Geophysical Research Abstracts
Vol. 17, EGU2015-10037, 2015
EGU General Assembly 2015

Earthquake statistics, spatiotemporal distribution of foci and source mechanisms as a key to understanding of causes leading to the West Bohemia/Vogtland earthquake swarms

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The origin of earthquake swarms is still unclear. The swarms typically occur at the plate margins but also in intracontinental areas. West Bohemia-Vogtland represents one of the most active intraplate earthquake-swarm areas in Europe. It is characterised by a frequent reoccurrence of ML < 4.0 swarms and by high activity of crustal fluids. The Nový Kostel focal zone (NK) dominates the recent seismicity of the whole region. There were swarms in 1997, 2000, 2008 and 20011 followed by reactivation in 2013 which forming a focal belt of about 15 x 6 km, focal depths vary from 6 to 15 km. An exceptional non-swarm activity (mainshock-aftershock sequences) up to magnitudes ML = 4.5, stroke the region in May to August 2014, the events were also located in the NK swarm-focal belt.

We analysed geometry of the NK focal zone applying the double-difference method to seismicity in the period 1997 – 2014. The swarms are located close to each other at depths between 6 and 13 km, the 2014 maishock-aftershock sequences among them. The 2000 and 2008 swarms were located on the same portion of the NK fault, similarly the swarms of 1997, 2011 and 2013 also occurred on the same fault segment. Other fault segment hosted three mainshock-aftershock sequences of 2014. The individual swarms differ considerably in their evolution, mainly in the rate of the seismic-moment release and foci migration. The frequency-magnitude distributions of all the swarms show bimodal-like character: the most events obey the b-value = 1.0 distribution, however, a group of the largest events ($\sim$ML > 2.8) depart significantly from it. Furthermore, we disclose that all the ML > 2.8 swarm events, which occurred in the given time span, are located in a few dense clusters. It implies that the most of seismic energy in the individual swarms has been released in step by step rupturing of one or a few asperities.

The source mechanisms have been retrieved in the full moment-tensor description (MT). The mechanism patters of the individual swarms indicate their complexity. All the swarms exhibit both oblique-normal and oblique-thrust faulting but the former prevails. We found a several families of mechanisms, which fit well geometry of respective fault segments being determined by means of the double-difference location. MTs of the most analysed events signify pure shears except for events the second phase of the 1997 swarm the MTs of which indicate significant amount of non-DC components.

The existing results do not allow us to explain properly an origin of earthquake swarms. Nevertheless, we infer that the individual earthquake swarms in West Bohemia-Vogtland are mixture of the mainshock-aftershock sequences which correspond to step by step rupturing of one or a few asperities. The swarms occur on short fault segments with heterogeneous stress and strength, which may be affected by crustal fluids. Pressurized fluids may reduce normal component of the tectonic stress and lower friction. Thus, critically loaded and favourably oriented faults are brought to failure and the swarm activity is driven by the differential local stress.