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2014 earthquake sequence in West Bohemia/Vogtland responsible for the sudden increase of CO_2 flow rate?

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Various mechanisms have been proposed to explain the role of crustal fluids in faulting. The fluids are expected to facilitate faulting by decreasing the normal stress on faults or by hydrothermal alteration of the fault plane. The active role of fluids is documented by repeated mineral precipitation along ancient fault zones due to fast, large-scale fluid flow after fault rupturing as a result of fault-valve behavior. There are however only very few examples of valve action of faults during present earthquakes.

Geodynamic activity in West Bohemia/Vogtland is demonstrated by M4+ earthquake swarms and degassing of deep-generated CO_2 of upper mantle origin. The migration patterns of seismicity, Coulomb stress analyses and related numerical models suggest that pressurized fluids act as triggering force of the earthquake swarms. In the period May-August 2014 three M3.5 – M4.5 mainshocks followed by aftershock sequences occurred in the area. CO_2 degassing rate is monitored on three mofettes in the area. While two of them showed no anomaly, the record at Hartoušov shows a transient change of trend of the CO_2 flow. In particular, the period of 4 years preceding the earthquake is characterized by a steady decrease of flow rate from 40 l/min in December 2009 to 6 l/min in May 2014. However since 24 May 2014, which was the time of the first mainshock, a rapid increase of the flow rate started, which lasted until mid July reaching 30 l/min.

The fast propagation of the pressure pulse to the surface points to high permeability of the CO_2 feeding channel, however, on the contrary, the long rise time of the flow rate indicates rather slow response of the intermediate crust properties to swarm activity. We use numerical modeling of fluid flow in porous media to resolve the contribution of the gas pressure source and response of the crust to the observed record of CO_2 flow rate on the surface.