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VOC and VOX in fluid inclusions of quartz: New chemical insights into hydrothermal vein mineralization by GC-MS and GC-IRMS measurements

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Fluid inclusions (FIs) in minerals are known to contain a variety of different liquids, gases, and solids. The fluids get trapped during mineral growth and can preserve the original mineral-forming fluid or fluids of later events. A new analytical technique developed by Mulder et al. (2013) [1] allows to measure trace gases in FIs. For the measurements, grains of 3–5 mm diameter are ground in an airtight grinding device, releasing the volatiles from FIs into the gas phase, where they can be measured by GC-MS, GC-FID and GC-IRMS.
The Taunus covers the southeastern part of the thrust-and-fold-belt of the Rhenish Massif (Germany). The Variscan rock sequences comprise sedimentary and volcanic units ranging from Ordovician to Lower Carboniferous. Several types of hydrothermal mineralization can be distinguished, which are – in regard to the Variscan orogeny – pre-orogenic, orogenic, late-orogenic, post-orogenic and recent in age [2]. They include SEDEX, vein, Alpine fissure, disseminated and stockwerk mineralizations. Thus, the Taunus mineralizations enable investigations of different hydrothermal systems at different age in one region. For most of them extensive studies of stable and radiogenic isotopes exist.
Quartz crystals of post-orogenic quartz veins and Pb-Zn-Cu bearing veins [3] were selected for our FI investigation. Sulphur containing compounds like COS and CS2 dominate the FIs but there are also volatile hydrocarbons (VOC) like different butenes, benzene, toluene and cyclopentene that were found very often. In some samples volatile halogenated organic carbons (VOX) like chloro- and bromomethane were found. Some FIs even contain iodomethane, chlorobenzene, vinyl chloride and -bromide.
The non-fossil-fuel subsurface chemistry of VOC and VOX is not fully understood. There are a lot of unknown geogenic sources [4][5]. For a better understanding δ13C- and δ2H-values of CH4 were measured by GC-IRMS to examine if the detected organic compounds are formed biotic, thermogenic or abiotic, and to investigate the relationship between aquifer rocks and FIs.
Our results add new information to the evolution of FIs in hydrothermal systems and the potential role of hydrothermal fluids to the origin of life [6].

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[6] Schreiber et al., 2012 Origins of Life and Evolution of Biosphere, 42: 47–54.