



Tidal analysis of groundwater level variations and CO₂ flow fluctuation in the seismically active region of western Bohemia

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The western part of the Bohemian Massif (Vogtland/West-Bohemia region at the Czech-German border) is characterized by relatively frequent intraplate earthquake swarms and by ascent of mantle-derived CO₂. We analyze variations in the groundwater level and CO₂ flow in six hydrological wells and in one mofette in the period 2006 – 2011 when two large earthquake swarms occurred (the swarm in 2008 and 2011 with magnitudes up to 3.8 and 3.5, respectively).

All four hydrological wells display distinct seasonal variations in the groundwater level with the maximum heights usually in spring, associated with seasonal thaw. During the 2008 and 2011 earthquake swarms, the groundwater level variations in the NK-1 and NK-2 wells were moderate and relatively smooth, without noticeable relations to the variations in seismic activity. Nevertheless, several drops in the water level in the NK-2 can be observed prior to the intervals of increased seismic activity. Interestingly the variations in the groundwater level during the swarms in the distant wells HM-1 and S-4 are surprisingly pronounced and self-similar, which indicates a possible coseismic effect. In contrast to the groundwater level, no coseismic anomaly in CO₂ flow was observed.

In addition, we analyzed also other factors influencing measured quantities of crustal fluids, such as meteorological and tidal influence. We used both harmonic tidal analysis and theoretical tides computed using software developed by Wenzel (1993) and modified by Skalsky (1991). We find a significant influence of earth tides both to the groundwater and CO₂ data with prevailing semidiurnal and diurnal periods. We focus on these short-period tidal components in the groundwater level and CO₂ flow to find possible changes in the phase characteristics of the Earth crust response due to stress changes associated with local seismicity. Using the frequency-time and cross-spectral analysis we find minor time variations in the tidal transfer function, which could be associated to the running seismic activity.

In general, one should expect much greater groundwater variations in the epicentral area than at distant localities. However, such behaviour has not been observed, the amplitudes of the variations being comparable in all wells. This probably indicates that the NK-1 and NK-2 wells are not hydrologically linked with the seismically active fault at depth. This indicates that the Mariánské Lázně fault, clearly seen on the topography, probably does not represent the true outcrop of the deep seismically active fault.