii». Glubinnye seismicheskie razrezy po profiliam GSZ [Atlas "Reference geological and geophysical profiles of Russia". Deep seismic sections according to GSS profiles]. (2013). Saint-Petersburg, Russia: VSEGEI Publ., 94 p. (In Russ.).
- Atlas kart glubinnogo stroeniia zemnoi kory i verkhnei mantii territorii SSSR [Atlas of maps of the deep structure of the Earth's crust and upper mantle of the area of the USSR]. (1989). Moscow, Russia: VNIIGeofizika Publ., 84 p. (In Russ.).
- Bogdanova, S.V., Gorbachev, R., & Garetsky, R.G. (2016). EUROPE. East European Craton. In Reference Module in *Earth systems and Environmental Sciences* (pp. 205-220). Elsevier Publ. doi: 10.1016/B978-0-12-409548-9.10020-X.
- Karabanov, A.K. (2014). *Neotectonics and neogeodynamics of Belarus*. Saarbrücken, Germany: LAMBERT Academic Publ., 252 p.
- Kopp, M. L., Verzhbitsky, V. E., Kolesnichenko, A. A., Tveritinova, T. Y., Vasil'ev, N. Y., Korchemagin, V. A., ... & Ioffe, A. I. (2014). Recent stress field in the east of the Russian Plate and the Urals from macro- and meso-structural evidence. *Geotectonics*, 48(4), 273-291.
- Krasnopevtseva, G.V., & Shchukin, Yu.K. (2000). [Volumetric depth model of the Earth's crust of the Eastern European platform based on regional seismic studies]. *Regional'naiia geologiya i metallogeniia* [Regional Geology and Metallogeny], 10, 73-84. (In Russ.).
- Leonov, M.G., Przhiyalgovsky, E.S., & Lavrushina, E.V. (2018). *Granity. Postmagmaticheskaiia tektonika i uglevodородnyi potentsial* [Granites. Postmagmatic tectonics and carbohydrate potential]. Moscow, Russia: Nauka Publ., 332 p. (In Russ.).
- Leonov, Yu.G., Gushchenko, O.I., Kopp, M.L., & Ras-tsvetaev, L.M. (2001). [Relationship of late Cenozoic stresses and deformations in the Caucasian sector of the Alpine belt and its Northern platform]. *Geotektonika* [Geotectonics], 1, 36-59. (In Russ.).

- Makarov, V.I. (1996). [Regional features of the newest Geodynamics of platform areas in connection with the assessment of their tectonic activity]. *Nedra Povolzh'ia i Prikaspiia* [The subsoil of the Volga and the Caspian], 13, 49-60. (In Russ.).
- Makarov, V.I., Shchukin, Yu.K., & Yudakhin, F.N. (2007). [The position of the Solovetsky islands in the nontectonic structure of the White Sea, their nature and newest geodynamics]. *Litosfera* [Lithosphere], 3, 86-94. (In Russ.).
- Makarova, N.V., Makeev, V.M., Dorozhko, A.L., Sukhanova, T.V., & Korobova, I.V. (2017). [Geodynamics systems and geodynamic active zones of the East European platform]. *Biulleten' Moskovskogo obshchestva ispytateley prirody* [Bulletin of the Moscow Society of Naturalists], 91(4-5), 9-25. (In Russ.).
- Makeev, V.M., Makarova, N.V., & Sukhanova, T.V. (2018). [Deep-seated Geodynamics of the East European platform and its reflection in the newest geodynamic systems]. In *Problemy tektoniki i geodinamiki zemnoy kory i mantii. Materialy L tectonicheskogo sovechaniya. T. 1* [Problems of Tectonics and Geodynamics of the Earth's crust and mantle. Materials of the L tectonic meeting. V. 1] (pp. 401-405). Moscow, Russia: GEOS Publ. (In Russ.).
- Mezhdunarodnaia tektonicheskaya karta Evropy i svezhnykh oblastey* [International tectonic map of Europe and adjacent areas]. (1981). Moscow, Russia: GUGK CM USSR Publ. (In Russ.).
- Mourner, N.A. (2004). Active faults and paleoseismicity in Fennoscandia, especially Sweden. Primary structures and secondary effects. *Tectonophysics*, 380, 39-157.
- Noveishaia tektonika, geodinamika i seismichnost' Severnoi Evrazii* [Neotectonics, Geodynamics and seismicity of Northern Eurasia]. (2000). Moscow, Russia: Probel Publ., 487 p. (In Russ.).
- Sharov, N.V., Malovichko, A.A., & Shchukin, Yu.K. (Eds.). (2007). *Zemletriaseniia i mikroiseimichnost' v zadachakh sovremennoi geodinamiki Vostochno-Evropeiskoi platformy. Kn. 1: Zemletriaseniia* [Earthquakes and microseismicity in the problems of modern geodynamics of the East European platform. V. 1: Earthquakes]. Petrozavodsk, Russia: Karelian SCRAS Publ., 381 p. (In Russ.).
- Shchukin, Yu.K. (2014). *Problemy, voprosy, resheniia* [Problems, questions, solutions]. Voronezh, Russia: IPC "Nauchnaya kniga" Publ., 504 p. (In Russ.).
- Shchukin, Yu.K., Babak, V.I., & Krasnopevtseva, G.V. (2008). [On the relationship of structural-geomorphological and geological-tectonic deep directions of the Earth's crust]. *Sviaz' poverkhnostnykh struktur zemnoi kory s glubinnymi. Materialy XIV Mezhdunarodnoy konferentsii* [Connection of the surface structures of the Earth's crust with the depths. Proceedings of the 14th International Conference] (pp. 369-373). Petrozavodsk, Russia: Karelian SCRAS Publ. (In Russ.).
- Sim, L.A., Marinin, A.V., Bryantseva, G.V., & Gordeev, N.A. (2018). Results of tectonic stress of the Northern Eurasia regions. *Geodynamics & Tectonophysics*, 9(3), 771-800.
- Stroenie i dinamika litosfery Vostochnoi Evropy. Rezul'taty issledovaniia po programme EUROPROBE* (2006). [Structure and Dynamics of the Lithosphere of Eastern Europe. Program research results EUROPRO]. Moscow, Russia: Geocart Publ., 736 p. (In Russ.).
- Tektonicheskaya karta Rossii, sopredel'nykh territorii i akvatorii* [Tectonic map of Russia, adjacent areas and water areas]. (2007). Moscow, Russia: FGUP PKO "Cartography" Publ. (In Russ.).
- Tektonicheskaya rassloennost' i regional'nye geologicheskie issledovaniia (Trudy GIN RAN)* [Tectonic lamination and regional geological studies (Proceedings of the GIN RAS)]. (1990). Moscow, Russia: Nauka Publ., 293 p. (In Russ.).
- Yudakhin, F.N., Shchukin, Yu.K., & Makarov, V.I. (2003). *Glubinnoe stroenie i sovremennye geodinamicheskie protsessy v litosfere Vostochno-Evropeiskoi platformy* [Deep structure and modern geodynamic processes in the lithosphere of the East European platform]. Yekaterinburg, Russia: UB RAS Publ., 299 p. (In Russ.).

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