

Seismotectonics of sources of strong earthquakes in the Caucasus: Results of studies by Evgeny Alexandrovich Rogozhin

© 2023 A.N. Ovsyuchenko, A.S. Larkov, N.V. Andreeva, R.N. Lukashova

IPE RAS, Moscow, Russia

Received June 2, 2023

Abstract The results of a consistent and versatile study of the seismotectonics of source zones of strong modern earthquakes in the Caucasus under the guidance and with the participation of E.A. Rogozhin. The sources of all strong modern earthquakes have been studied from a unified methodological standpoint. The collected data on the tectonic position of seismic sources make it possible to draw certain conclusions that are of practical interest in order to seismic hazard assessment.

Keywords E.A. Rogozhin, seismotectonics, Caucasus, source zone, seismic hazard.

For citation Ovsyuchenko, A.N., Larkov, A.S., Andreeva, N.V., & Lukashova, R.N. (2023). [Seismotectonics of sources of strong earthquakes in the Caucasus: Results of studies by Evgeny Alexandrovich Rogozhin]. *Rossiiskii seismologicheskii zhurnal* [Russian Journal of Seismology], 5(3), 28-44. (In Russ.). DOI: <https://doi.org/10.35540/2686-7907.2023.3.02>. EDN: GFJYHA

References

- Albarede, F., Bogachkin, B.M., Oleinik, A.E., Rogozhin, E.A., Rybakov, L.M., & Philip, E. (1990). [On a prehistoric strong earthquake near the town of Spitak (Northern Armenia)]. *Doklady Akademii nauk SSSR* [Doklady of the USSR Academy of Sciences], 313(2), 397-400. (In Russ.).
- Amirkhanov, H.I. (Ed.). (1980). *Dagestanskoe zemletriasenie 14 maia 1970 g. Seismologiya, geologiya, geofizika* [Dagestan earthquake May 14, 1970. Seismology, Geology, Geophysics]. Moscow, Russia: Nauka Publ., 220 p. (In Russ.).
- Arefiev, S.S., Rogozhin, E.A., Aptekman, Z.Y., Bykova, V.V., & Dorbath, C. (2006). Deep structure and tomographic imaging of strong earthquake source zones. *Izvestiya, Physics of the Solid Earth*, 42(10), 850-863. DOI: [10.1134/S1069351306100090](https://doi.org/10.1134/S1069351306100090). EDN: LJTZFF
- Arefiev, S.S., Stasyuk, E.I., & Rivera, L. (2004). Source model of the Dagestan, 1970 earthquake. *Izvestiya, Physics of the Solid Earth*, 40(2), 102-113. EDN: LIRXCN
- Bachmanov, D.M., Kozhurin, A.I., & Trifonov, V.G. (2017). [The active faults of Eurasia database]. *Geodinamika i Tektonofizika* [Geodynamics and Tectonophysics], 8(4), 711-736. (In Russ.). DOI: [10.5800/GT-2017-8-4-0314](https://doi.org/10.5800/GT-2017-8-4-0314). EDN: ZWRGNL
- Bune, V.I., & Gorshkov, G.P. (Rev. Eds.). (1980). *Seismicheskoe raionirovanie territorii SSSR* [Seismic zoning of the territory of the USSR]. Moscow, Russia: Nauka Publ., 308 p. (In Russ.).
- Gabsatarova, I.P., Selivanova, E.A., Golovkova, L.V., Asmanov, O.A., Devyatkina, L.V. (Resp. Comp.), Aleksandrova, L.I., Ivanova, L.E., Malyanova, L.S., Amirov, S.R., Musalaeva, Z.A., Sagatelova, E.Yu., Gamidova, A.M., Abdullaeva, A.R., Kaloeva, I.Yu., Kiseleva, O.A., Perevoznikov, K.A., & Tsirikhova, G.V. (2014). [Aftershocks of the Kurchaloy earthquake on October 11, 2008 for 2008]. In *Zemletriaseniia Severnoi Evrazii, 2008 god* [Earthquakes of Northern Eurasia, 2008]. Obninsk, Russia: GS RAS Publ. Application on CD (In Russ.).
- Gomez, J.M., Bukchin, B., Madariaga, R., & Rogozhin, E.A. (1997). A study of the Barisakho, Georgia, earthquake of 1992 October 23 from broadband surface and body waves. *Geophysical Journal International*, 129(3), 613-623. DOI: [10.1111/j.1365-246X.1997.tb04497.x](https://doi.org/10.1111/j.1365-246X.1997.tb04497.x). EDN: LELUJJ
- Gvishiani, A.D., Gorshkov, A.I., Kossobokov, V.G., & Rantsian, E.Ya. (1988). [Morphostructures and earthquake occurrence sites of the Greater Caucasus]. *Izvestiia AN SSSR. Fizika Zemli* [Izvestiya of the Academy of Sciences of the USSR. Physics of the Solid Earth], 9, 42. (In Russ.).
- Gvishiani, A.D., Gorshkov, A.I., & Zhidkov, M.P. (1987). [Recognition of places of possible occurrence of strong earthquakes. XV. Morphostructural nodes of the Greater Caucasus, M≥5.5]. *Vychislitel'naia seismologiya. Chislennoe modelirovanie i analiz geofizicheskikh protsessov* [Computational seismology. Numerical modeling and analysis of geophysical processes], 20, 136-148. (In Russ.). EDN: RZYSUF

