Chemical evolution of continental basement brines – a field study from the Schwarzwald, SW Germany

BENJAMIN F. WALTER[1*], MATHIAS BURISCH[1] AND GREGOR MARKL[1]

[1]University of Tübingen, Department of Geoscience, Wilhelmstrasse 56, 72074 Tübingen, Germany
*benjamin.walter@uni-tuebingen.de

High salinity, deep-seated basement brines are a common phenomenon worldwide. Here, we present the evolution with time of a typical continental basement fluid from the Schwarzwald in SW Germany. This 320 Ma history is based on fluid inclusion investigations in hydrothermal veins of various ages, which act as recorders of the fluids present during their time of formation. A combination of detailed microthermometry with crush leach analyses enabled to distinguish varying fluid signatures with time: During the Carboniferous, late magmatic quartz-tourmaline veins precipitated from a low salinity (<4.5wt.% $NaCl+CaCl_2$), high temperature (up to 390°C) H_2O-NaCl-(CO_2-CH_4) fluid with Cl/Br ~100. In the Permian, cooling H_2O-NaCl-(KCl-$CaCl_2$) metamorphic fluids (T≤ 250°C, 2-4.5wt.% $NaCl+CaCl_2$, Cl/Br = 70-100) lead to the precipitation of quartz. Quartz-hematite veins formed around the Triassic/Jurassic boundary contain in alternating growth zones the Permian fluid type and a new, high-salinity fluid (T=100-320°C, >20wt.% $NaCl+CaCl_2$, Cl/Br =70-110). Jurassic-Cretaceous veins record fluid mixing processes involving a older bittern brine (Cl/Br ~ 80) and a younger halite dissolution brine (Cl/Br >1000) of similar salinity. The mixed fluid was an H_2O-NaCl-$CaCl_2$ brine (75-140°C, 23-26wt.% $NaCl+CaCl_2$, Cl/Br =80-570). In post-Cretaceous times, the opening of the Upper Rhinegraben and juxtaposition of the high salinity reservoirs with different low salinity aquifers lead to vein formation from a H_2O-NaCl-$CaCl_2$-(SO_4-HCO_3) fluid (70-190°C, 5-25wt.% NaCl-$CaCl_2$, Cl/Br =10-140). The first occurrence of a high-salinity brine is recorded in veins formed just a few Ma after the deposition of halite in the Muschelkalk ocean. This indicates an evaporitic source of the basement brine salinity. Hence, today's deep-seated, highly saline brines in central European basement probably developed from an inherited high salinity ultimately derived from evaporitic bittern brines. These were later modified by fluid-rock interaction and by mixing with younger meteoric fluids and halite dissolution brines.