EXPERIENCE OF THE ELECTROMAGNETIC MONITORING IN FREQUENCY RANGE 0.1 HZ – 1 MHZ IN THE AREA OF BISHKEK (KYRGYZSTAN)

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An approach to the multiparametric monitoring including apparent resistivity variations, electrotelluric fields, electromagnetic emission, and ionospheric disturbances perspective for short-term and mid-term earthquake prediction is described. Experience of the monitoring in the area of Bishkek (Kyrgyzstan) in a wide frequenciy range of from 0.1 Hz to 1 MHz is considered.

The multiparametric electromagnetic (EM) monitoring technology in frequency range 0.1 Hz – 1 MHz is developed and tested in the area of Bishkek (Kyrgyzstan). The technology includes registration of such EM earthquake precursors, as apparent resistivity variations, ULF magnetic and electrotelluric anomalies, electromagnetic emission and ionosphere disturbances. Two types of equipment are used for the EM monitoring: the audiomagnetotelluric (AMT) system ACF-4M (0.1-1000 Hz) and the radiomagnetotelluric (RMT) system RMT-F (1-1000 kHz). The equipment ensure time series registration of electric and magnetic field components, robust data processing, spectral parameters calculations, apparent resistivity and impedance phase determination. The integrated multiparametric monitoring of the considered precursors is carried out simultaneously and obtaining of informative parameters is differed by methods of measured time series data processing only. In order to select the most informative parameters different forms of measured data presentation with the ACF-4M system (Fig. 1) RMT-F system (Fig.2) can be used during the monitoring.

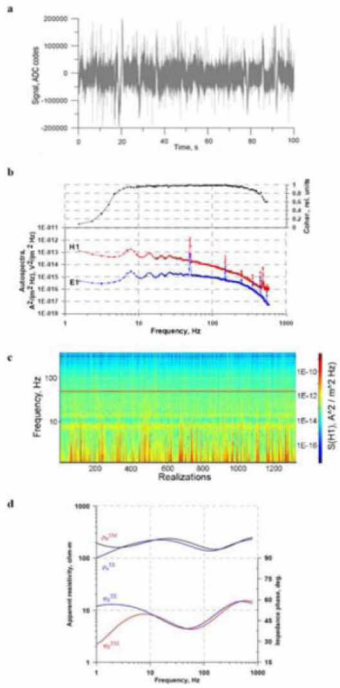

Fig. 1. AMT monitoring data: time series (a), autospectra and mutual coherence of electric and magnetic fields (b), dynamic spectrum of the magnetic field (c), and sounding curves (d).

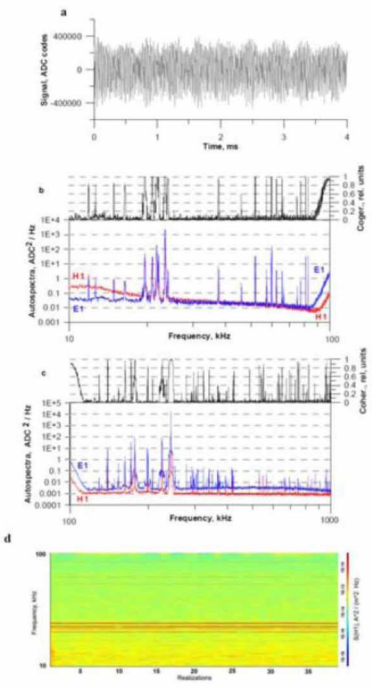

Fig. 2. RMT monitoring data: time series (a), autospectra and mutual coherence of electric and magnetic fields for frequency ranges 10–100 kHz (b) and 100–1000 kHz (c), dynamic spectrum of the magnetic field for frequencies 10–100 kHz (d).

For the monitoring of apparent resistivity variations we apply the AMT sounding method in frequency range 7-300 Hz with the sufficiently large investigation depth for decreasing of seasonal and daily factors influence, temperature changes and other weather conditions. In this frequency range natural EM fields are quite stable for reliable data obtaining in any time of day and season with accuracy 0.3 % for apparent resistivity. For ULF magnetic, electrotelluric and electromagnetic emission anomalies study we use the wide-band registration of time-series of electric and magnetic fields in frequency range from 0.1 Hz up to 1 MHz. Ionosphere disturbances are studied in radio (observations of remote radio transmitter's signals) and audio (observations of Schumann resonances) frequency ranges. Supplementary information about the state of ionosphere gives us the study of Alfven resonances (Fig. 3).

