Geophysical monitoring of the geodynamic regime of Central Armenia

© 2022 R.A. Pashayan[1], D.K. Karapetyan[2], L.V. Arutyunyan[3], K.G. Tovmasyan[1], R.A. Karamyan[2]

[1]IGES NAS RA, Yerevan, Republic of Armenia; [2]IGES NAS RA, Gyumri, Republic of Armenia; [3]IGIC NAS RA, Yerevan, Republic of Armenia

Abstract Geophysical monitoring of the geodynamic regime of the territory of Armenia is carried out including observations of the chemical composition of groundwater, changes in the stress-strained state of the earth's crust and current seismicity. Hydrogeochemical effects of changing the stress-strained state of the medium as indicators of modern geodynamic processes have been revealed. Based on published data, the authors suggest that the nature of the manifestation of geochemical anomalies depends on the parameters of the forthcoming seismic event — magnitude (M) and epicentral distance (Δ). A map of the spatial-temporal distribution of deformations of the earth's crust because of earthquakes over the past three years in the region has been compiled. The main components of ionic (Cl^-, HCO_3, SO_4, Mg_2^+, total mineralization) and gas ($CO2$) composition of mineral waters in comparison with seismicity in the earth's crust are studied. A map of the distribution of earthquake epicenters in space and in time has been compiled. The obtained graph shows the hypocenters dependence of magnitude of earthquakes that occurred during the investigated period on the depth of hypocenters. Earthquake catalogue is using to plot earthquake recurrence. Statistical analysis of observational data showed that the most informative predictive characteristic is the dispersion of carbon dioxide content in water. According to the time series of concentrations of chemical indicators, the effects associated with the geodynamic regime of the earth's crust of Central Armenia were determined. A map of the distribution of deformations in the earth's crust of central Armenia was compiling taking into account the depths of the hypocenters of earthquakes.

References

Akhverdyan, L.A., Pashayan, R.A., & Arutyunyan, L.V. (2018). [Relationship between variations in the stress-strain state of the Earth's crust and seismic activity on the territory of Armenia]. *Doklady NAN RA* [Reports NAS RA], *118*(3), 260-268. (In Russ).

Barsukov, V.L., Belyayev, A.L., Bakaldin, Yu.A., et al. (1992). *Geokhimicheskiye metody prognoza zemletryaseniy* [Geochemical methods for earthquake prediction]. Moscow, Russia: Nauka Publ., 212 p. (In Russ.).

CSEM EMSC. (2022). Earthquake. Latest data contributions. Retrieved from: *https://www.emsc-csem.org/Earthquake/seismologist.php*

Dobrovolskiy, I.P., Zubkov, S.I., & Myachkin, V.I. (1980). [On estimating the size of the zone of manifestation of earthquake harbingers]. In *Modelirovaniye predvestnikov zemletryaseniy* [Modeling earthquake precursors] (pp. 7-44). Moscow, Russia: Nauka Publ. (In Russ.).

Dobrovolsky, I.P. (1984). *Mekhanika podgotovki tektonicheskogo zemletriaseniia* [Mechanics of tectonic earthquake preparation]. Moscow, Russia: Nauka Publ., 188 p. (In Russ).

Dzens-Litovsky, A.I., & Tolstikhin, N.I. (1937). [Natural mineral waters and mud of the Soviet Union]. *Priroda* [Nature], *10,* 104-124.

Grigoryan, S.V., Pashayan, R.A., & Arutyunyan, L.V. (2015). [Hydrogeodynamic and geochemical precursors of earthquakes on the territory of Armenia]. *Doklady NAN RA* [Reports NAS RA], *115*(1), 50-58. (In Russ.).

Kissin, I.G. (2015). *Fliuidy v zemnoi kore* [Fluids in the Earth's crust]. Moscow, Russia: Nauka Publ., 327 p. (In Russ).

Kurlov, M.G. (1928). *Klassifikatsiia sibirskikh tselebnykh mineral'nykh vod* [Classification of Siberian healing mineral waters]. Tomsk, Russia: Tomsk Research Institute of Balneology Publ., 73 p. (In Russ).

Nersesov, I.L., Latynina, L.A. (Eds.). (1989). *Deformatsionnye protsessy v period*, *predshestvuiushchii Spitakskomu zemletriaseniiu* [Deformation processes in the period preceding the Spitak earthquake] (pp. 7-10). Moscow, Russia: IPE AS USSR Publ. (In Russ.).

Osika, D.G. (1981). *Flyuidnyy rezhim seysmicheski aktivnykh oblastey* [Fluid regime of seismically active regions]. Moscow, Russia: Nauka Publ., 204 p. (In Russ.).

Pashayan, R.A. (2008). [Hydrogeochemistry of the Ararat geodynamic seismic polygon]. *Izvestiya NAN RA. Nauki o Zemle* [News of NAS RA. Earth Sciences], *LXI*(3), 39-45. (In Russ.).

Pashayan, R.A. (2009). [Seismotectonics and seismic regime of Central Armenia]. In *Sovremennyye metody obrabotki i interpretatsii seysmologicheskikh dannykh. Materialy Chetvertoy Mezhdunarodnoy seysmologicheskoy shkoly* [Proceedings of the Fourth International Seismological Workshop "Modern Methods of Processing and Interpretation of Seismological Data"] (pp. 154-158). Obninsk, Russia: GS RAS Publ. (In Russ.).

Pashayan, R.A. (2019). *Mineral'nye vody Tsentral'noi Armenii* [Mineral waters of Central Armenia]. Chisinau, Moldova: LAP Lambert Academic Publishing, 68 p. (In Russ).

Pashayan, R.A., & Tumanyan, G.A. (2010). [Seismic regime and tectonics of the Ararat seismic prognostic range]. In *Sovremennye metody obrabotki i interpretatsii seismologicheskikh dannykh. Materialy Piatoi Mezhdunarodnoi seismologicheskoi shkoly* [Proceedings of the Fifth International Seismological Workshop "Modern Methods of Processing and Interpretation of Seismological Data"] (pp. 149-154). Obninsk, Russia: GS RAS Publ. (In Russ.).

Sargsyan, A.Z. (2006). [Hydrogeodeformational characteristics of the earth's crust in the territory of Armenia (2002−2004)]. *Izvestiya NAN RA. Nauki o Zemle* [News of NAS RA. Earth Sciences], *LLX*(3), 30-36. (In Russ.).

Information about authors

Pashayan Romela Artavazdovna, PhD, Leading Researcher of the Institute of Geophysics and Engineering Seismology after A. Nazarov of the National Academy of Sciences of Republic of Armenia (IGES NAS RA), Yerevan, Republic of Armenia. E-mail: romellapashayan@sci.am

Karapetyan John Kostikovych, PhD, Director of the IGES NAS RA, Gyumri, Republic of Armenia. E-mail: jon_iges@mail.ru

Harutyunyan Levon Vartanovich, PhD, Head of Laboratory of the Institute of General and Inorganic Chemistry after M.G. Manvelyan of the National Academy of Sciences of Republic of Armenia (IGIC NAS RA), Yerevan, Republic of Armenia. E-mail: levonharutyunyan25@rambler.ru

Tovmasyan Kristina Gagikovna, Senior Engineer of the IGES NAS RA, Yerevan, Republic of Armenia. E-mail: kristina.tovmasyan.2020@mail.ru

Karamyan Raffi Araikovich, PhD, Researcher of the IGES NAS RA, Gyumri, Republic of Armenia. E-mail: rafo.karamyan@gmail.com