Katav-Ivanovsk earthquake on 04.09.2018, m_b=5.4 (Urals)

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Abstract The article summarizes the instrumental and macroseismic data obtained in the area of Katav-Ivanovsk earthquake, which occurred on September 4, 2018, in Chelyabinsk region, Russia. The earthquake was the strongest instrumentally recorded earthquake in the Urals (m_b=5.4) and at the same time, it had the most seismic intensity among other earthquakes in Russia in 2018 (I_0=6 points). The uniqueness of this event was given by the fact that after it for the first time for the Urals the aftershock process was recorded, the active stage of which lasted more than 1 year. Like the mainshock, some aftershocks had a significant macroseismic effect. The work contains the results of studies that allowed to determine the exact coordinates of the epicenter in conditions of lack of near stations using the relative location technique. New processing approaches also made it possible to estimate the depth of the focus through a function of phase spectrum matching. Finally, a considerable amount of macroseismic data formed the basis of the macroseismic field map.

Keywords earthquake, seismic intensity, aftershock, Southern Urals, relative location, temporal seismic station, phase spectrum matching function, macroseismic field.

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References

Dyagilev, R.A., & Golubeva, I.V. (2008). [Estimation of efficiency of seismic event discrimination criteria As/Ap for stations of Ural region using statistic approaches]. In *Seismichnost' Severnoi Evrazii. Materialy mezhdunarodnoi konferentsii* [Seismicity of Northern Eurasia. Proceedings of international conference] (pp. 78-80). Obninsk, Russia: GS RAS Publ. (In Russ.).

Dyagilev, R.A., Guseva, N.S., & Verkholantsev, F.G. (2016). [Anisotropy of macroseismic field of Sredneural'skoye earthquake on 18 October 2015]. *Geofizika* [Russian Geophysics], *5*, 42-46. (In Russ.).

Dyagilev, R.A., Zlobina, T.V., & Guseva, N.S. (2018). [Uchaly induced earthquake on 5 September 2012 with K_P=9.5, ML=3.4, I_0=5 (Bashkortostan)]. In *Zemletriaseniia Severnoi Evrazii* [Earthquakes in Northern Eurasia], *21*(2012), 387-391. (In Russ.).

EMSC. Earthquake. Search for earthquakes. (2020). Retrieved from: https://www.emsc-csem.org/Earthquake/?filter=yes

Epifanskiy, A.G., Gabsatarova, I.P., Muromtsev, L.K., Kartavenko, D.V., & Babkova, E.A. (2018). [Application of a method of "spectral phases matching" for a research of depth of the Altai (Chuya) earthquake of 27.09.2003]. In *Rezul'taty kompleksnogo izucheniia sil'neishego Altaiskogo* (*Chuiskogo*) *zemletriaseniia 2003 g., ego mesto v riadu vazhneishikh seismicheskikh sobytii XXI veka na territorii Rossii: materialy XXI Nauchno-prakticheskoi Shchukinskoi konferentsii s mezhdunarodnym uchastiem* (*g. Moskva, 1-4 oktiabria 2018 g.*) [Results of complex studying of the strongest Altai (Chuya) earthquake of 2003, its place among the most important seismic events of the XXI century in the territory of Russia: proceedings of the XXI Scientific and practical Shchukin conference with the international participation (Moscow, on October 1-4, 2018)] (pp. 142-147). Moscow, Russia: IPE RAS Publ. (In Russ.).

Gibowicz, S.J., & Kijko, A. (1994). *An introduction to mining seismology*. San Diego, California: Academic Press, Inc., 396 p.

Godzikovskaja, A.A. (2016). [Catalogue of seismic events of the Ural region since ancient time till 2002 (Accompanying primary data)]. Moscow, Russia: IPE RAS Publ., 258 p. (In Russ.).

GOST R 57546-2017 (2017). [Earthquakes Seismic Intensity Scale. Enter 2017-07-19]. Moscow, Russia: Standardinform, 28 p. (In Russ.).