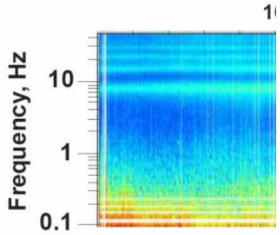

Fig. 3. Registration of signals of Schumann resonances at frequencies 8, 14, 20, 26, 32 … Hz and Alfven resonances around frequency 1 Hz.

An EM emission anomaly was registered before an earthquake of M=3.3 on 4 April 2013 (22:07 LT) in the monitoring station near Bishkek at 100 km distance to the West from the earthquake epicenter (Issyk-Kul lake area). Anomalous disturbances of the magnetic field horizontal component for azimuths 60° (Fig. 4, above) and 150° (Fig. 4, below) in radio frequency range 10-1000 kHz was registered before the earthquake. In the dynamic spectrum of magnetic field horizontal components the anomaly is seen in intervals 10-25 and 70-100 kHz (Fig. 4). The duration of the anomaly is approximately 2 hours before the earthquake.

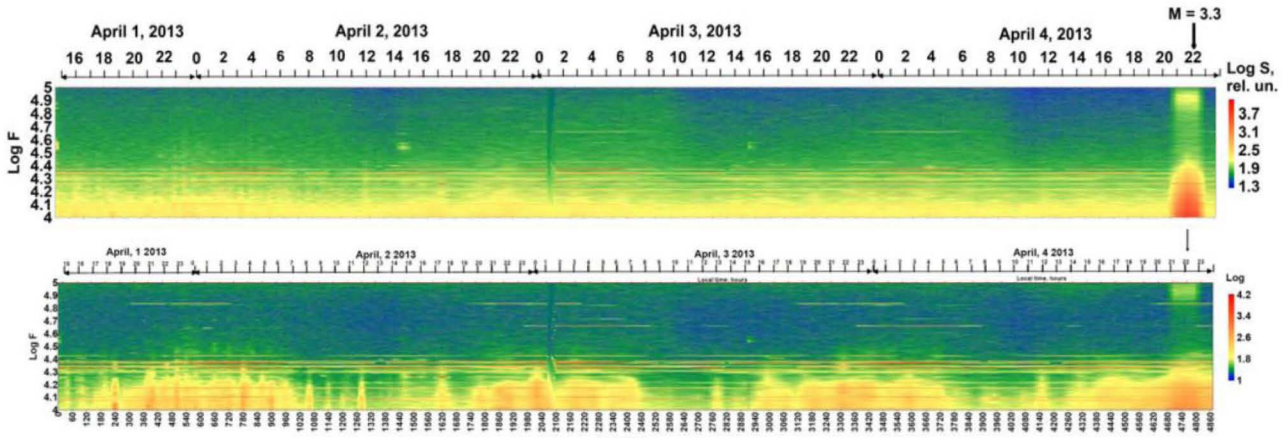

Fig. 4. Anomalous disturbances of magnetic field horizontal components for azimuths 60° (above) and 150° (below) in radio frequency range 10-100 kHz before the earthquake on 4 April, 2013, 22:07 LT (M=3.3) at the distance of 100 km from the source.

Similar anomaly was registered during the monitoring in the preriod of 06:00 to 11:00 LT on 22 November 2013, but seismic events were not observed in this area after the anomaly. The considered two anomalies were registered during a quite long (42 days) period of the monitoring session. Due to lack of statistical data to explain definitely the nature of both anomalies is difficult, however, the obtained results confirm a high infomative value of electromagnetic monitoring using dynamic spectra registration and analysis in radio frequency range.

Results of investigations show prospects of the multiparametric monitoring of electromagnetic earthquake precursors in a wide frequenciy range 0.1 Hz – 1 MHz.

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