The possibility of determining magnitude MS of technogenic seismic events in the Voronezh Crystalline Massif territory

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GS RAS, Voronezh

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Abstract For the territory of the Voronezh crystalline massif (VCM), formulas are proposed that establish the ratios between the magnitude (MS) of technogenic seismic events and the dimension of the energy class (KR). For research, catalogs of seismic events registered in the territory of the VCM were using. The obtained ratios can be used in the compilation of consolidated catalogs of local seismic events that occurred in the territory of the VCM, in cases where the direct definitions of the energy class, due to the absence of transverse waves on the records of transverse waves, is not possible.

Keywords Voronezh crystalline massif, seismic events, industrial explosion, energy class, magnitude.

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References

Adushkin, V.V., & Malovichko, A.A. (Eds.). (2013). *Vzryvy i zemletryaseniya na territorii Evropeiskoi chasti Rossii* [Explosions and earthquakes on the European territory of Russia]. Moscow, Russia: GEOS Publ., 384 p. (In Russ.).

Akimov, A.P., & Krasilov, S.A. (2020). [WSG software package "Seismic data processing system"]. Certificate of state registration of a computer program No. 2020664678. (In Russ.).

Dubyansky, A.I., Efremenko, M.A., & Pivovarov, S.P. (2018). [Estimation of the energy class of technogenic seismic events in the conditions of the Voronezh crystalline massif]. *Vestnik NIaTs RK* [NNC RK Bulletin], *2*, 125-128. (In Russ).

Efremenko, M.A., Zolototrubova, E.I., Ezhova, I.T., & Pivovarov, S.P. (2020). [Influence of geological conditions on the nature of recordings of waveforms of industrial explosions]. In *Struktura*, *veshchestvennyi sostav*, *svoistva*, *sovremennaia geodinamika i seismichnost' platformennykh territorii i sopredel'nykh regionov*: *materialy XXII Vserossiiskoi s mezhdunarodnym uchastiem nauchno-prakticheskoi Shchukinskoi konferentsii. Pod red. L.I. Nadezhka, T.B. Silkinoi* [Structure, material composition, properties, modern geodynamics and seismicity of platform territories and adjacent regions: materials of the XXII All-Russian scientific and practical Shchukin conference. Eds. L.I. Nadezhka, T.B. Silkina] (pp. 131-136). Voronezh, Russia: VSU Publishing House. (In Russ).

Fedotov, S.A. (1972). *Energeticheskaia klassifikatsiia kurilo-kamchatskikh zemletriasenii i problema magnitu*d [Energy classification of the Kuril-Kamchatka earthquakes and the problem of magnitudes]. Moscow, Russia: Nauka Publ., 116 p. (In Russ.).

Kondorskaya, N.V., Aranovich, Z.I., Solov'yeva, O.N., & Shebalin, N.V. (1981). *Instruktsiya o poryadke proizvodstva i obrabotki nablyudeniy na seysmicheskikh stantsiyakh Yedinoy sistemy seysmicheskikh nablyudeniy SSSR* [Instructions on the production and processing of observations procedure at seismic stations of a Unified system of seismic observations of the USSR]. Moscow, Russia: Nauka Publ., 272 p. (In Russ.).

Krasilov, S.A., Kolomiyets, M.V., & Akimov, A.P. (2006). [Organization of processing of digital seismological data using the WSG software package]. In *Materialy Mezhdunarodnoy seysmologicheskoy shkoly "Sovremennyye metody obrabotki i interpretatsii seysmologicheskikh dannykh"* [Proceedings of the International Seismological Workshop "Modern Methods of Processing and Interpretation of Seismological Data"] (pp. 77-83). Obninsk, Russia: GS RAS Publ. (In Russ.).

Mikhailova, N.N., & Neverova, N.P. (1986). [Calibration function σ(Δ) for determining the magnitude MPVA of earthquakes in the northern Tien Shan]. In *Kompleksnye issledovaniia na Alma-Atinskom prognosticheskom poligone* [Comprehensive research at the Alma-Ata prognostic range] (pp. 41-48). – Alma-Ata, Kazakhstan: Nauka Publ. House of the Kazakh SSR. (In Russ.).

Morozov, A.N. (2008). [Explosive seismicity identification method in the Arkhangelsk region]. *Vestnik Kamchatskoi regional'noi organizatsii Uchebno-nauchnyi tsentr. Seriia*: *Nauki o Zemle* [Bulletin of Kamchatka Regional Association «Educational-Scientific Center». Earth Sciences], *11*(1), 177-184.

Nadezhka, L.I., Pivovarov, S.P., & Efremenko, M.A. (2018). [Assessment of the registration capabilities of a network of seismic stations on the territory of the Voronezh crystalline massif]. *Zemletryaseniia Severnoi Evrazii* [Earthquakes of the Northern Eurasia], *21*(2012), 466-470. (In Russ.).

