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Variations in the concentration of subsoil gases and the atmospheric electric field prior to some earthquakes in Kamchatka

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Abstract. In Kamchatka, there are continuous networks of observation of variations in subsoil gases, the atmospheric electric field, and the Earth's surface tilts. The aim of the study was to compare the data obtained by these networks to identify common anomalous variations prior to some strong earthquakes in Kamchatka. The article presents new information on the development of anomalous variations in the subsoil gas field and the atmospheric electric field prior to two strong earthquakes in Kamchatka: March 16, 2016, with M_W = 6.6, and the Zhupanovo earthquake on January 30, 2016, with M_W = 7.2. The presented data demonstrate the processes of influence of the exhalation of subsoil radon and its daughter products on the ionization balance of the surface layer of the atmosphere. A conclusion was made about the necessity of integrating various methods of recording geophysical fields, including direct measurements of crustal deformation, for the successful advancement of approaches to earthquake forecasting.

Keywords:

Kamchatka Peninsula, subsoil radon, precursor, earthquake,

Earth's surface tilts, atmospheric electric field

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References

1. Rudakov V.P. **2009.** [*Emanation monitoring of the geoenvironments and processes*]. M.: Nauch. Mir, 175 p. (In Russ.).
2. Adushkin V.V., Spivak A.A. **2014.** [*Physical fields in near-surface geophysics*]. M.: GEOS, 349 p. (In Russ.).
3. Firstov P.P., Makarov E.O. **2018.** [*Dynamics of subsoil radon in Kamchatka and strong earthquakes*]. Petropavlovsk-Kamchatskii: KamGU im. Vitusa Beringa, 148 p. (In Russ.).
4. Hauksson E. **1981.** Radon content of groundwater as an earthquake precursor: evaluation of worldwide data and physical basis. *J. of Geophysical Research: Solid Earth*, 86: 9397–9410. https://doi.org/10.1029/jb086ib10p09397
5. Cicerone R.D., Ebel J.E., Beitton J.A. **2009.** Systematic compilation of earthquake precursors. *Tectonophysics*, 476: 371–396. https://doi.org/10.1016/j.tecto.2009.06.008
6. Petraki E., Nikolopoulos D., Panagiotaras D., Cantzos D., Yannakopoulos P., Nomicos C., Stonham J. **2015.** Radon-222: A potential short-term earthquake precursor. *J. of Earth Science and Climatic Change*, 6(6): 000282. https://doi.org/10.4172/2157-7617.1000282
7. Immè G., Morelli D. **2012.** Radon as earthquake precursor. In: D'Amico S. (ed.) *Earthquake research and analysis – statistical studies, observations and planning*, p. 143–160. https://doi.org/10.5772/29917
8. Wakita H. **1981.** Precursory changes in ground water prior to the 1978 Izu-Oshima-Kinkai earthquake. *Earthquake Prediction: An Intern. Review*, 4: 527–532. https://doi.org/10.1029/ME004p0527
9. Majumdar K. **2004.** A study of fluctuation in radon concentration behaviour as an earthquake precursor. *Current Science*, 9(86): 1288–1292.
10. Tsunomori F., Tanaka H., Murakami M., Tasaka S. **2011.** Seismic response of dissolved gas in groundwater. In: *Proceedings of the 10th Taiwan-Japan Intern. Workshop on hydrological and geochemical research for earthquake prediction, October 25*, *Taiwan.* National Cheng Kung University, Tainan, p. 29–35.
11. İnan S., Akgu T., Cemil S. **2008.** Geochemical monitoring in the Marmara region (NW Turkey): A search for precursors of seismic activity. *J. of Geophysical Research*, 113: B03401. https://doi.org/10.1029/2007JB005206

