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Reflection seismic investigation of the geodynamically active West-Bohemia/Vogtland region

N. Mullick (1), S. Buske (1), S. Shapiro (2), P. Wigger (2), B. Ruzek (3), J. Horalek (3), P. Hrubcova (3), and T. Fischer (4)

(1) Institute of Geophysics and Geoinformatics, TU Bergakademie Freiberg, Germany, (2) Institute of Geological Sciences, FU Berlin, Germany, (3) Institute of Geophysics, Academy of Sciences, Czech Republic, (4) Institute of Hydrology, Engineering Geology and Applied Geophysics, Charles University, Czech Republic

The West Bohemia-Vogtland region in central Europe attracts much scientific interest due to recurrent earthquake swarms and continuous emission of CO_2 dominated fluid from the subsurface. Seismological and geochemical studies reveal 1) significant upper mantle derived content of the emitted fluid, 2) an updoming of the Moho below that area 3) possible existence of a magmatic fluid reservoir in the upper mantle and 4) fluid activity as a possible trigger for the swarm earthquakes. In this study the subsurface structure beneath the region is investigated by reprocessing the deep reflection seismic profile 9HR, which runs closely east almost parallel to the earthquake swarm. The migrated image confirms the upwelling of the Moho known from receiver function studies. Directly below one of the major gas escape centres, channel like fault structures are observed which seem to have their roots at the Moho. They may represent deep reaching degassing channels that allow direct transport of mantle-derived fluid. A region of diffused reflectivity is observed that extends from the Moho and ends immediately below the main cluster of the swarm earthquake hypocenters. The upper boundary of the swarm earthquakes is clearly marked by a prominent high-amplitude reflector (bright spot). Together with the gas-escape related observations these features suggest that fluids ascend from the Moho upward through fractured rock and generate swarm earthquakes. These fluids are then blocked by near surface non-permeable rocks directly above the swarm earthquake region, thereby causing the bright spot, while they escape unblocked at the gas escape centres where such a barrier may not exist. A comparison of the spatiotemporal evolution of the recent swarms in the years 2000 and 2008 with the subsurface reflectivity shows that in both cases the swarm activity initiates at the upper edge of the highly diffuse reflectivity zone, moves upward, bends at the bright spot above and finally stops after travelling a few kilometers along the bright spot. This correlation may indicate the movement of an overpressured trapped fluid forcing its way into a less permeable volume above it and thereby generating earthquakes swarms. These observations and in particular their joint interpretation give new insight into the causes and driving mechanisms of earthquake swarms in the West Bohemia-Vogtland region.