Atlas of Science
another view on science
http://atlasofscience.org

As simple method for the rapid analysis of radiostrontium in drinking water, river water and seawater

Radiostrontium (mainly strontium-90, ^{90}Sr) belongs to the radionuclides, which are emitted to the environment when nuclear fission gets out of control. The main source is from bomb fallout. Radiostrontium was released to the environment from 1945…1970, when over 600 bombs were tested in the atmosphere. Nuclear accidents, such as of the NPP of Chernobyl or Fukushima-Dai-Ichi, are another source of this artificial radionuclide. ^{90}Sr has a half-life of 30 years and is known as a bone seeker. Therefore, it is important to obtain^{90}Sr-data within a short time during after an emergency case. The focus is then on drinking water.

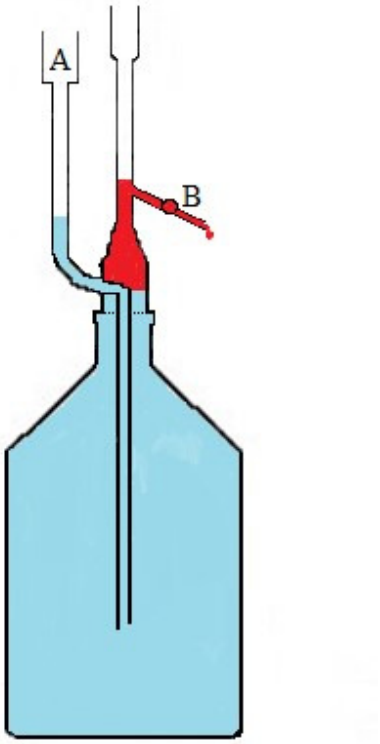

Fig. 1. Microseparator for the liquid/liquid extraction of water (blue) with a small extraction volume (red). By adding water to inlet A, the STRONEX-Phase is moved up to outlet B.

We extract the ^{90}Sr directly from the water sample with an organic solvent. The extracting solvent contains the crown ether dicyclohexano-18-crown-6 as an extracting agent and didodecylnaphthalene sulfonic acid as a scintillator. It is commercially available as STRONEX. It has to be converted into the ionic form by adding 8 ml of a 1:1 mixture of $NaN0_3$/NaOH to 8 mL of STRONEX. With 8 mL of STRONEX about 80…90% of radiostronium is extractable from one litre of tap water. Before the extraction, the filtered water sample is set to a pH of 10. After extraction (5 minutes of vigorous stirring with a magnet bar) and a phase separation time of 1 hour, the scintillator phase is removed by using a phase separation system (Fig. 1). Interfering β-nuclides (such as ^{140}Ba) can be eliminated by a scavenge with barium chromate prior to the extraction. The

extract is then counted with a Hidex 300 SL system from Hidex Oy for one hour. The ROI is set to 50-350 keV.

The extraction efficiency depends on the salt content of the water. In normal river water recoveries of 82-93 % are achievable. In water samples of higher hardness, the recovery is only 70%. In seawater, only 30% are recovered due to losses by coprecipitation of the radiostrontium with magnesium salts. Here, a dilution of the sample prior to the extraction step helps. 1:10 diluted seawater raises the recovery up to 92%. In addition, highly mineralised mineral waters should be diluted with demineralised water. The achieved detection limit is sufficient (about 0.5 … 1 Bq/L). In undiluted water samples, ^{90}Sr can be detected at a lower activity (0.1 Bq/L). The working range is linear up to over 1'000 Bq/L (Fig. 2).

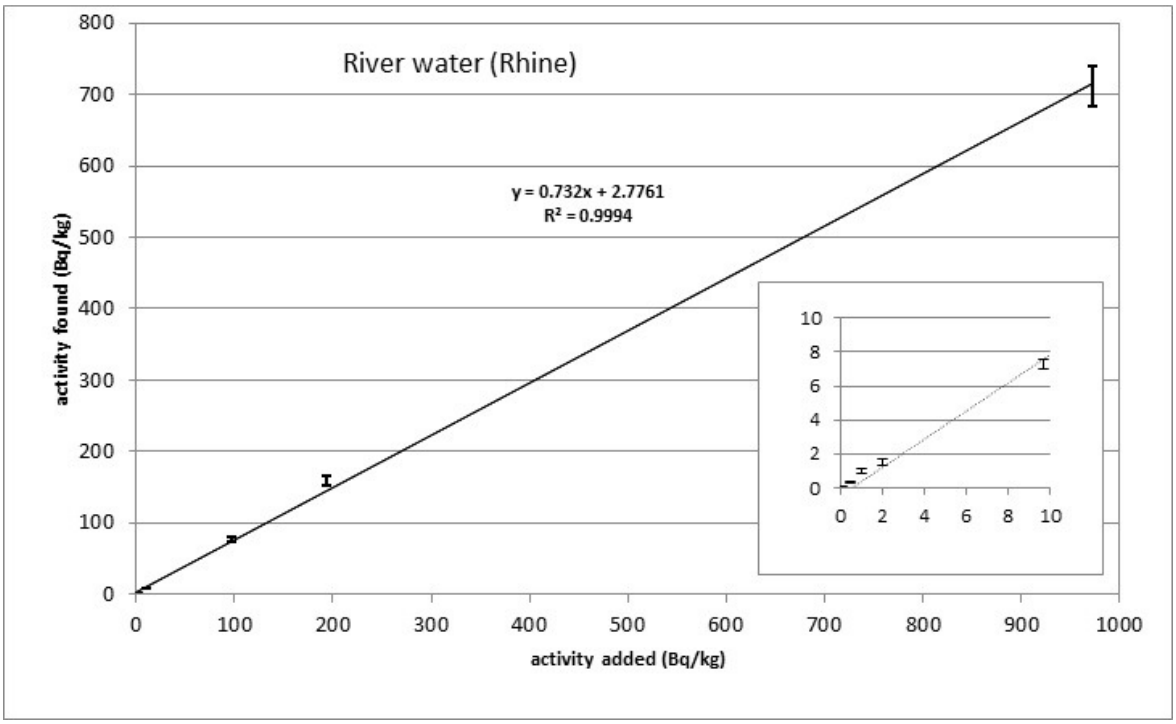

Fig. 2. Recoveries of 90Sr in water of the river Rhine (error bars are the relative standard deviation of the liquid scintillation counting).

This extraction method is fast. Three hours after starting the sample preparation, first ^{90}Sr results are available. Twenty samples can be analysed within 24 hours when using one liquid scintillation counter for the β-spectrometry. The analyses of ^{90}Sr in drinking water by liquid/liquid extraction and β-spectrometry is fast and sensitive enough for emergency analyses. It is a reliable tool for the fast survey of drinking water at an emergency case.

Zehringer Markus
State-Laboratory Basel-City, Basel, Switzerland

Publication

Fast Survey of Radiostrontium after an Emergency Incident involving Ionizing Radiation.
Abraham J, Kammerer F, Wagmann M, Zehringer M
Chimia (Aarau). 2016 Nov 30