Guseva, N.S., & Dyagilev, R.A. (2017). [Macroseismic field of Bilimbay earthquake in 1914 at the Urals]. In *Sovremennye metody obrabotki i interpretatsii seismologicheskikh dannykh. Materialy XII Mezhdunarodnoi seismologicheskoi shkoly* [Modern methods of processing and interpretation of seismological

data. Materials of XII International Seismological School] (pp. 133-137). Obninsk, Russia: GS RAS Publ. (In Russ.).

Helmholtz-Centre Potsdam - GFZ German Research Centre for Geosciences (2019). Retrieved from: https://www.gfz-potsdam.de/en/home/

Kul'chitskii, V.E. (2014). [Estimation of anisotropic macroseismic field decay parameters]. G*eofizicheskii zhurnal* [Geophysical Journal], *36*(2), 138-149. (In Russ.).

Malovichko, A.A., Dyagilev, R.A., Malovichko, D.A., Verkholantsev, F.G., & Golubeva, I.V. (2012). [Seismicity review. Urals]. In *Zemletriaseniia Severnoi Evrazii*, *2006* [Earthquakes in Northern Eurasia, 2006] (pp. 238-246). Obninsk, Russia: GS RAS Publ. (In Russ.).

Malovichko, A.A., Malovichko, D.A., Dyagilev, R.A., Verkholantsev, F.G., Golubeva, I.V., & Verkholantsev, A.V. (2011). [Permskii krai 2000-2005]. In *Zemletriaseniia Severnoi Evrazi*i, *2005* [Earthquakes in Northern Eurasia, 2005] (pp. 269-289). Obninsk, Russia: GS RAS Publ. (In Russ.).

Malovichko, A.A., Morozov, A.N., Vaganova, N.V., Asming, V.E., Dyagilev, R.A., & Evtiugina, Z.A. (2020). [The August 17, 1914 Bilimbaev earthquake: relocation based on instrumental data]. *Rossiiskii seismologicheskii zhurnal* [Russian Journal of Seismology], *2*(1), 40-47. (In Russ.). doi: /10.35540/2686-7907.2020.1.04

Mendecki, A.J. (1997). *Seismic monitoring in mines*. Chapman & Hall, 262 p.

Seismological monitoring of the Western Urals. (2020). Retrieved from: http://pts.mi-perm.ru/seismo_data/ (In Russ.).

Spottiswoode, S.M., & Milev, A.M. (1998). The use of waveform similarity to define planes of mining-induced seismic events. *Tectonophysics*, *289*(1-3), 51-60. doi: 10.1016/S0040-1951(97)00306-5

Tevelev, Al.V., Tevelev, Ark.V., Khotylev, A.O., Prudnikov, I.A., Volodina, E.A., & Moseichuk, V.M. (2019). [Earthquakes of 2018 in Katav-Ivanovsk (Southern Urals): kinematics of initiating failures]. In *Problemy tektoniki kontinentov i okeanov. Materialy LI Tektonicheskogo soveshchaniia* [Problems of tectonics of continents and oceans. Proceedings of LI seminar on tectonics] (pp. 286-290). Moscow, Russia: GEOS Publ. (In Russ.).

Thorbjarnardottir, B.S., & Peachmann, J.C. (1987). Constraints on relative earthquake locations from cross-correlation of waveforms. *Bulletin of the Seismological Society of America*, *77*(5), 1626-1634.

Ulomov, V.I., & Shumilina, L.S. (1999). *Komplekt kart obshchego seismicheskogo raionirovaniia territorii Rossiiskoi Federatsii – OSR-97* [*Karty*]. *Masshtab 1:8 000 000. Ob"iasnitel'naia zapiska i spisok gorodov i naselennykh punktov, raspolozhennykh v seismoopasnykh raiona* [Set of common seismic zonation maps for the territory of Russian Federation – OSR-97. Scale 1:8 000 000. Explanation note and the list of cities and settlements in seismic prone regions]. Moscow, Russia: UIPE RAS Publ., 57 p. (In Russ.).

USGS. Earthquake Hazards. Earthquakes. (2020). Retrieved from: https://www.usgs.gov/natural-hazards/earthquake-hazards/earthquakes

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