

Occurrence and distribution of natural occurring radioactive materials at a geothermal facility in the North German Basin

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The occurrence of mineral precipitates with elevated activity concentrations of radionuclides of natural origin is a well known observation from wells of the oil and gas industry. Similar natural occurring radioactive materials (NORM) were found at some deep geothermal facilities. Presumably, these radionuclides are transported with the geothermal fluids and co-precipitate upon change of thermodynamic conditions with the respected oversaturated mineral.

On the one hand, the occurrence of NORM offers the identification of geochemical processes, but on the other hand elevated activities might lead to an enhanced exposure due to radiation. At the geothermal research facility in Groß Schönebeck (North German Basin) the mobility of potassium (⁴⁰K) and radionuclides of the natural uranium- and thorium decay series was intensively monitored. Radionuclide concentrations were measured by gamma-ray spectrometry in samples from reservoir rocks, scalings, filter residues and fluids. Additionally the ambient gamma dose rate of several plant components was monitored. It was found that the content of natural radioactivity in the reservoir rocks is relatively low, whereas a strong enrichment was detected for ²¹⁰Pb and especially for the radium isotopes ²²⁶Ra and ²²⁸Ra in the filter residues of the plant. Filter residues and fluid samples were not in equilibrium with respect to these nuclides.

Since these residues consist mainly of the mineral barite (BaSO₄) and Ra is known as substitute for barium in minerals, barite precipitates apparently act as scavenger for these radionuclides. Further, it was found, that in sandstone reservoir rocks the radionuclides ²²⁶Ra and ²¹⁰Pb are in deficiency compared to their parent ²³⁸U.

REE mobility in carbonatites: insights from the trace-element composition of dolomite

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Dolomite is a principal constituent of many carbonatites. Whereas the major-element chemistry of this mineral has been studied reasonably well, its trace-element variations have not. Here, we examined the trace-element composition of dolomite from carbonatites at Aley (British Columbia, Canada) to improve the current understanding of the processes that affected these rocks after their emplacement.

The examined dolomite shows extremely variable levels of Mn, Co, Sr, Ba, Sc and REE (900-13500, 0-15, 22-7000, 0-600, 0-60 and 0-400 ppm, respectively). Late-stage rhombohedral dolomite associated with quartz and chlorite (\pm REE minerals) is consistently enriched in REE relative to the groundmass. The pattern of enrichment varies from light-REE dominated to heavy-REE dominated. The former type correlates with enrichment in Mn, Sr, Co and Ba. Late-stage dolomite enriched in heavy REE contains lower levels of these elements. There is a general increase in REE content from the core of rhombohedral crystals toward their rim. The groundmass dolomite is characterized by relatively flat chondrite-normalized profiles, which are, in some cases, interrupted by a small negative Y anomaly. With the exception of one sample, REE patterns of the late-stage dolomite show appreciable positive Eu and Y anomalies.

The observed trace element characteristics of dolomite indicate an influx of REE, possibly scavenged from fluorapatite and transported by F-bearing crustal fluids under reducing conditions. The trace-element composition of the late-stage dolomite was further influenced by the precipitation of other associated phases, such as monazite and chlorite.