- Kerimov, I.A., & Gajsumov, M.Ja. (2009). [Kurchaloevsky earthquake on October 11, 2008]. *Vestnik Akademii nauk Chechenskoj Respubliki* [Bulletin of the Academy of Sciences of the Chechen Republic], 2, 48-53. (In Russ.). EDN: PXJEYT
- Levkovich, R.A. (Resp. Ed.). (2007). *Obshchii katalog zemletriasenii na territorii Dagestana. Makroseismicheskie i instrumental'nye dannye o zemletriaseniiakh za period s VII v n.e. do 2005 g.* [General catalog of earthquakes in the territory of Dagestan. Macro seismic and instrumental data on earthquakes for the period from the 7th Century AD until 2005]. Makhachkala, Russia: Epoch Publ., 393 p. (In Russ.). EDN: QKHOQL
- Mammadli, T.Y., & Rogozhin, E.A. (2019). Transverse faults of the Eastern Caucasus and their manifestations in seismicity. *Seismic Instruments*, 55(2), 220-228. DOI: 10.3103/S0747923919020099
- Milanovsky, E.E. (1968). *Noveishaia tektonika Kavkaza* [Recent tectonics of the Caucasus]. Moscow, Russia: Nedra Publ., 483 p. (In Russ.).
- Milyukov, V.K., Mironov, A.P., Drobyshev, V.N., Khubaev, K.M., Ovsyuchenko, A.N., Rogozhin, E.A., Gorbatiykov, A.V., & Nikolaev, A.V. (2018). Velocities of present-day horizontal movements in the central sector of the Greater Caucasus according to GPS observations and their relation to tectonics and the deep structure of the Earth's crust. *Doklady Earth Sciences*, 481(1), 879-882. DOI: 10.1134/S1028334X18070279. EDN: YBIFZJ
- Ovsyuchenko, A.N., Korzhenkov, A.M., Larkov, A.S., Rogozhin, E.A., & Gadjev, M.S. (2020). Seismotectonic deformation of the early medieval fortress wall of Derbent (Dagestan). *Doklady Earth Sciences*, 493(1), 535-538. DOI: 10.1134/S1028334X20070132. EDN: TJCPGP
- Ovsyuchenko, A.N., Marakhanov, A.V., Lar'kov, A.S., & Novikov, S.S. (2014). Late quaternary dislocations and seismotectonics of the Racha earthquake source, the Greater Caucasus. *Geotectonics*, 48(6), 440-458. DOI: 10.1134/S0016852114050057. EDN: UFKLCV
- Philip, H., Rogozhin, E., Bousquet, J.C., Borisov, B., Cisternas, A., & Karakhanian, A. (1992). The Armenian earthquake of 1988 December 7: faulting and folding, neotectonics and palaeoseismicity. *Geophysical Journal International*, 110(1), 141-158. DOI: 10.1111/j.1365-246X.1992.tb00718.x. EDN: XJDFOP
- Prilepin, M.T., Balasanyan, S., Baranova, S.M., Guseva, T.V., Mishin, A.V., Nadaria, M., Rogozhin, E.A., Rozenberg, N.K., Skovorodkin, Yu.P., Hamburger, M., King, R., & Reilinger, R. (1997). [Studying the kinematics of the Caucasus region using GPS technology]. *Fizika Zemli* [Physics of the Earth], 6, 68-75. (In Russ.).
- Rejsner, G.I., Ioganson, L.I., Rejsner, M.G., & Baranov, Yu.E. (1993). *Tipizatsiya zemnoi kory i sovremennye geologicheskie protsessy* [Typification of the Earth's crust and modern geological processes]. Moscow, Russia: UIPE RAS, 208 p. (In Russ.).
