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Potential Tools for Deep Exploration - Rare Earth Elements, Sr-Nd-isotopes, δD and $\delta^{18}O$ in Oil- and Gasfield Brines from the North German Basin

D. Kraemer*, M. Bau*, V. Lüders**, M. Sośnicka**
*Jacobs University Bremen, Department of Physics and Earth Sciences
**Helmholtz Centre Potsdam GFZ, German Research Centre for Geosciences, Potsdam, Germany

Abstract

Exploration for ore deposits is becoming increasingly challenging. As many of the surficial (<1km) ore deposits have already been discovered, mining industry has to target mineralization at ever greater depths in the future, also in greenfield exploration, in order to detect unknown ore deposits that are buried deeply in the underground. Easy and especially cost-effective probing tools are urgently needed in order to detect element anomalies in the deep underground. Geochemical pathfinders for covered mineralization will probably gain even more importance in years to come. In this contribution we report on formation waters from oil and gas production sites in the North German Basin and discuss their potential relation to mineral deposit formation. The North German Basin (NGB) features numerous oil and gas deposits which are currently exploited by a number of companies. Exploration and production drilling exposed hydrothermal mineralization in numerous areas all over the NGB. The formation waters are coproduced during oil and gas production and are highly saline brines representing deep groundwaters. Those waters are mixtures of connate brines, meteoric brines and other fluids. Previous research indicates that formation waters from the North German Basin, especially from Rotliegend strata, may represent, at least in certain regions, original connate waters, i.e. basinal brines, which were capped and sealed by overlying Zechstein evaporite strata. Hence, the formation waters and their geochemical signatures are potential archives for very long-term (>> 1 million years) water rock interaction, and their chemical signature might be used as a geochemical tool for exploration of mineral deposits under deep cover or to reconstruct the physicochemical conditions in the deep underground.
In this contribution we present trace element (including REY) as well as $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, δD and $\delta^{18}O$ isotope data for formation waters from North German oil and gas reservoirs and compare the results to geochemical data from adjacent hydrothermal mineralization and fluid inclusions hosted in base metal and fluorite-barite mineralization from nearby drill cores. Our results indicate certain similarities in the trace element and isotopic signatures of the formation waters to those found in hydrothermal minerals such as calcite, dolomite and fluorite and fluid inclusions hosted within different types of mineralization.