Geophysical Research Abstracts
Vol. 15, EGU2013-4823, 2013
EGU General Assembly 2013
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Space and time distribution of foci and source-mechanisms of West-Bohemia/Vogtland earthquake swarms - a tool for insight into their triggering mechanisms and driving forces

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West Bohemia/Vogtland (border area between Czech Republic and Germany) belongs to the most active intraplate earthquake-swarm regions in Europe. Above, this area is characteristic by high activity of crustal fluids. Swarm earthquakes with magnitudes ML < 4.0 occur frequently in the area of about 3 000 km2, however, the Nový Kostel focal zone (NK), which shows a few tens of thousands events within the last twenty years, dominates the recent seismicity of the whole region. During last fifteen years there were four earthquake swarms in 1997, 2000, 2008 and 20011 (besides a few tens of microswarms) encompassing a fault plane of about 15 x 6 km. The swarms were located close to each other. Moreover, the 2000 (MLmax = 3.3) and 2008 (MLmax = 3.8) swarms were "twins", i.e. their hypocenters fall precisely on the same portion of the NK fault plane; and the 1997 (MLmax = 2.9) and 2011 (MLmax = 3.6) swarms also occurred on the same fault segment. However, the individual swarms differed considerably in their evolution, mainly in the rate of the seismic-moment release and foci migration. Source mechanisms (in the full moment-tensor description) and their time and space variations also show different patterns. All the 2000- and 2008-swarm events were pure shears, most of them showing the oblique normal faulting. Although source mechanisms of majority of the 2000- and 2008 events signify the faulting parallel to the main NK fault plane, there is a significant amount of events having different source mechanisms. We also found alteration of the source mechanisms with depths. The 1997 and 2011 swarms took place on two differently oriented fault segments thus two different source mechanisms occurred: the oblique-normal on the one segment and the oblique-thrust type on the other one. Moreover, source mechanisms of the oblique thrust events suggest combined sources (possessing significant non-DC components). This indicates complexity of both NK focal zone (where earthquake swarms have periodically occurred) and rupturing in the individual swarms.

Similar pattern of the strain energy release we disclosed for seismicity due to fluid injection into deep boreholes at HDR site Soultz-sous-Forêts (France) in 2003. We analyzed the spatial and temporal distribution of micro-earthquakes and their source mechanisms and found that injected fluids triggered large seismicity (pure-shear events) at two existing natural fault segments, which ran independently of the injection strategy.

Taking into account all our results, we can conclude that earthquake swarms occur on short subcritically loaded fault segments which are affected by crustal fluids. Pressurized fluids reduced normal component of the tectonic stress and lower friction, thus decrease the shear strength of the medium (in terms of Coulomb friction criterion). On critically loaded and favourably oriented fault segments the swarm activity is driven by the differential local stress, the shear rupturing occurs.