Variations of gas compositions during a drilling process: A key study on the Hartoušov Mofette, Czech Republic

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The Eger Rift (Czech Republic) is an intraplate region without active volcanism but with emanations of magma-derived gases and the recurrence of mid-crustal earthquake swarms with small to intermediate magnitudes (M < 5) in the Cheb Basin. To understand the anomalous earthquake activity and CO₂ degassing, an interdisciplinary well-based observatory is built up for continuous fluid and earthquake monitoring at depth.

The fluid observatory is located at the Hartoušov Mofette (Cheb Basin), an area characterized by intense mantle degassing with a subcontinental lithospheric mantle (SCLM) contribution of He that increased from 38% in 1993 to 89% in 2016. Two drillings with depths of 30 and 108 m (F1 and F2, respectively) are being monitored since August 2019 for the composition of ascending fluids. Additionally, the environmental air composition is monitored. Gas concentrations were determined in-situ at 1-min intervals, while direct sampling campaigns took place periodically and samples were analyzed for their chemical and isotope composition. Samples of gases emerging in the mofette were also collected. During this period, a third borehole (F3) with a depth of 238 m was drilled.

At Hartoušov, carbon dioxide is the prevailing gas component (concentrations above 99.5%), with helium presenting a mantle origin (up to 90% considering a SCLM-type source). The atmospheric contribution is negligible, even though during drilling of F3 enrichments in atmospheric components such as Ar and N₂ have been observed. An increase in both CH₄ and He has been noticed in F2 (108 m borehole) at 40 m depth, whilst a decrease in He has been observed at 193 m depth in both F1 and the natural mofette. Enrichments in less soluble gases (e.g. He and N₂) at various depths accompanied by a minor CO₂ decrease have also been noticed. Such variations may have been caused by the different solubilities of gases in aquatic environments. Moreover, a decrease in CO₂ followed by a subsequent enrichment of CH₄ and CₓHᵧ during the first days after the initial drilling could promote the hypothesis of the generation of microbially derived CH₄.

Diurnal variations were observed for the majority of the gas components during the last phase of
the F3 drilling, when the well reached a depth >200 m.

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