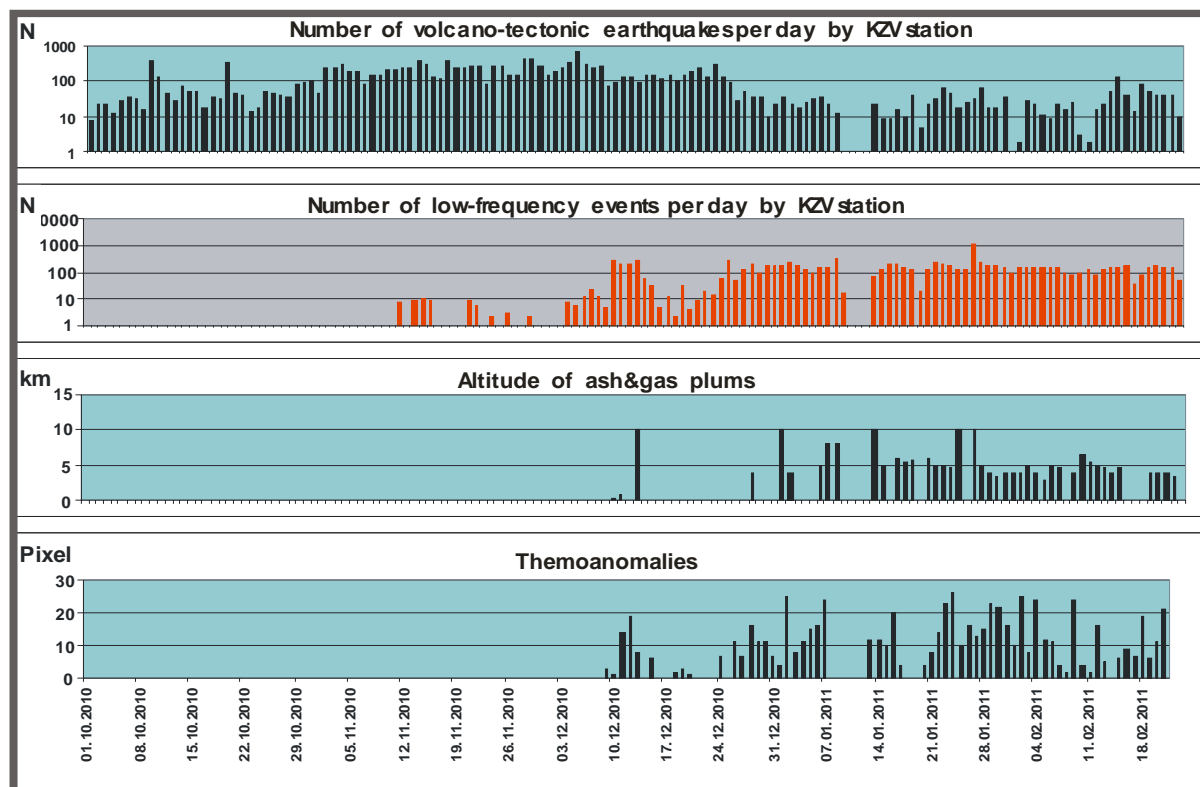


## SPECTRAL COMPONENTS IN THE WAVEFORMS OF VOLCANO SEISMIC EVENTS

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There is continuous, real-time, seismic monitoring at 11 from 29 active Kamchatka's volcanoes. In active volcanoes we can observe both volcano-tectonic (VT) earthquakes and low-frequency (LF) seismic events. LF volcanic earthquakes are the indicators of magma transportation and activity within shallow conduit systems. LF earthquakes appearance in seismic flow can be a precursor of coming volcanic eruption. For example, by seismic data of Kamchatkan regional seismic network, current Kizimen activation was observed from June, 2009. All earthquakes were VT with clear P waves and S waves. Eruption began with strong explosive events on December 12, 2010. LF earthquakes appeared in seismic records in the middle of November as the main precursor of coming eruption (Fig.1). LF seismicity significantly increased on December 9-10 (two days before the strong explosive events).



*Fig. 1. The beginning of explosive eruption at Kizimen volcano in 2010.*

In Kamchatka seismic monitoring survey, earthquakes processing is interactive digital signal analysis on PC screen. In the case of volcanic activation the number of earthquakes increases significantly. So signal processing and fast detection of LF earthquakes becomes difficult. Partially the problem solving is in automatic analysis of spectral amplitudes of seismic records.

