

Determination of initial seismicity score and seismic microzoning of infrastructure area of Kolyma Hydro Power Plant

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Abstract Earthquakes' nature was studied and detailed seismic zoning (DSZ) and seismic micro-zoning (SMZ) were carried out for the Kolyma hydro power plant (KHPP) region, considering new geological, geophysical and seismological data. DSZ was based on tectonic zoning maps of Magadan region and seismological monitoring data in the vicinity KHPP facilities, carried out by Magadan Branch of Geophysical Survey of Russian Academy of Sciences. Eight source zones and 10 faults generating earthquakes were identified. Hypocenters of potential maximum earthquakes were determined. They are associated with the largest deep faults: Debinsky, Chay-Yuryinsky and Ulakhan and can cause ground shake in the area of main structures with intensities $I=8.8, 8.5$ and 8.4 scores, which is consistent with OSR-2015-C map, selected as the main one for objects with increased level of responsibility. According to the DSR results, the initial seismicity of KHPP area on OSR-2015-C map was 8.8 scores. With repeatability of ~ 5000 years, the magnitude of the most dangerous earthquake for KHPP facilities will be $M=6.5$, with epicentral distance of 10 km. The obtained results of the DSZ were the initial estimates of seismic impacts for SMZ. The basis of SMZ is the nature of soils of the upper part of the section of the structures zone. The rock outcropping area was chosen as a reference, where the initial seismicity, taking into account DSZ, was 7.8 scores. The calculated increment of the score and the calculated intensity of the seismic impact on the areas of the main structures of KHPP were calculated. Moreover, in areas characterized by different engineering and geological conditions of the soils of the upper part of the section, both the method of direct registration of earthquakes and explosions, and the method of acoustic stiffness were used. According to both methods, the maximum shaking of the area of the main KHPP facilities amounted to 8 points, which is 1 point lower than the OSR-2015-C map.

Keywords Kolyma hydro power plant, Kolyma hydroelectric station, seismicity, seismic tectonics, TMA zones, potential maximum earthquakes, source zones, surveys, seismic profiling.

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References

- Alyeshina, E.I., Godzikovskaya, A.A., Gunbina, L.V., et al. (2015). *Svodnyj Katalog zemletryasenij Severo-Vostoka Rossii s drevnejshih vremen po 1974* [Consolidated Catalogue of Earthquakes of the North-East of Russia from Ancient Times to 1974]. Obninsk, Magadan, Russia: GS RAS Publ., 152 p. (In Russ).
- Global CMT Web Page (2020). Global CMT Catalog Search. Retrieved from <https://www.globalcmt.org/CMTsearch.html>
- Imayev, V.S., Imayeva, L.P., & Kozmin, B.M. (2000). *Seismotektonika Iakutii* [Seismotectonics of Yakutia]. Moscow, Russia: GEOS Publ., 227 p. (In Russ). EDN: TIOCPL
- Imayeva, L.P., Kolodeznikov, I.I., eds. (2017). *Seismotektonika severo-vostochnogo sektora Rossijskoj Arktiki* [Seismotectonics of the North-Eastern sector of Russian Arctic]. Novosibirsk, Russia: Russian Academy of Sciences Publ., 134 p. (In Russ).
- International Seismological Centre. (2020). On-line Bulletin. Retrieved from <http://www.isc.ac.uk/iscbulletin>. DOI: 10.31905/D808B830
- Kondorskaya, N.V., & Shebalin, N.V. (Eds.). (1977). *Novyj katalog sil'nyh zemletryasenij na territorii SSSR s drevnejshih vremen do 1975 g.* [New catalogue of strong earthquakes on the territory of the USSR from ancient times to 1975]. Moscow, Russia: Nauka Publ., 536 p. (In Russ).
- Kozmin, B.M. (1984). *Sejsmicheskie poyasa Iakutii i mekhanizmy ochagov ih zemletryasenij* [Seismic belts of Yakutia and mechanism of earthquakes]. Moscow, Russia: Nauka Publ., 125 p. (In Russ).

