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Estimation of seismological conditions at the sites of nuclear power stations from small aperture array data

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Since the time of design and construction of most Russian nuclear power stations (NPP), the estimate of seismic risk of large number of territories has changed. The East-European Platform (EEP) has long been considered aseismic and no preliminary detailed seismic studies have been performed for the NPP sites in this area. At present seismic observations are carried out at the NPP sites, the main goal is to detect weak seismic events including microseisms.

For several years our group carried out observations at the sites of different NPP with the use of small aperture arrays. The results obtained by arrays positioned on sediments prove the possibility of reliable recording of events with magnitude b $\geq$ 1 at distances up to 90 km; with b $\geq$ 1.5 at distances up to 200 km; with b $\geq$ 1,7 (2,0) — at distances up to 300 km. Minimum recorded magnitudes relate to events at 10 km distance, at the distance of 4 km event with minimum Mb= -1 can be recorded. Compared to the sites on hard crystalline rocks these results are less efficient, but enable obtaining sufficient amount of seismic data for the territory in observed time period= .

One of our small aperture arrays has been performing continuous recording of weak seismic events within the distance of 300 km from the Nizhny Novgorod NPP (Russia, Volga region). The average level of microseisms at the site is 0.1-0.2 mkm/s. The average number of events recorded by the array was several times higher than those recorded by traditional network of individual seismic stations, 70 events per month by the array against 10 by network. It concerns recording of comparatively large signals from the quarries with magnitudes Mb = 2–3.5. Taking into the account that arrays on crystalline rocks increase the magnitude limit of registration by 0.4–0.8 units compared to networks, we conclude, that the array on sediments will improve the efficiency of recording by up to 1.5 units of magnitude.

Continuous recording of weak seismicity enables construction of recurrence relationship for local areas. The period of observations should be considerably long, 10–20 years, owing to changes in the activity level. New data from formerly quiet seismic areas prove the increase of amount of weak seismic events, which can be attributed both to active influence of industrial activity and to increase in the resolution of the systems of observations.

For the area of Nizhny Novgorod we calculated Gutenberg–Richter frequency–magnitude law for the cumulative number of events during one year for the reference square of 10 km2, taking into account representative radii for detection of sources of different magnitudes. The value of Mmax=5.3, obtained from analysis of microseismic events is close to =5.0, suggested by geodynamic data and included in the project documentation. Evaluation of magnitudes of weak seismic signals is complicated due to uncertain nature of the source. Accumulation of recorded data with exactly determined source will lead to more accurate estimate of released seismic energy, which is possibly still underestimated due to restricted frequency range of present recording instruments.

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