Geosistemy perehodnykh zon = Geosystems of Transition Zones / Геосистемы переходных зон
Content is available under the Creative Commons Attribution 4.0 International License (CC BY 4.0)
2025, vol. 9, No. 2, pp. 125–144
http://journal.imgg.ru/archive.htm; https://elibrary.ru/title_about.asp?id=64191
https://doi.org/10.30730/gtrz.2025.9.2.125-144; https://elibrary.ru/rrjeoc

Variations in the vertical component of the electrotelluric field at the Yuzhno-Sakhalinsk geophysical test site in 2024

[@1] Stovbun, Nikolai S. (https://orcid.org/0009-0004-1927-798X), n1kolay19971997@yandex.ru
[1] Zakupin, Alexander S. (https://orcid.org/0000-0003-0593-6417), a.zakupin@imgg.ru
[1] Bogomolov, Leonid M. (https://orcid.org/0000-0002-9124-9797), bleom@mail.ru
[2] Kostylev, Dmitry V. (https://orcid.org/0000-0002-8150-9575), d.kostylev@imgg.ru
[1] Dudchenko, Ilya P. (https://orcid.org/0000-0002-4967-7405), ilpadu@mail.ru
[1] Gulyakov, Sergey A. (https://orcid.org/0009-0001-7924-6972), gulyakov_97@mail.ru

[1] *Institute of Marine Geology and Geophysics of the Far Eastern Branch of RAS, Yuzhno-Sakhalinsk, Russia*
[2] *Sakhalin Branch of the FRC "Geophysical Survey of the Russian Academy of Sciences", Yuzhno-Sakhalinsk, Russia*

Abstract PDF RUS PDF ENG Full text PDF RUS

Abstract. In 2024, the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences started continuous measurements of the vertical component of the electrotelluric field (ETF), which were integrated into the previously organized monitoring of the horizontal components of the ETF. The vertical component of the ETF is measured by the potential difference between metal plates located in the ground, one above the other, at a depth of about 2 m. Two systems of plates were installed at the Yuzhno-Sakhalinsk geophysical test site (on the territory of IMGG FEB RAS) and were connected to an analog-to-digital converter (ADC). The aim of the study is to identify and analyze variations in the vertical ETF that may be associated with the geological deformation and variations in seismicity. In the first year of measurements of the vertical component of the ETF, 4 periods with an abnormally high level of field strength were identified compared to the average value for the observation period: maximum by 35 times, minimum by 5 times. In total, these periods occupy about half of the entire registration time; it was during these periods that 80% of all earthquakes in the southern part of Sakhalin Island occurred over 11 months of 2024 (24 events out of 30). For the horizontal components of the ETF, no such significant anomalies were observed as for the vertical one. Obtained results indicate that changes in the vertical component of the ETF may reflect variations in seismic activity in the near field. These changes can presumably be considered a sign of earthquake activity near the measurement point.

Keywords:
electrotelluric field, vertical component, data recording, geophysical field anomalies, seismic events

For citation: Stovbun N.S., Zakupin A.S., Bogomolov L.M., Kostylev D.V., Dudchenko I.P., Gulyakov S.A. Variations in the vertical component of the electrotelluric field at the Yuzhno-Sakhalinsk geophysical test site in 2024. *Geosistemy perehodnykh zon = Geosystems of Transition Zones*, 2025, vol. 9, No. 2, pp. 125–144. (In Russ.). https://doi.org/10.30730/gtrz.2025.9.2.125-144; https://elibrary.ru/rrjeoc

Для цитирования: Стовбун Н.С., Закупин А.С., Богомолов Л.М., Костылев Д.В., Дудченко И.П., Гуляков С.А. Вариации вертикальной компоненты электротеллурического поля на Южно-Сахалинском геофизическом полигоне в 2024 году. *Геосистемы переходных зон*, 2025, т. 9, № 2, с. 125–144. https://doi.org/10.30730/gtrz.2025.9.2.125-144; https://elibrary.ru/rrjeoc

References

1. Adushkin V.V., Spivak A.A., Kishkina S.B., Loktev D.N., Solov'ev S.P. **2006.** Dynamic processes in the system of interacting geospheres at the Earth's crust-atmosphere boundary. *Izv., Physics of the Solid Earth*, 42(7): 567–584. doi:10.1134/S1069351306070044
2. Spivak A.A. **2009.** [Topical problems of interaction between the geospheres at the subsurface segments of the continental crust]. In: *Problems of interacting geospheres*. Moscow: GEOS, p. 211–221. (In Russ.).
3. Adushkin V.V., Spivak A.A. **2014.** [*Physical fields in near-surface geophysics*]. Moscow: GEOS, 360 c. (In Russ.). EDN: WHELXR
4. Zubkov S.I. **2002.** [*Earthquake precursors*]. Moscow: OIFZ RAN, 140 p. (In Russ.).
5. Dovbnya B.V. **2014.** [Electromagnetic precursors of earthquakes and their recurrence]. *Geophysical Journal*, 36(3): 160–165. (In Russ.).
6. Johnston M.J.S. **2002.** 38 - Electromagnetic fields generated by earthquakes. *International Geophysics*, 81(Pt A): 621–635. https://doi.org/10.1016/s0074-6142(02)80241-8

