INTERFERENCES IN THE RADIOCHEMICAL DETERMINATION OF $^{230}$Th

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(Received July 6, 1982)

Earlier work on the coprecipitation of $^{230}$Th and $^{234}$Th with BaSO$_4$ has been confirmed and in particular the influence of other ions was investigated. Potassium ions, both in the solution and in the crystals, promote the coprecipitation, while polyvalent cations tend to prevent it. It is shown that increased concentration of K$^+$ causes a marked change in the BaSO$_4$ crystal form, with a concomitant increase in surface area. At the same time, the rate of exchange of $^{133}$Ba$^{2+}$ with the BaSO$_4$ surface is also increased. This can be roughly accounted for by the change in surface area. It is conjectured that an equilibrium occurs involving foreign cations in the lattice.

Introduction

The radiochemical determination of $^{230}$Th in environmental soil and water is important because of the successive formation of $^{226}$Ra, $^{222}$Rn and other harmful radionuclides on its decay.$^1$ One of the methods used for its quantitative measurement involves its coprecipitation, along with radium, on BaSO$_4$ carrier$^{2,3}$ in the presence of K$^+$. Redissolution of the BaSO$_4$ allows separate precipitation of radium and thorium for radioactivity determination by $\alpha$-particle spectroscopy. For $\alpha$-spectroscopy the quantities must be small: a quantity of 1–2 mg Ba$^{2+}$ is as much as can be tolerated without loss of resolution in the spectra.$^4$ This method is especially elegant since consecutive determination of $^{226}$Ra and $^{230}$Th can be done on the same solution with little difficulty in most cases.

A problem which we have encountered in analysing some lake and pond waters is mentioned in the literature$^{2,4,5,6}$ but is not well understood. In this method, $^{234}$Th is used as tracer to determine the chemical recovery of $^{230}$Th in the coprecipitation. While in most cases we find that the recovery of the $^{234}$Th tracer is about 90%, on occasion the recovery drops to 50% and even lower. This loss can seriously affect the sensitivity and accuracy of the determination of $^{230}$Th even though, in principle, a simple correction factor is given by the recovery of the $^{234}$Th tracer.
The interfering effects of polyvalent cations in the coprecipitation has been shown by SILL and WILLIS who reported illustrative data showing that many cations such as Fe$^{3+}$, Al$^{3+}$ and Zr$^{4+}$ cause serious loss of Thorium. The chemical nature of the coprecipitation reaction was described by AMBE and LIESER who conjectured that a species K$_2$BaTh(SO$_4$)$_4$ was coprecipitated with the BaSO$_4$, and led ultimately to an increase in the crystal lattice spacing.

We have met this problem in numerous environmental water samples, the most serious of which comes from north-eastern Saskatchewan. The results can be illustrated as in Fig. 1, which shows the recovery of $^{234}$Th tracer from a series of mixtures of lake water with distilled water. It is quite clear from this figure that some components of the lake water are interfering with the analytical method.

The present report gives further data to complement the information given by SILL and WILLIS and by AMBE and LIESER.

**Experimental**

The reagents used were all analytical grade, and were used without further purification. $^{234}$Th was separated from $^{235}$ U-depleted $\text{UO}_2(\text{NO}_3)_2\cdot6\text{H}_2\text{O}$ by extraction of uranium (VI) from a nitrate solution into diethyl ether. This was followed by an anion exchange purification in 8M HCl. The thorium was prepared as a stock solution in 1M HCl.

$^{234}$Th measurement was done using a 3'' X 3'' Na(Tl)I scintillation counter, coupled to a multichannel pulse height analyser. The combined activity of the 63 and