DETERMINATION OF PLUTONIUM AND AMERICIUM IN ENVIRONMENTAL SAMPLES AND ASSESSMENT OF THORIUM IN BONE SAMPLES FROM NORMAL AND HIGH BACKGROUND AREAS

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The procedures developed and standardised for estimation of ultra trace quantities of Pu and Am in environmental samples involve matrix dependent sample preparation, preconcentration of the nuclides by coprecipitation on iron hydroxide and or bismuth phosphate, ion exchange, electrodeposition and counting by alpha spectrometry. Isotopic analysis of Th in chicken bone using oxalate precipitation, ion exchange, electrodeposition and alpha spectrometry has indicated higher build-up of $^{228}$Th in chicken bone from monazite areas possibly from metabolized $^{228}$Ra.

Introduction

The discovery of nuclear fission and subsequent nuclear technological developments for peaceful and military applications have enhanced the potential for contamination of the environment. Though global fallout levels of man made elements like Pu and Am from nuclear weapon tests are extremely low, internal exposure through inhalation and ingestion pathways could be assessed by use of sensitive analytical techniques and proper dosimetric models.

About 70% of the estimated annual exposure of man to natural sources is contributed by Uranium and Thorium and their decay products in normal background areas. Though the contribution from Thorium is only one third of that of Uranium in normal areas, this could be quite different in high background regions of the world like in Monazite areas in India. External exposures in these areas have been studied in detail, however internal exposure aspects have not been covered adequately.
Different methods for estimation of Pu and Am in environmental samples using coprecipitation, ion exchange, solvent extraction, electrodeposition followed by alpha spectrometry have been reported (1-6). Initial sample preparation and pre-concentration steps are matrix dependent. $^{242}\text{Pu}$ and $^{243}\text{Am}$ are the isotopic tracers used. A number of techniques using coprecipitation with BiPO$_4$, Fe(OH)$_3$, Fe(OH)$_2$, BaSO$_4$, CaC$_2$O$_4$ and partial precipitation of Mg(OH)$_2$ + CaCO$_3$ have been used. The elements are radiochemically separated from each other and other naturally occurring alpha emitters by ion exchange or by solvent extraction using TBP, DTP, D$_2$EHPA, TOPO or TLA. Electrodeposition is normally carried out for preparing the isolated source for alpha spectrometry.

The present paper discusses the analytical techniques followed in our laboratory for estimation of Pu and Am in environmental samples - water (fresh and sea water) sediments and biological organisms. The preliminary results of Th estimation in animal and human bones (using calcium oxalate precipitation followed by ion-exchange and alpha spectrometry) from monazite area are also discussed.

Experimental

Sample Preparation

Water: 1 to 100 l of fresh water/sea water were filtered through 0.22 µm millipore. Sample was acidified using HNO$_3$ and 0.1 to 2 dpm of $^{242}\text{Pu}$ and $^{243}\text{Am}$ tracers were added, stirred and allowed to equilibrate.

Sediments: 5 to 1000 g of sediment is repeatedly extracted with hot 8 M HNO$_3$ after addition of $^{242}\text{Pu}$ and $^{243}\text{Am}$ tracers. Extracts are collected together, centrifuged and supernatant evaporated to a smaller volume. The solution is further diluted to pH 1-2. If silica separates