Investigation of Electromagnetic and Acoustic Emissions Associated with Seismic Activity

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Temporal variations in the strength of pulsed very low frequency (VLF) emissions were recorded in Crimea, Ukraine (44.5° N, 34.1° E), during the July – August, 2002 interval, and in the Kharkiv province, eastern Ukraine (49.7° N; 36.2° E), during the November 2004 – December, 2007 period. The statistical analysis of these data has utilized the entire database http://neic.usgs.gov/neic/epic/ on earthquakes occurring regionally and worldwide. The observation site in eastern Ukraine is located in a seismically quiet region while the observation site in Crimea is at the border of the Mediterranean seismically active region. The dataset on infrasound emissions at a frequency of 4 Hz collected at the Ukrainian Academician Vernadsky Antarctic Observatory is also included in the analysis.

The observations of pulsed VLF emissions are made with the Tezey VLF receiver that counts the number of pulses with amplitudes greater than a reference level of 5 μV/m. The instrument comprises three wideband orthogonal coil sensors measuring the components of the magnetic field.

It is shown that the variations in the VLF emission intensities are proportional to the number of background earthquakes ($M < 3.6$ for the Mediterranean region, and $M < 4.9$ for global seismic activity). The revealed associations may be useful in establishing the nature of electromagnetic precursors to earthquakes.

The time delay of the appearance of earthquake precursors in VLF emissions appreciably depends on the magnitude of an earthquake. The strongest earthquakes observed in the Mediterranean seismically active region ($M \sim 4.4$) are determined to be characterized by an anomalous increase in VLF emission intensities about two days prior to the earthquakes. Analysis of the VLF data collected in the Kharkiv province has permitted the detection of electromagnetic precursors to the strongest earthquakes regardless of their distance from the observation site. In particular, for the Indonesia earthquake of December 26, 2004 ($M = 9.0$), an anomalous increase in VLF emission intensities was observed 14 days prior to the earthquake, and an increase in infrasound amplitudes was recorded at the Ukrainian Academician Vernadsky Antarctic Observatory at the same time. Thus, strong earthquakes have a well-pronounced global effect of a complicated physical nature.