STUDIES ON THE GEOCHEMICAL BEHAVIOUR OF URANIUM ISOTOPES IN TUWA SPRINGS AND KHARI RIVER SEDIMENTS

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High activities of radium were observed in the spring waters of Tuwa in Panchamahal district of Gujarat state. These determinations have led to further studies on geochemical behaviour of uranium in the surface sediments of this region. Labile uranium from the surface of the sediment particles is leached with saturated solution of ammonium carbonate. Uranium is chemically separated from the leachates by cellulose column chromatography. Unusually high activity ratios of $^{234}\text{U}/^{238}\text{U}$ in the range of 2.3 to 2.77 were observed on the surface of the particles. The core of the particles exhibited a ratio of 1.00 indicating soluble $^{234}\text{U}$ fraction has migrated.

Introduction

Radium does occur in some natural hot springs, but Tuwa spring waters contain large amounts of radium accompanied with almost 0.5 g/l of calcium. These waters contain no measurable concentrations of uranium and thorium.

During the last few years, investigators have studied the anomalous behaviour between $^{238}\text{U}$ and $^{234}\text{U}$ in deep sea sediments, corals, reefs etc. but little investigations are available on spring sediments.

$^{238}\text{U}$, $^{235}\text{U}$ and $^{234}\text{U}$ are three long-lived isotopes belonging to the uranium and actinium series. A part of the decay chain of uranium series is given below:

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\begin{align*}
^{238}\text{U} \xrightarrow{\text{a}} ^{234}\text{Th} & \xrightarrow{\beta} ^{234}\text{Pa} \xrightarrow{\beta} ^{234}\text{U} \\
^{234}\text{U} \xrightarrow{\text{a}} ^{230}\text{Th} & \xrightarrow{\alpha} ^{226}\text{Ra} \xrightarrow{\alpha} ^{222}\text{Rn} \xrightarrow{\alpha} \ldots
\end{align*}
\]
Since the $^{226}$Ra content is very high in the spring waters, this radium must come from uranium which may be present as a deposit in areas around Tuwa. In the present investigations, $^{238}$U, $^{235}$U and $^{234}$U activities are measured by leaching the sediment samples from Tuwa with saturated solution of ammonium carbonate, and the activity ratios of $^{234}$U/$^{238}$U are obtained on the surface labile layers of the sediment particles.

The spring sediment samples are also treated with phosphate free hydrogen peroxide and 0.05M hydrochloric acid for the destruction of organic matter on the surface of the particles. The $^{234}$U/$^{238}$U activity ratios are then determined in the hydrogen peroxide hydrochloric acid leachate and in sediment residues.

**Sample collection**

The spring sediments are collected from top layers (<15 cm deep) after removing stagnant spring waters of each pond. About 2 kg of sediment sample from each pond are air-dried in trays. Sediment samples from the surface are also collected from Khari River, which flows near these springs. Fig. 1 shows the sampling site.

**Experimental procedures**

*Sediment samples*

300 g of air-dried sediments are leached by equilibration with 800 ml of saturated solution of ammonium carbonate. The procedure is repeated four times. The leachates are filtered and evaporated to dryness. The carbonates and organic matter are destroyed by concentrated nitric acid – hydrogen peroxide treatment. The solution is evaporated to dryness and the residue is dissolved in 10 ml of 10% nitric acid.

*Cellulose column chromatographic separation of uranium.* Cellulose powder is thoroughly mixed with 10 ml of 10% nitric acid solution of the sample. The mixed slurry is then transferred to a pyrex glass column (2 X 45 cm) containing a cellulose column of ca. 8 cm in height. 500 ml of a 5% ether-nitric acid mixture is passed through the column at a flow rate of 2 ml/min. Uranium is stripped off from the column and is collected in the effluent. Ether is allowed to evaporate and uranium is further purified. Chemically pure uranium is then electrodeposited on stainless steel discs.\(^1\)