We used Kamchatka regional seismic catalog and data base of earthquakes wave forms (digital records) of Geophysical Survey of Russia. Dominant frequencies of LF earthquakes are between 2-3 Hz. VT earthquakes usually have high-frequency components in spectrum. We propose to use for analysis the dispersion of seismic signal in three frequency ranges: 1.5-3.0 Hz, 3.0-6.0 Hz and 6.0-12.0 Hz. For visualization of hidden correlation in waveform spectral characteristics the triangle diagram is available.

In given report we present VT and LF earthquakes separation with the triangle diagram for 4 active volcanoes, located in the Eastern Kamchatka volcanic belt (fig.2): (1) Mutnovsky (continues intensive fumaroles and hydrothermal activity); (2) Koryaksky (2009-2010 activation, strong steam-gas and ash emission); (3) Kizimen (2010-2011 explosive eruption); (4) Gorely (2010 activation).

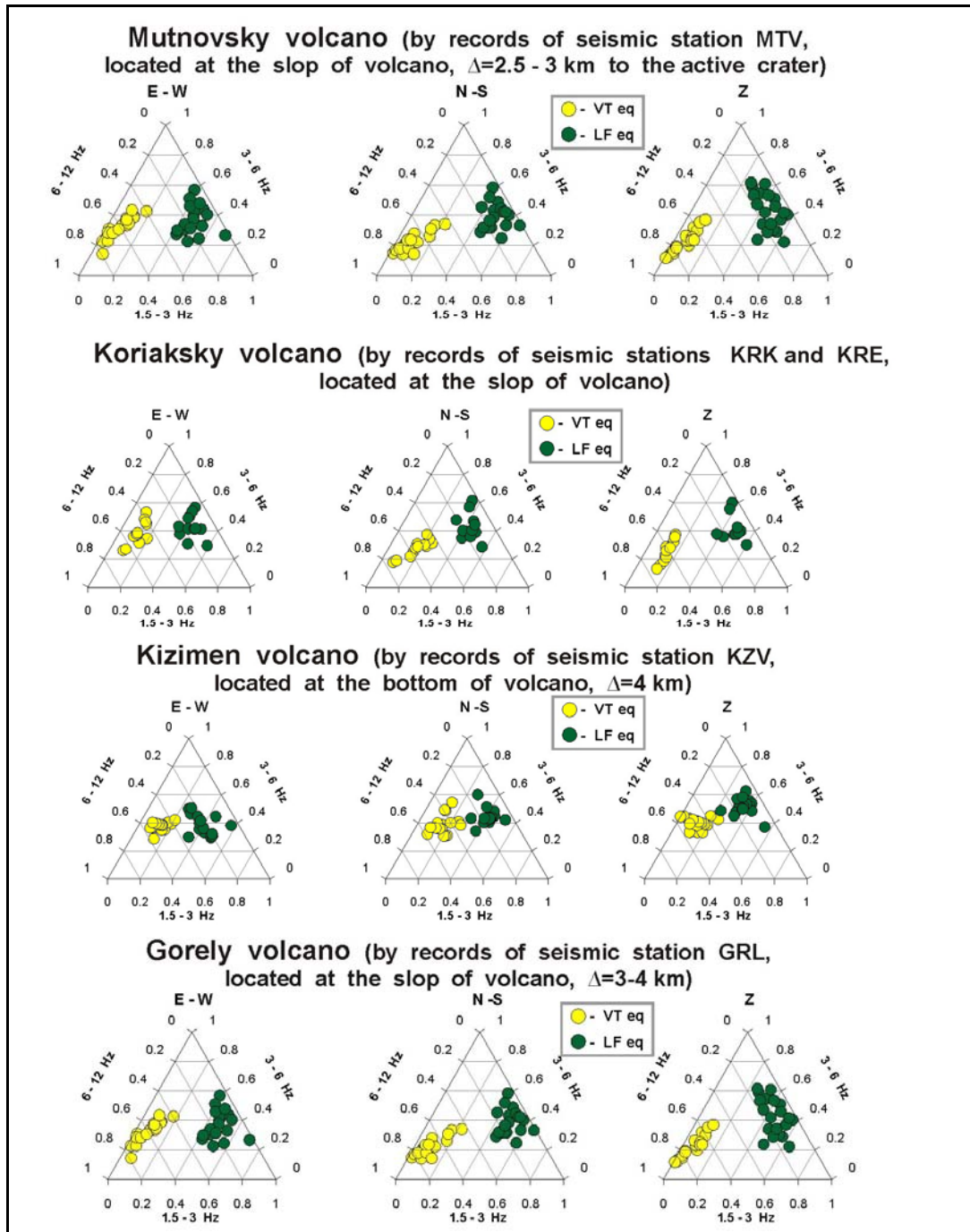


Fig.2. Relative intensity of the seismic signal in the different frequency bands for volcano-tectonic earthquakes and low-frequency events.