12. Baykara O., İnceöz M., Doğru M., Aksoy E., Külahcı F. **2009.** Soil radon monitoring and anomalies in East Anatolian Fault System (Turkey). *J. of Radioanalytical and Nuclear Chemistry*, 1(279): 159–164. https://doi.org/10.1007/s10967-007-7211-2
13. Biryulin S.V., Kozlova I.A., Yurkov A.K. **2019.** Investigation of informative value of volume radon activity in soil during both the stress build up and tectonic earthquakes in the South Kuril Region. *Vestnik KRAUNTs. Nauki o Zemle = Bulletin of KRAESC*. *Earth Sciences*, 4(44): 73–83. (In Russ.). https://doi.org/10.31431/1816-5524-2019-4-44-73-83
14. Piersanti A., Cannelli V., Galli G. **2016.** The Pollino 2012 seismic sequence: clues from continuous radon monitoring. *Solid Earth*, 7: 1303–1316. https://doi.org/10.5194/se-7-1303-2016
15. Iwata D., Nagahama H., Muto J., Yasuoka Y. **2018.** Non-parametric detection of atmospheric radon concentration anomalies related to earthquakes. *Scientific Reports*, 8(13028). https://doi.org/10.1038/s41598-018-31341-5
16. Parovik R.I. **2014.** [*Mathematical models of the classical theory of the emanation method*]. Petropavlovsk-Kamchatskii: KamGU im. Vitusa Beringa, 128 p. (In Russ.).
17. 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 Akademii nauk*, 431(2): 242–245. (In Russ.).
18. 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(3): 183–193. https://doi.org/10.1134/s0742046314030051
19. Firstov P.P., Cherneva N.V., Ponomarev E.A., Buzevich A.V. **2006.** Subsoil radon and electric field intensity in the atmosphere in case of Petropavlovsk-Kamchatsky Geodynamic Chain in 1998–2003. *Vestnik KRAUNTs. Nauki o Zemle = Bulletin of KRAESC. Earth Sciences*, 1(7): 102–109. (In Russ.).
20. Akbashev R.R., Firstov P.P., Budilov D.I., Zavodevkin I.A. **2022.** Monitoring the potential gradient of the electric field the atmosphere on the Kamchatka Peninsula and on the Paramushir Island (Kuril Islands). *AIP Conference Proceedings, CAMSTech-II 2021*, 080013. https://doi.org/10.1063/5.0092738
21. Yakovleva V.S., Karataev V.D., Vukolov A.V. Ippolitov I.I., Kabanov M.V., Nagorskii P.M., Smirnov S.V., Firstov P.P., Parovik R.I. **2009.** [Methodology of a multi-factor experiment on the processes of radon transfer in “lithosphere–atmosphere” system]. *Apparatura i novosti radiatsionnykh izmerenii*, 4: 55–60. (In Russ.).
22. Makarov E.O., Firstov P.P., Voloshin V.N. **2013.** Hardware complex for recording soil gas concentrations and searching for precursor anomalies before strong earthquakes in South Kamchatka. *Seismic Instruments*, 49: 46–52. https://doi.org/10.3103/s0747923913010064
23. Glukhov V.E., Makarov E.O., Boldina S.V. **2023.** Hardware and software complex of the tilt-measuring observations network of deformation processes on the Kamchatka Peninsula. *Vestnik KRAUNTs. Fiziko-matematicheskie nauki = Bulletin of KRAESC. Physical and Mathematical Siences*, 44(3): 157–172. (In Russ.). https://doi.org/10.26117/2079-6641-2023-44-3-157-172
24. Firstov P.P., Shirokov V.A. **2005.** Dynamics of molecular hydrogen and its relation to deformational processes at the Petropavlovsk-Kamchatskii Geodynamic Test Site: evidence from observations in 1999–2003. *Geochemistry International*, 43(11): 1056–1064.
25. Boldina S.V., Kopylova G.N., Kobzev V.A. **2022.** Study of seismic effects on changes in groundwater pressure: Equipment and some well observation results for the Kamchatka Peninsula. *Geodynamics & Tectonophysics*, 13(2): 0594. (In Russ.). https://doi.org/10.5800/gt-2022-13-2-0594
26. Bornyakov S.A., Salko D.V., Shagun A.N., Dobrynina A.A., Usynin L.A. **2019.** The slow deformation waves as a possible precursor of seismic hazard. *Geosistemy perehodnykh zon = Geosystems of Transition Zones*, 3(3): 267–276. (In Russ.). https://doi.org/10.30730/2541-8912.2019.3.3.267-276
27. Dieterich J.H. **2007.** 4-04 **–** Applications of rate- and state-dependent friction to models of fault-slip and earthquake occurrence. *Treatise on Geophysics (Second Edition)*, 4(107): 93–110. https://doi.org/10.1016/B978-0-444-53802-4.00075-0
28. Ohnaka M. **2013***. The physics of rock failure and earthquakes*. Cambridge Univ. Press, 270 p.
29. Nagorskiy P.M., Cherepnev M.S., Firstov P.P., Makarov E.O. **2014.** Consistency of component variations of ionizing radiation and atmospheric-electric values. In: *XV Intern. Conf. on Atmospheric Electricity, Norman, Oklahoma, USA*, 4.
30. Chebrov V.N., Kugaenko Yu.A., Abubakirov I.R., Droznina S.Ya., Ivanova E.I., Matveenko E.A., Mityushkina S.V., Ototyuk D.A., Pavlov V.M., Raevskaya A.A., Saltykov V.A., Senyukov S.L., Serafimova Yu.K., Skorkina A.A., Titkov N.N., Cebrov D.V. **2016.** The January 30th, 2016 earthquake with K_S = 15.7, M_W = 7.2, I = 6 in the Zhupanovsky region (Kamchatka). *Vestnik KRAUNTs. Nauki o Zemle = Bulletin of KRAESC. Earth Sciences*, 29(1): 5–16. (In Russ.).
31. Boldina S.V., Kopylova G.N. **2017.** Effects of the January 30, 2016, M_W =7.2 Zhupanovsky earthquake on the water level variations in wells YU Z-5 and E-1 in Kamchatka. *Geodynamics & Tectonophysics*, 8(4): 863–880. (In Russ.). https://doi.org/10.5800/gt-2017-8-4-0321