Spatial distribution of clustered seismicity in Khibiny Mountains Baranov S.V., Motorin A.Yu, Shebalin P.N.

33°40'E

33°50'E



Mining induced seismicity obeys earthquake productivity law (Shebalin, et al., 2020)

Distribution of from triggering to triggered earthquakes

 $F_r(x) = P(r < x) = 1 - \left(\frac{x}{r_0}\right)^{1-n}$

 $f_r(x) \sim x^{-n}, x \ge r_0.$

(Huc, Main, 2003; Felzer, Brodsky, 2006; Richards-Dinger et al., 2010)



Averaged model of the maximal distances at which triggered events are expected

$$F_{\Lambda}(x) = P(R_{max} < x) = \sum_{k=0}^{\infty} F_r(x)^k \frac{\Lambda^k}{k!} e^{-\Lambda} = e^{-\Lambda[1 - F_r(x)]}, x \ge r_0.$$

 $-\Lambda/L$

 $f_{ex}(\Lambda) = \frac{1}{I}e$

Earthquake productivity law L – mean number of triggered events with $M_{\text{triggering}} \ge M_{\text{triggered}} - \Delta M$

$$F_{a}(x) = \int_{0}^{\infty} F_{\Lambda}(x) f_{ex}(\Lambda) d\Lambda = \frac{1}{1 + L[1 - F_{r}(x)]}$$
$$f_{a}(x) = \frac{Lf_{r}(x)}{\{1 + L[1 - F_{r}(x)]\}^{2}}$$



Space model of triggered seismicity





	Strategy	q	τ	V	
	Epicentral estimates				R _{max} , km
0	Neutral	0.75	0.08	0.12	0.7
1	Soft	0.56	0.01	0.30	0.25
2	Hard	0.83	0.26	0.05	1.28
	Depth estimates				H _{max} , km
0	Neutral	0.66	0.25	0.19	0.25
1	Soft	0.41	0.11	0.47	0.11
2	Hard	0.88	0.69	0.009	0.69