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Separation and Spectrophotometric Determination of Uranium in Caspian Sea Water

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Samples of Caspian sea water (from the Islamic Republic of Iran) were collected from a range of depths, up to 400 m, at 10 stations; uranium is successfully separated using a flotation technique and determined spectrophotometrically at 650 nm using arsenazo(III) as complexing reagent.

Uranium is present in sea water as the uranyl tricarbonate ion complex,[1] and is strongly complexed even at extreme dilution. Many approaches have been proposed to recover and determine uranium in sea water. In all investigations, it is necessary to separate and concentrate uranium from a solution containing high background contamination. Among the techniques reported as preconcentration methods ion exchange,[2–5] extraction[6,7] and flotation,[8,9] are well known. In the flotation technique the uranium is precipitated and a surface active collector is then added to the dispersion and stirred while a flow of inert gas is passed through the solution. The separated precipitate is then collected for determination by spectrophotometry. This method is simple and rapid and permits the determination of uranium in sea water without serious interference from sodium chloride and other major salts in sea water.

A synthetic sea water solution was prepared by dissolving 5.50 g $MgCl_2 \cdot 6H_2O$, 28.00 g NaCl, 1.66 g $CaCl_2$, 6.20 g Na_2SO_4, 0.52 g NaBr and 7.20 g KCI in deionized water to give 1 dm^3 of solution. Trace uranium standard solutions were prepared from chloride salts. 500 ml of the required standard solution, unfiltered sea water or synthetic sea water acidified to pH 2 was transferred to a 1 dm^3 acid cleaned polyethylene bottle. Then 5 ml of 0.01 M iron(II) chloride solution was added and the bottle shaken for 3 min. The pH was then measured, recorded and for optimisation studies, when required, adjusted with ammonium hydroxide. Then 5 ml of a 0.01 M solution of manganese dodecyl sulfate, freshly prepared in 50% ethanol water, was added and the solution transferred to the flotation cell. The flotation was started by passing pure nitrogen gas at various rates. The filter funnel assembly was tilted at the angle required to collect only the foam containing the precipitate (Fig. 1). A 2 ml portion of 0.01 M arsenazo(III), 0.5 mg ascorbic acid and 5 ml of 0.02 M EDTA were added to the collected solution. The absorbance of the pale green complex was measured using a double beam spectrophotometer.

Although the total amount of uranium in sea water is high, its concentration is relatively low, usually at the ppb level. This extreme dilution in the presence of relatively high concentrations of other ions, makes it difficult to measure directly. To improve sensitivity and selectivity, EDTA was added as a masking agent and ascorbic acid added to reduce uranium(VI).

As shown in Table 1, the uranium content of sea water from various depths at different stations have been measured. Although the results indicate that at 400 m depth the concentration of uranium is greater than at other depths, there is no consistent relationship between depth and concentration of uranium.

Table 1 Concentration of uranium in sea water at various depths and stations, sample collected during 5–15 July, 1997.

				Concentration (ppb)		
				Depth/m		
Station	Latitude	Longitude	Distance from offshore/km	50	100	400
S1	38°19′	49°19′	38	1.43	1.97	1.59
S2	38°56′	49°46′	50	2.87	4.30	2.53
S3	38°27′	50°49′	150	1.38	1.30	1.35
S4	37°43′	49°44′	25	1.99	1.35	1.94
S5	37°28′	50°15′	12	2.00	2.16	3.40
S6	37°50′	50°21′	50	2.67	2.70	2.80
S7	37°21′	51°24′	65	1.55	1.75	1.73
S8	36°52′	52°25′	20	1.49	2.99	2.47
S9	37°29′	52°52′	70	2.48	5.13	4.30
S10	37°58′	51′51′	150	1.98	2.89	3.01

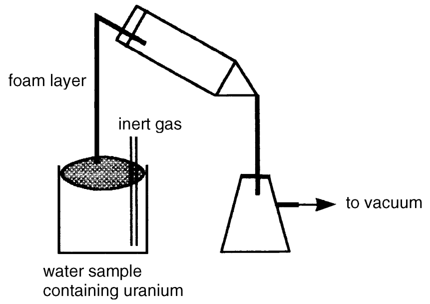

Fig. 1 Apparatus used for the flotation technique

Techniques used: flotation, spectrophotometry Refs. 11

Table 2: Relative percentage recovery of uranium

Table 3: Effect of foreign ions on the determination of 2 ppb uranium

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