Radium in Geothermal Fluids.

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Abstract

Thermal waters from springs and wells in Switzerland are known to have increased ^{226}Ra activity concentrations, up to some 100 mBq/l . Only few ^{228}Ra measurements have been done. A deep geothermal project in Western Switzerland has created new interest in not only ^{226}Ra, but also ^{228}Ra measurements. Uranium, ^{226}Ra and ^{228}Ra have to be measured in the water released to a publicly accessible water body. The limits given are for weekly averages. Results thus have to be available within about a week to make a decision if the release point has to be changed. There is no time to wait for months until a considerable amount of ^{228}Th has been built up from ^{228}Ra.This has been the motivation for the work presented : to have a closer look at what happens with the radium daughter products after the mothers being adsorbed on a MnO_2 thin film. Is there for instance an optimal time window to measure ^{224}Ra as a proxy for ^{228}Ra ? The films are thin enough to allow for alpha spectrometry at high energy resolution. Three of the four radium isotopes decay by alpha particle emission to a radon isotope. These radon isotopes have very different half lives, from days to seconds. As a noble gas radon can diffuse out of the thin film before decaying. Due to the very different half lives this so called emanation is very different for the three radon isotopes. Nearly all ^{222}Rn(^{226}Ra daughter,$T_{1/2}$ = 3.8 d) can escape before decaying, whereas ^{220}Rn (^{224}Ra daughter,$T_{1/2}$ = 56 s) and ^{219}Rn (^{223}Ra daughter,$T_{1/2}$ = 4 s) mainly decay still adsorbed. Alpha spectra presented clearly show these differences in the emanation factors. The differences have an important consequence when quantifying ^{224}Ra in the presence of comparable ^{226}Ra concentrations. Due to the strong ^{222}Rn (^{226}Ra daughter) emanation there is nearly no spectral interference from ^{222}Rn and its daughter products in the energy range of the alpha peaks from ^{224}Ra and its daughter products.

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Increased radium concentrations are abundant in geothermal fluids. This may lead to radioprotection issues.

^{226}Ra can be measured by alpha spectrometry after selective adsorption on MnO_2 thin films. There are many data for ^{226}Ra in Swiss geothermal fluids, but ^{228}Ra data are scare as ^{228}Ra is a beta emitter. One has to wait for several months until alpha emitting daughter products are built up. A fast method giving results within some days after sampling would help to take timely radioprotection measures.

Such a method is presented. It makes use of the fact that long lived radon isotopes escape to a lager extent from the thin film than short lived ones. This leads to less interference from ^{226}Ra daughter products in the ^{228}Ra daughter products alpha energy region. This allows for measuring low ^{228}Ra concentrations in the presence of comparable ^{226}Ra concentrations. The measurement has to be done within some days after sampling as the ^{224}Ra (a proxy for the ^{228}Ra) decays with a half live of 3.6 days.