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Inter-magnitude relations for the seicmicity of the Klyuchevskaya group of volcanoes

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In this study, the object of research is the volcanic seismicity of the Klyuchevskaya group of volcanoes (KGV), located on the Kamchatka Peninsula. The Klyuchvskaya group of volcanoes represents one of the largest and most active volcanic structures on Earth, formed in a subduction zone by magma generation at the plate boundary [1, 2].

Volcanic earthquakes are commonly divided into two main types: long-period (LP) and volcano-tectonic (VT) earthquakes. These earthquakes occur at or near volcanoes, are associated with volcanic processes, and differ from tectonic ones in their source mechanisms and characteristics of seismic signals [3]. Within the framework of this study, a preliminary identification of volcanic earthquake types was carried out based on characteristic frequencies by estimating the ratio of spectral amplitudes between low and high frequencies. For LP earthquakes, the frequency limits were selected as 1 Hz and 3 Hz; for VT earthquakes, as 4 Hz and 11 Hz.

For this analysis, we used waveform data from permanent seismic stations of the Kamchtka Branch of the Geophysical Survey of the Russian Academy of Sciences (KB GS RAS), recorded during the period 01.02.2021–18.02.2021, prior to the Gorshkov vent eruption (18.02.2021) of Klyuchevskoy volcano [4]. In this study the data from temporary stations were also used. They were installed in 2015-2016 for a one-year period in the Klyuchevskaya group of volcanoes region as part of the KISS experiment (Klychevskoy Investigation – Seismic Structure of an Extraordinary Volcanic System), the primary goal of which was to study the deep structure of the crust and upper mantle in the KGV area [5,6].

For each earthquake type, moment magnitudes and duration magnitudes were determined. The moment magnitudes were estimated using a method based on the relationship between the level of the low-frequency plateau of the body-wave amplitude spectrum at zero frequency and the seismic moment [7]. To determine the duration magnitudes, an automated algorithm for signal duration estimation was developed, in which the signal onset is determined by the Allen method [8], and the signal end is determined based on the analysis of a smoothed envelope.

Based on the obtained data, a comparative analysis was carried out of the moment magnitude, duration magnitude, and local magnitude estimates provided by the Kamchatka Branch of the Geophysical Survey of the Russian Academy of Sciences (KB GS RAS). The result of the study is presented in the form of inter-magnitude relations for the seismicity of the KGV.

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