- Kuznetsov, V.M. (2001). *Skhema tektonicheskogo rajonirovaniya Ohotsko-Kolymского водораздела. Masshtab 1:1 000 000* [Scheme of tectonic zoning of Okhotsk-Kolymsky watershed. Scale 1:1,000,000]. Magadan, Russia: Magadan Federal State Unitary Enterprise «Magadangeologiya» Publ., 8 sheets.
- Lutikov, A.I., Andreeva, N.V., Gabsatarova, I.P., Dontsova, G.Yu., & Karpenko, L.I. (2019). [Seismicity and seismic hazard assessment of Magadan region on a scale close to detailed seismic zoning]. *Voprosy inzhenernoj seismologii* [Questions of engineering seismology], 46(3), 16-31. (In Russ.). DOI: 10.21455/VIS2019.3-2. EDN: BWZCFP
- Mackey, K.G. Seismological Studies in Northeast Russia. Dissertation for the degree of Ph.D. / Michigan State University. Department of Geological Sciences, 1999. — 346 p.
- Medvedev, S.V., Sponheuer, W., & Karnik, V. (1965). *Shkala seismicheskoi intensivnosti MSK-64* [Seismic Intensity Scale MSK-64]. Moscow, Russia: Interdepartmental Geophysical Commission of the USSR Acad. Sci. Publ., 11 p. (In Russ.).
- Mishin, S.V., Andreev, T.A., & Smirnov, V.N. (1977). *Ocenka seismicheskoy opasnosti rajona stroyashcheysya Kolymской GES* [Seismic hazard assessment of the area under construction of Kolyma HPP]. Magadan, Russia: NESC FEB RAS Publ., 242 p. (In Russ.).
- Rautian, T.G. (1964). [On the determination of the energy of earthquakes at a distance of 3000 km]. In *Eksperimental'naya seismika. Trudy IFZ ANSSSR N 32(199)* [Experimental seismic. Proceedings of the IPE AS USSR N 32(199)] (pp. 88-93). Moscow, Russia: Nauka Publ. (In Russ.).
- Riznichenko, Yu.V. (1979). *Seismicheskaya sotryasemost' territorii SSSR* [Seismic shaking of the territory of the USSR]. Moscow, Russia: Nauka Publ., 190 p. (In Russ.).
- RSN 65-87. *Inzhenernye izyskaniya dlya stroitel'stva. Seismicheskoe mikrorajonirovanie. Tekhnicheskie trebovaniya k proizvodstvu robot.* (1988). [RSN 65-87. Engineering survey for construction. Seismic microzoning. Technical requirements]. Moscow, Russia: Gosstroj RSFSR Publ., 8 p. (In Russ.).
- SNiP II-7-81* *Stroitel'stvo v seismicheskikh rajonah.* (1982). [SNiP II-7-81*. Construction in seismic areas]. Moscow, Russia: Gosstroj RSFSR Publ., 46 p. (In Russ.).
- Ulomov, V.I., & Schumilina, L.C. (2015). *Komplekt kart obshchego seismicheskogo rajonirovaniya territorii Rossijskoj federacii OSR-2015. Masshtab 1:8000000. Ob'yasnitelnaya zapiska i spisok gorodov i naseleennykh punktov, raspolozhennykh v seismoopasnykh rajonah* [Set of maps of general seismic zoning of the territory of Russian Federation OSR-2015. Scale 1:8000000. Explanatory note and list of cities and settlements located in seismic hazardous areas]. Moscow, Russia: UIPE RAS Publ., 57 p. (In Russ.).
- Vladimirova, L.V., Vorobyova, L., Efremova, L.V., et al. (1984). [Kupkinskoye earthquake on November 8, 1981]. In *Seismicheskie processy na Severo-Vostoke SSSR* [Seismic processes in the Northeast of USSR] (pp. 39-53). Magadan, Russia: NESC FEB RAS Publ., (In Russ.).
- Voronkov, O.K. (2009). *Inzhenernaya seismika v kriolitozone (izuchenie stroeniya i svoystv merzlykh i talykh massivov)* [Engineering seismics in permafrost zone (study of the structure and properties of frozen and melted masses)]. St.-Peterburg, Russia, 402 p. (In Russ.).
- Wells, D.L., & Coppersmith, K.J. (1994). New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement. *Bulletin of the Seismological Society of America*, 84, 974-1002.

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