A model for the release of Radium isotopes into saline deepwaters

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Highly saline fluids as e.g. produced by geothermal plants often show enhanced levels of some 10 $Bq \cdot l^{-1}$ for the Radium isotopes ^{226}Ra (half life 1600 y), ^{228}Ra (5.75 y) and ^{224}Ra (3.63 d) [1]. In a previous contribution [2] we suggested the dominance of alpha recoil processes at mineral surfaces in the release of the observed Radium isotopes.

An adequate description of alpha recoil processes in aquifers must taken into account

- the development of a surface layer in the mineral phase depleted in members of the natural decay chains due to the release of decay products into the fluid
- an ingrowth of the depletion layer along the decay series
- the formation of a surface sorption layer of insoluble decay products and their contribution to alpha recoil events

The model was implemented by a Monte Carlo simulation routine of alpha decays at the solid/fluid interface. The results of the routine deviate in a characteristic way from the results of a more simple model [2], [3] and allow a deeper understanding of the observed Radium concentrations and isotope ratios in fluids from natural aquifers.

A comprehensive data collection was performed on sample material from typical deep geothermal aquifers of Germany and used as input data for the simulation of the Radium isotope signature in the fluids. Hydrothermal systems show generally a good agreement between model and analytical results. The processes in fractured reservoirs are still under discussion.

An experimental approach investigated the time dependence of Radium isotope concentrations in Na-Ca-Cl-solution (110 $g \cdot l^{-1}$) containing suspended kaolin. The increase of ^{224}Ra activity with contact time is in contrast to constant $^{226,228}Ra$ concentrations but in agreement with the model of predominating alpha recoil in Radium isotope release.

[1] Degering, D., Köhler, M., Hielscher, M. (2011), *Zeitschrift für geologische Wissenschaften 39 3/4*: 275-290. [2] Degering, D., Köhler, M (2011), *Mineralogical Magazine, 75 (3),* 735. [3] Eggeling, L. et al. (2013), *Geothermics 47*, 80-88