The chemical behavior of calcium, barium and radium in the ion exchange resins Dowex 50W-X8, AG 50W-X8 and Merk I in the presence of ammonium tartrate, EDTA, and citrate has been studied. No differences were observed in results while using any one of the three resins. Calcium, barium and radium were fixed to the exchange column at pH 4.8 EDTA solution. Calcium was eluted in an EDTA solution at pH 5.3. Barium and radium between pH 8-11. Elution in citrate media for calcium was achieved at pH 6.1 and for radium at pH 10. In ammonium tartrate, calcium was eluted at pH 6, barium and radium at pH 11.5. Radium was also eluted from the ion exchange resins with a 2M nitric acid solution. The radium free of calcium was electrodeposited onto a stainless steel disc cathode using a 0.1M potassium fluoride solution, pH 12-14, with a yield of > 50%. The energies of $^{226}$Ra were analyzed through high resolution $\alpha$-spectra. The $^{226}$Ra utilized for these experiments was separated from Mexican carnotite.

Introduction

The alkaline earth elements are all quite frequently found together in nature; of these, calcium in abundance and radium in microamounts. Besides, the $^{226}$Ra isotope, is often recovered from uranium minerals by coprecipitation with barium sulfate. Prior isolation of the element is required to resolve the energies of this isotope mainly from calcium and barium in high resolution $\alpha$-spectra.

Earlier, radium was separated from ammonium EDTA solution at pH 7.5 by means of ion exchange, utilizing Zeokarb 225 resin and eluted with 2M nitric acid solution. As reported, radium was then coprecipitated with barium sulfate for low resolution $\alpha$-spectroscopy. Although to obtain high resolution $\alpha$-spectra, radium must adhere as a thin tight film when deposited upon a polished surface, few reports about electrodeposition of radium from aqueous solutions are found in the literature. SORRET and TAUVERON, assuming that radium could not be satisfactorily electroplated from aqueous solutions onto metal electrodes, adapted the GETOFF and BILDSTEIN plutonium technique, to electrodeposit from a hydrochloric acid/isopropanol mixture radium onto platinum at 600 V and 12 mA. In 1980, ROMAN, researching to electrodeposit $^{228}$Th from an aqueous solution of sodium acetate, found that from high...
pH solutions $^{224}\text{Ra}$ was also electrodeposited. More recently radium electrodeposition from nitric-ammonium acetate aqueous solutions$^7$ and from hydrochloric-ammonium acetate aqueous solutions$^8$ have also been reported.

Our experiments were designed to study the behavior of calcium, barium and radium on ion-exchange resins in presence of chelating agent solutions at different pH values and to obtain high resolution α-spectra by electrodeposition of $^{226}\text{Ra}$. The $^{226}\text{Ra}$ was separated from Mexican carnotite mineral.

**Experimental**

EDTA was the only reagent requiring purification before use. It was dissolved in concentrated ammonia and filtered through Whatman No. 40 paper, then recrystallized by adding a hydrochloric acid solution up to pH 1.5, filtered, rinsed with water and finally dried under reduced pressure.$^9$

40 ppm solutions of calcium and barium prepared from commercial aqueous solutions in 2% ammonium EDTA at pH 4.8 were utilized for the ion-exchange experiments. All quantitative determinations of these elements were made by means of atomic absorption spectrometry.

$^{226}\text{Ra}$ was separated from Mexican carnotite following the steps$^{10}$ diagramed in Fig. 1. Gamma-spectrometry was carried out for all the resultant fractions using a hyperpure germanium detector. In Fig. 2a a peak at 186 keV due to $^{226}\text{Ra}$ appears contrasted with two peaks at 143 and 185 keV due to $^{235}\text{U}$. The apparent absence of the uranium peaks from the spectrum as shown in Fig. 2b signals clearly completion of the uranium separation. Calculations taking into account the 186 keV peak area for all the fractions allowed us to estimate that more than 80% of the radium was recovered as sulfate from the carnotite.

Experiments were conducted utilizing 25, 5 and 2.5 g of dry ion-exchange resins namely: Dowex 50W–X8, Ion-exchanger Merk I and AG 50W–X8. The resins were swollen in 5% hydrochloric acid solution for one hour and then loaded into the columns. 2N ammonium chloride solution was passed first through the columns and then, water.$^{11}$

Separate or mixed alkaline earth element solutions were applied on the exchange columns. The eluent volumes were: 250 ml to 25 g of resin, 30 ml to 5 g and 15 ml to 2.5 g, depending on the column size. The rate of elution was kept constant at 1 ml/minute and each of the eluted volumes was adjusted to 30 ml for quantitative analysis.

Elution percentage, $E(\%)$ was calculated from the following equation:

$$E(\%) = \frac{[AEl]/[AEIl]}{100}$$