- Rogozhin, E.A. (1993). [The 1992 Barisakh earthquake on the southern slope of the Greater Caucasus: the tectonic position of the source]. In *Seismichnost' i seismicheskoe raionirovanie Severnoi Evrazii. Vyp. 1* [Seismicity and seismic zoning of Northern Eurasia. Issue 1] (pp. 148-151). Moscow, Russia: IPE RAS Publ. (In Russ.).
- Rogozhin, E.A. (2012). *Ocherki regional'noi seismotektoniki* [Essays on regional seismotectonics]. Moscow, Russia: IPE RAS Publ., 340 p. (In Russ.). EDN: QKLHLT
- Rogozhin, E.A., & Jakovlev, F.L. (1983). [Opyt kolichestvennoj ocenki morfologii skladchatosti Tfanskoj zony Bol'shogo Kavkaza]. *Geotektonika* [Geotectonics], 3, 87-98. (In Russ.).
- Rogozhin, E.A., & Philip, E. (1991). [Geological and tectonic study of the source zone of the Spitak earthquake]. *Izvestiya AN SSSR. Fizika Zemli* [Izvestia of the USSR Academy of Sciences. Physics of the Earth], 11, 3-17. (In Russ.).
- Rogozhin, E.A., & Rybakov, L.M. (1990). [Tectonic position and geological manifestation of the Spitak earthquake on December 7, 1988]. *Geotektonika* [Geotectonics], 6, 32-45. (In Russ.).
- Rogozhin, E.A., Arefiev, S.S., Bogachkin, B.M., Cisternas, A., & Philip, E. (1993a). [Complex analysis of geological and seismological data and seismotectonic representation of the source of the Racha earthquake]. *Fizika Zemli* [Physics of the Earth], 3, 70-77. (In Russ.).
- Rogozhin, E.A., Arefiev, S.S., Marakhanov, A.V., Ovsyuchenko, A.N., Novikov, S.S., Matveev, I.V., & Molotkov, S.G. (2009). [Recent earthquake in the Central Caucasus]. *Geofizicheskie issledovaniia* [Geophysical Research], 10(4), 64-66. (In Russ.). EDN: LJMGBF
- Rogozhin, E.A., Bogachkin, B.M., Nechaev, Yu.V., & Arefiev, S.S. (1993b). [Experience in using materials from the study of secondary seismic dislocations to build a geological model of the source of a strong earthquake]. *Doklady Akademii nauk* [Doklady of the Academy of Sciences], 333(1), 96-100. (In Russ.).
- Rogozhin, E.A., Bogachkin, V.M., & Nechaev, Yu.V. (1993c). [Seismotectonic significance of the transverse zonality of the Northwestern part of the Greater Caucasus]. In *Postroenie modelei razvitiia seismicheskogo protsessa i predvestnikov zemletriasenii. Vyp. 1* [Construction of models for the development of the seismic process and earthquake precursors. Iss. 1] (pp. 139-148). Moscow, Russia: UIPE RAS Publ. (In Russ.).
- Rogozhin, E.A., Borisov, B.A., & Bogachkin, B.M. (1991). [Racha earthquake (Georgia, April 29, 1991): materials of geological survey]. *Doklady Akademii nauk SSSR* [Doklady of the USSR Academy of Sciences], 321(2), 353-358. (In Russ.).
- Rogozhin, E.A., Borisov, B.A., Rejsner, G.I., & Sholpo, V.N. (1987). [Geological conditions for the occurrence of foci of strong earthquakes in the Mediterranean Alpine belt]. In *Stroenie i evoliutsiya tektonosfery*