7. Dovbnya B.V., Pashinin A.Yu., Rakhmatulin R.A., **2019.** Short-term electromagnetic precursors of earthquakes. *Geodynamics & Tectonophysics*, 10(3): 731–740. (In Russ.). https://doi.org/10.5800/GT-2019-10-3-0438
8. Lukovenkova O.O., Malkin E.I., Mishchenko M.A., Solodchuk A.A. **2021.** Anomalies in electromagnetic and geoacoustic emission signals before Kamchatka earthquakes (ML ≥ 4.75) in 2013. *Vestnik KRAUNC. Fiz.-mat. Nauki*, 34(1): 137–149. (In Russ.). https://doi.org/10.26117/2079-6641-2021-34-1-137-149
9. Moroz Yu.F., Moroz T.A. **2009.** A study in the dynamics of the geoelectrical medium from electrotelluric field data. *Journal of Volcanology and Seismology*, 3(1): 34–43. doi:10.1134/S0742046309010047
10. Gavrilov V.A., Poltavtseva E.V., Titkov N.N., Panteleev I.A., Buss Yu.Yu. **2023.** Monitoring of changes in the stress-strain state of geoenvironment at the Petropavlovsk Geodynamic Testing Site based on the multi-instrumental borehole and GPS data during the active phase of preparing the Zhupanovsky earthquake (January 30, 2016, Mw 7.2). *Geodynamics & Tectonophysics*, 14(6), 0732. (In Russ.). doi:10.5800/GT-2023-14-6-0732
11. Li M., Lu J., Parrot M., Tan H., Chang Y., Zhang X., Wang Y. **2013.** Review of unprecedented ULF electromagnetic anomalous emissions possibly related to the Wenchuan M_S = 8.0 earthquake, on 12 May 2008. *Natural Hazards and Earth System Sciences*, 13: 279–286. https://doi.org/10.5194/nhess-13-279-2013
12. Cataldi D., Cataldi G., Straser V. **2024.** Electromagnetic signals that preceded the destructive earthquakes that occurred in Taiwan between April 2 and 3, 2024. *New Concepts in Global Tectonics Journal*, 12(2): 132.
13. Seminsky K.Zh., Dobrynina A.A., Bornyakov S.A., Sankov V.A., Pospeev A.V., Rasskazov S.V., Perevalova N.P., Seminskiy I.K., Lukhnev A.V., Bobrov A.A., Chebykin E.P., Edemskiy I.K., Ilyasova A.M., Salko D.V., Sankov A.V., Korol S.A. **2022.** Integrated monitoring of hazardous geological processes in Pribaikalye: pilot network and first results. *Geodynamics & Tectonophysics*, 13(5), 0677. (In Russ.). https://doi.org/10.5800/GT-2022-13-5-0677
14. Nepeina K.S., Matiukov V.E. **2021.** Analysis of geophysical parameters variations and seismic events at the point of deep magnetotelluric sounding. *Interexpo GEO-Siberia*, 2(2): 174–180. (In Russ.). doi:10.33764/2618-981X-2021-2-2-174-180
15. Vargas C.A., Gomez J.S., Gomez J.J., Solano J.M., Caneva A. **2023.** Space-time variations of the apparent resistivity associated with seismic activity by using 1D-Magnetotelluric (MT) data in the central part of Colombia (South America). *Applied Sciences*, 13, 1737. https://doi.org/10.3390/app13031737
16. Piriyev R.H. **2021.** Effectiveness of electromagnetic monitoring in studying earthquakes. *Geophysical Journal*, 43(2): 166–177. doi:10.24028/gzh.v43i2.230195
17. Fan Y., Hu W., Han B., Tang J., Wang X., Ye Q. **2023.** Characteristic identification of seismogenic electromagnetic anomalies based on station electromagnetic impedance. *Frontiers of Earth Science,* 11, 1110056. doi:10.3389/feart.2023.1110056
18. Kuptsov A.V., Marapulets Yu.V., Mishchenko M.A., Shevtsov B.M., Shcherbina A.O., Rulenko O.P. **2007.** On the relation between high frequency acoustic emissions in near-surface rocks and the electric field in the near-ground atmosphere. *Journal of Volcanology and Seismology*, 1, 349–353. https://doi.org/10.1134/S0742046307050077
