Gasanalysis at a geothermal facility: On-line monitoring above ground and measurements in the borehole

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The formation fluid from Permian (Rotliegend) vulcanite and sandstone layers of the geothermal in-situ laboratory in Groß Schönebeck (North German Basin) contains a high volume of dissolved gases (volume ratio of liquid : gas is about 1:1 and increases up to 1 : 1.6 at reservoir conditions). It's mainly composed of nitrogen (N_2; 84-90 vol-%) and methane (CH_4; 10-16 vol-%) with minor concentrations of CO_2, H_2, He, Ethane, Kr, Propane, *n*-Buthane and *i*-Buthane. The fluid is degassed above ground and the gas composition was monitored on-line at the degasser during several circulation tests at the facility. The measurements indicated relatively constant values of gas composition over the whole production time.

Additionally, several deep fluid samples have been collected in the production well at various depths (1700m, 2200m, 4200m) to analyze changes in liquid : gas ratio and in chemical composition of formation gas in dependence of the fluid depth. The collected results show, that the beginning of degassing takes place at about 2200 m depth.

However, some samples at 4200 m appear to be above gas saturation (calculated for a gas mixture with 85 % N_2 and 15 % CH_4 in 5 M NaCl). Thus the presence of free gas in the reservoir seems likely. The impact of free gas on plant operation is still under investigation.

Noble gas constraints on reduced deep subsurface fluids

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The noble gases are conservative tracers of fluid interactions over geological time scales. By applying high precision stable isotope noble gas multi-collector mass spectrometry to deep subsurface free fracture fluids and fluid inclusions, it is possible to discern the origin (e.g. atmospheric, crustal or mantle), age and interactions of these fluids. Two distinct end-member fluids have been found in the deep Precambrian continental subsurface: (i) palaeometeoric water that falls along the global meteoric water line (GMWL) and contains atmospheric noble gas signatures and (ii) highly saline hydrothermal fluids that lie above the GMWL and contain abiogenic hydrocarbons, significant radiogenic noble gas input and fluid components billions of years old [1].

Previous noble gas studies have highlighted disparities between the neon component of free fracture fluids and fluid inclusions [2] and have used high precision heavy noble gas analysis to study free fracture fluids [3].

For this study, gas, water and rock samples have been collected from exploratory boreholes in deep mines within the Precambrian Witwatersrand basin, South Africa and Abitibi greenstone belt, Canada. By combining noble gas mass spectrometry with traditional stable isotope techniques, we aim to fully characterize these samples to relate the free fracture fluid phase with fluids trapped within hydrocarbon-rich quartz-hosted inclusions to provide constraints on the rate of abiogenic gas formation, the extent of the free fracture fluid networks and the degree of communication between deep abiogenic reduced carbon sources and the biosphere.

Here we report on our progress in the development of a sample handling and processing system that will enable us to analyze hydrocarbon-rich free fracture fluids and fluid inclusions using high precision multi-collector noble gas mass spectrometry, a key advance in the application of noble gases to crustal fluid systems.

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