- [Structure and evolution of the tectonosphere] (pp. 133-150). Moscow, Russia: IPE AS USSR Publ. (In Russ.).
- Rogozhin, E.A., Ovsyuchenko, A.N., & Larkov, A.S. (2021). Source of strong earthquake as a geological object. *Geotectonics*, 55(3), 307-333. DOI: 10.1134/S0016852121030079. EDN: JFKPPJ
- Rogozhin, E.A., Ovsyuchenko, A.N., Lutikov, A.I., Sobisevich, A.L., Sobisevich, L.E., & Gorbatikov, A.V. (2014). *Endogennye opasnosti Bol'shogo Kavkaza* [Endogenous dangers of the Greater Caucasus]. Moscow, Russia: IPE RAS Publ., 256 p. (In Russ.).
- Rogozhin, E.A., Reisner, G.I., & Mamedov, T.Ya. (1988). [Transverse zoning of the Eastern part of the Greater Caucasus]. *Issledovanie seismicheskoi opasnosti. Voprosy inzhenernoi seismologii* [Study of seismic hazard. Questions of Engineering Seismology. Issue], 29, 15-20. (In Russ.).
- Rogozhin, E.A., Sobisevich, L.E., Nechaev, Yu.V., Sobisevich, A.L., Bogatkov, O.A., Gurbanov, A.G., Kovalenko, V.I., Gazeev, V.M., Polyak, B.G., Pokrovsky, B.G., Lavrushin, V.Yu., Kulikov, V.I., Melekestsev, I.V., Kashchuk, D.G., Milyukov, V.K., & Kopaev, A.V. (2001). *Geodinamika, seismotektonika i vulkanizm Severnogo Kavkaza. Pod red. N.P. Laverova* [Geodynamics, seismotectonics and volcanism of the North Caucasus. Ed. N.P. Laverov]. Moscow, Russia: UIPE RAS Publ., 338 p. (In Russ.).
- Tatevossian, R.E., & Aptekman, Z.Y. (2011). Source model and the macroseismic effect of the 1991 Racha earthquake. *Seismic Instruments*, 47(2), 107-115. DOI: 10.3103/S0747923911020095
- Ulomov, V.I. (Resp. ed.). (2012). *SKZ OSR-2012. Spetsializirovannyi katalog zemletriasenii Severnoi Evrazii dlia obshchego seismicheskogo raionirovaniia territorii Rossiiskoi Federatsii* [SKZ OSR-2012. Specialized catalog of earthquakes in Northern Eurasia for general seismic zoning of the territory of the Russian Federation]. Moscow, Russia. (In Russ.). Retrieved from <http://seismos-u.ifz.ru/documents/Eartquake-Catalog-CK3.pdf>
- Vakarchuk, R.N., Tatevossian, R.E., Aptekman, Z.Y., & Bykova, V.V. (2013). The 1991 Racha earthquake, Caucasus: Multiple source model with compensative type of motion. *Izvestiya, Physics of the Solid Earth*, 40(5), 653-659. DOI: 10.1134/S1069351313050121. EDN: RFNBC
- Yetirmishli, G.D., Mammadli, T.Ya., Rogozhin, E.A., & Sysolin, A.I. (2019). [Seismic activation in the eastern part of the southern slope of the Greater Caucasus in the late XX - early XXI Century]. *Geophysical Processes and Biosphere*, 18(2), 82-96. (In Russ.). DOI: 10.21455/GPB2019.2-7. EDN: RCNBPT

Information about authors

Ovsyuchenko Alexander Nikolayevich, PhD, Head of Laboratory of the Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences (IPE RAS), Moscow, Russia. E-mail: ovs@ifz.ru

Larkov Alexander Sergeevich, PhD, Head of the Laboratory of the IPE RAS, Moscow, Russia. E-mail: las119@yandex.ru

Andreeva Nadezhda Vyacheslavovna, PhD, Senior Researcher of the IPE RAS, Moscow, Russia. E-mail: znv@ifz.ru

Lukashova Raisa Nikolaevna, Researcher of the IPE RAS, Moscow, Russia. E-mail: lur@ifz.ru