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# Study of changes of thermal neutrons intensity of lithospheric origin for the diagnostics and forecast of earthquakes

**Valentina Antonova**, Sergey Kryukov, Vadim Lutsenko, and Andrey Malimbaev
National Center for Space Research and Technology, Institute of Ionosphere, Almaty, Kazakhstan (valanta@rambler.ru)

Studies of variations in the intensity of thermal (epithermal) neutrons at the high-mountain station of cosmic rays near the fracture of the earth's crust (3340 m above sea level, Northern Tien- Shan) showed the promising of using them for the diagnosis and forecast of earthquakes in seismically active regions. A method is proposed for distinguishing features of changes in the intensity of thermal neutrons of lithospheric origin against the background of variations caused by solar and atmospheric disturbance sources. However, a necessary condition for this is the synchronous registration of high-energy neutrons of galactic origin.

It is known that neutrons in the Earth's atmosphere arise mainly as a result of the interaction of primary cosmic radiation with the nuclei of air atoms. Statistical analysis of neutron measurements during effective solar events (coronal mass ejections), changes of atmospheric pressure confirmed the genetic relationship of thermal neutrons near the Earth's surface with high-energy neutrons of galactic origin and the similarity of the spectral composition of their variations. The difference is observed only in the range ($2\cdot10^{-7}\div2\cdot10^{-6}$)Hz. Variations with the period of 29.5 days (synodic lunar month), due to the gravitational influence of the moon, are present throughout the 12-year period of research of thermal neutrons. The amplitude and its changes were determined by the method of complex demodulation. The periodicity of 29.5 days is absent in the spectrum of high-energy neutrons variations.

Analysis of experimental data during of seismic activity showed the frequent breakdown of the correlation between the intensity of thermal and high-energy neutrons. The cause of this phenomenon is the additional thermal neutron flux of the lithospheric origin, which appears under these conditions. Simple statistical processing of measured parameters makes it possible to exclude variations of interplanetary and atmospheric origin in the intensity of thermal neutrons and to isolate changes caused by seismic processes.

We used this method for analysis of thermal neutrons intensity during earthquakes with intensity ≥ 3b in the vicinity of Almaty which took place in 2007-2018. The catalog includes 30 events. The increase of thermal neutrons flux was observed for ~ 60% of events. However, before the earthquake the increase of thermal neutron flux is only observed for ~ 25-30% of events. The amplitude of the additional thermal neutron flux of the lithospheric origin is equal to 5-7% of the background level. Sometimes it reaches values of 10-12%.

The analysis of our catalog of earthquakes in the vicinity of Almaty also showed that 70% of these events occurred during the full moon or new moon (+/- 2 days).