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Aftershock domain estimation by first aftershocks on the example of the Khibiny deposits

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Seismic monitoring has been provided in rockburst hazardous apatite deposits of the Khibiny massif [1] since the mid-1990s. In result, a catalog of mining-induced earthquakes with the magnitude of completeness $M_c = 0$ has been compiled by the Kirovsk Branch of JSC Apatit. The completeness and accuracy of hypocenters estimates (25 m) in the catalog allow filling a gap between laboratory and in-situ studies.

Former studies of post-seismic activity features of the Khibiny deposits had proved the earthquake Δ-productivity law [2], [3] and the power law of mainshock-aftershock distances distribution [4]. The main shock-based aftershock forecast model has been designed based on these studies [5].

The current research refines forecast models for prospect aftershock domains based on first aftershocks data. The scaling technique on different parameters of the mainshock and first aftershocks training set has been applied to test various forecast domains. The best forecast domain has been selected using the loss function defined as a sum of type I (false alarms) and type II errors (target miss) with the Molchan error diagrams. In total, 11 aftershock activity domains with different shape, size and estimation methods applied have been tested for the epicentral forecast. Eight aftershock activity domains have been tested for the depth forecast.

In result, the optimal epicenter domain has proved to be a stadium with a size depending on a mainshock rupture, and the location and orientation on an aftershock training set. The depth optimal forecast occurs as a segment, which size depends on the mainshock rupture and its location depends on the magnitude weighted aftershock training set as well.

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