Nadezhka, L.I., Pivovarov, S.P., Pivovarov, R.S., Semenov, A.E., Efremenko, M.A., Kalinina, E.V., Semenov, A.M., Kolesnikov, I.M., & Savenkov, A.V. (2016). [Some results of seismic observations on the territory of the Voronezh crystalline massif for 2013–2015]. In *Materialy XI Mezhdunarodnoy seysmologicheskoy shkoly* "S*ovremennyye metody obrabotki i interpretatsii seysmologicheskikh dannykh*". *Otv. red. A.A. Malovichko* [Proceedings of the XI International Seismological Workshop "Modern Methods of Processing and Interpretation of Seismological Data". Ed. A.A. Malovichko] (pp. 224-227). Obninsk, Russia: GS RAS Publ. (In Russ.).

Nadezhka, L.I., Safronich, I.N., Orlov, R.A., & Pivovarov, S.P. (2006). [Voronezh crystalline massif]. In *Zemletriaseniia Severnoi Evrazii v 2000 godu* [Earthquakes in Northern Eurasia in 2000] (pp. 193-196). Obninsk, Russia: GS RAS Publ. (In Russ.).

Pivovarov, S.P., Efremenko, M.A., & Pivovarov, R.S. (2021). [Experience in the practical application of the MS scale for determining the magnitudes of technogenic seismic events in the territory of the Voronezh crystalline massif]. In *Materialy XV Mezhdunarodnoy seysmologicheskoy shkoly* "*Sovremennyye metody obrabotki i interpretatsii seysmologicheskikh dannykh*". *Otv. red. A.A. Malovichko* [Proceedings of the XV International Seismological Workshop "Modern Methods of Processing and Interpretation of Seismological Data". Ed. A.A. Malovichko] (p. 69). Obninsk, Russia: GS RAS Publ. (In Russ.).

Raschet magnitudy M (MLH, MS) [Calculation of magnitude M (MLH, MS)] (2022). *Database* "*Earthquakes of Russia*". Available at: http://eqru.gsras.ru/files/Calc-magnitude_S_2003-2020.pdf (In Russ.).

Rautian, T.G. (1964). [On the determination of the energy of earthquakes at a distance of 3000 km]. In *Eksperimental'naia seismika. Trudy IFZ AN SSSR N 32*(*199*) [Experimental seismic. Proceedings of the IPE AS USSR N 32(199)] (pp. 88-93). Moscow, Russia: Nauka Publ. (In Russ.).

Sanina, I.A., Nesterkina, M.A., Konstantinovskaya, N.L., Kulikov, V.I., Volosov, S.G., Nadezhka, L.I., Dubyansky, A.I., Safronich, I.N., & Pivovarov, S.P. (2009). [Velocity model and peculiarities of recordings of explosions from the Yelets-Lipetsk zone]. In *Geologicheskie opasnosti: Materialy XV Vserossiiskoi konferentsii s mezhdunarodnym uchastiem. Otv. red. F.N. Iudakhin* [Geological hazards: Proceedings of the XV All-Russian Conference with international participation. Ed. F.N. Yudakhin] (pp. 396-400). Arkhangelsk, Russia: IEP of the North ASC UB RAS Publ. (In Russ.).

Solovyov, S.L., & Solovieva, O.N. (1967). [Relationship between the energy class and magnitude of the Kuril earthquakes]. *Izvestiia AN SSSR. Fizika Zemli* [Izvestiya of the Academy of Sciences of the USSR. Physics of the Solid Earth], *2*, 13-22. (In Russ.).

Zolototrubova, E.I., Ezhova, I.T., Nadezhka, L.I., Efremenko, M.A., & Kalinina, E.V. (2019). [Features records of seismic events in areas with different geological structure]. In *Tezisy XIV Mezhdunarodnoi seismologicheskoi shkoly* "*Sovremennye metody obrabotki i interpretatsii seismologicheskikh dannykh*". *Otv. red. A.A. Malovichko* [Modern methods of processing and interpretation of seismological data. Abstracts of the XIV International Seismological Workshop. Ed. A.A. Malovichko] (p. 46). Obninsk, Russia: GS RAS Publ. (In Russ.).

Information about authors

Pivovarov Sergey Pavlovich, Researcher of the Laboratory of Seismic Monitoring of the Voronezh Crystalline Massif (LSM VCM) of the Geophysical Survey of the Russian Academy of Sciences (GS RAS), Voronezh, Russia. E-mail: serg@geophys.vsu.ru

Efremenko Marina Alekseevna, PhD, Researcher of the LSM VCM GS RAS, Voronezh, Russia. E-mail: 2880@mail.ru

Pivovarov Roman Sergeevich, Research Engineer of the LSM VCM GS RAS, Voronezh, Russia. E-mail: serg@geophys.vsu.ru