19. Marapulets Yu.V., Rulenko O.P., Mishchenko M.A., Shevtsov B.M. **2010.** Relationship of high-frequency geoacoustic emission and electric field in the atmosphere in seismotectonic process. *Doklady Earth Sciences*, 431: 361–364. https://doi.org/10.1134/S1028334X10030207
20. Marapulets Y.V., Rulenko O.P. Larionov I.A., Mishchenko M.A. **2011.** Simultaneous response of high-frequency geoacoustic emission and atmospheric electric field to strain of near-surface sedimentary rocks. *Doklady Earth Sciences*, 440: 1349–1352. https://doi.org/10.1134/S1028334X11090285
21. Druzhin G.I., Marapulets Yu.V., Cherneva N.V., Isaev A.A., Solodchuk A.A. **2017.** Acoustic and electromagnetic emissions preceding the earthquake in Kamchatka. *Doklady Earth Sciences*, 472: 215–219. https://doi.org/10.1134/S1028334X17020118. –.
22. Bobrovsky V.S. **2016.** Distributed network of electrical measurements in the near-surface soils and some obtained results. *Izvestiya Tula State University. Technical Sciences*, 7-1: 129–138.
23. Rulenko O.P., Marapulets Yu.V., Mishchenko M.A. **2014.** An analysis of the relationships between high-frequency geoacoustic emissions and the electrical field in the atmosphere near the ground surface. *Journal of Volcanology and Seismology*, 8: 183–193. https://doi.org/10.1134/S0742046314030051
24. Zakupin A.S., Dudchenko I.P., Bogomolov L.M. et al. **2024.** Short temporal variations of electrotelluric field in the vicinity of the earthquake source-site in the Sakhalin Island. *Vestnik KRAUNC. Fiz.-mat. nauki*, 46(1): 134–164. (In Russ.). https://doi.org/10.26117/2079-6641-2024-46-1-134-164
25. Gulyakov S.A., Stovbun N.S., Kostyleva N.V., Bogomolov L.M., Kostylev D.V., Dudchenko I.P., Kamenev P.A. **2025.** An estimate of the possible impact of an experimental electric pulse source on seismic and seismoacoustic noise in the Central Sakhalin Fault Zone. *Geodynamics & Tectonophysics*, 16(2), 0818. (In Russ.). https://doi.org/10.5800/GT-2025-16-2-0818
26. Parasnis D.S. **1986.** *Principles of applied geophysics*. 4th ed. London: Chapman and Hall, 402 p. https://doi.org/10.1007/978-94-009-4113-7
27. Mogilatov V.S., Zlobinsky A.V. **2014.** A circular electric dipole: A transmitter for TEM surveys. *Russian Geology and Geophysics*, 55(11): 1340–1346. (In Russ.). https://doi.org/10.1016/j.rgg.2014.10.009
28. Rozhdestvensky V.S., Saprygin S.M. **1999**. Active faults and seismicity in the South Sakhalin. *Russian Journal of Pacific Geology*, 6: 59–70. (In Russ.).
29. Novikov V.A., Sorokin V.M., Yashchenko A.K., Mushkarev G.Yu. **2023.** Physical model and numerical estimates of telluric currents generated by X-ray radiation of a solar flare. *Dynamic Processes in Geospheres*, 1(15): 23–44. (In Russ.). https://doi.org/10.26006/29490995_2023_15_1_23
30. Chen H., Mizunaga H., Tanaka T. **2022.** Influence of geomagnetic storms on the quality of magnetotelluric impedance. *Earth Planets Space*, 74, 111. https://doi.org/10.1186/s40623-022-01659-6
31. Cherneva N.V., Firstov P.P. **2013.** Weather factor effects on electric parameters in the lower atmosphere. *Meteorology and Hydrology*, 38: 177–184. https://doi.org/10.3103/s1068373913030060
32. Spivak A.A., Ovtchinnikov V.M., Rybnov Yu.S., Riabova S.A., Kharlamov V.A. **2022.** Seismic, atmospheric-wave, electrical, and magnetic effects of powerful atmospheric. *Izv., Physics of the Solid Earth*, 58(4): 493–506. doi:10.31857/S0002333722040111
33. Nelson M. **2020.** Contingency tables, Chi-Squared test, and Fisher's exact test. In: *Statistics in nutrition and dietetics*. Chapter 8. https://doi.org/10.1002/9781119541509.ch8