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Rubidium and strontium levels of natural water samples from the Middle Anatolia Region of Turkey

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ABSTRACT

Rubidium and strontium contents of water samples collected from the Central Region of Anatolia have been determined by flame atomic emission spectrometry (FAES). The results found by FAES were compared with the results found by total reflection x-ray fluorescence spectrometry (TXRF). No significant correlation was found between Rb and Sr concentrations of water samples.

INTRODUCTION

Rubidium and strontium have essential roles in body systems (e.g. strontium is necessary for the activity of the epidermal transglutaminase) (Ogawa & Goldsmith 1976; Liu *et al.* 1994). Several instrumental techniques such as ICP-AES, AAS, TXRF, FAES etc. have been used for the determination of trace levels of Rb and Sr in various matrices (Evans & Read 1985, Gunther & von Bohlen 1990, Vandecasteele *et al.* 1990). Rubidium and strontium are present in the natural waters at trace levels and the determinations of the Rb and Sr levels are routinely performed (Michard 1990, Piette *et al.* 1994). However, according to our literature search, no paper has been published about the levels of Rb and Sr in mineral and drinking waters from the Middle Anatolia Region of Turkey.

In the present work, rubidium and strontium levels of some natural water samples in Kayseri, Nevşehir and Niğde, Turkey have been determined by flame atomic emission spectrometry. The relation between Rb and Sr concentrations in these waters has been investigated.

ANALYTICAL

Reagents

Analytical reagent-grade chemicals were employed for the preparation of all solutions. Freshly prepared doubled distilled water from a quartz still was used in all

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determinations. Stock solutions of rubidium and strontium, 1000 mg/l (E.Merck, Darmstadt), were diluted daily to obtain reference and working solutions.

Instrument

A Perkin-Elmer Model 3110 atomic absorption spectrometer in the emission mode was used for the determinations of Rb and Sr. Atomic emission measurements were carried out for Rb at 780.0 and for Sr at 460.7 nm in an air/acetylene flame.

Sampling and determinations of Rb and Sr

Samples were collected from various mineral springs in the central region of Anatolia and some municipal water sources in Kayseri and Niğde. The samples were filtered through a Millipore cellulose membrane of pore size 45 μm and stored in 1 liter polyethylene bottles. The samples were acidified to 1% with concentrated HNO_3. The samples were refrigerated at 4°C. Rb and Sr contents of the water samples were determined by flame atomic emission spectrometry (FAES) (Vogel 1978, Skoog 1985, Ozdemir *et al.* 1994).

Before the determination of Rb and Sr contents of the water samples by FAES, the effects of the major ions of the natural waters were investigated in model solutions. The results are given in Table 1. The determination of Rb and Sr by FAES was not interfered with until major ions of the water samples exceeded concentrations given in Table 1. Above these concentrations, the major ions produced interference in the determination of rubidium and strontium.

The highest levels of the major ions in the investigated water sources were in Yeşilhisar Dutluk Spring. The levels of these ions were Na^+ (1682 mg/l), Ca^{2+} (244 mg/l), K^+ (45 mg/l), Mg^{2+} (24 mg/l), Cl^- (1250 mg/l) and SO_4^{2-} (1598 mg/l) (Soylak 1993, Soylak and Doğan 1995, Narin *et al.* 1996). These levels of major ions interfered in the determination of Rb and Sr by FAES (Table 1). To solve this problem,

Table 1. Interferic effects of major ions of water samples on the determination of Rb and Sr (Rb : 100 μg/l, Sr : 200 μg/l)

Ion Added	Concentration (mg/l)	Concentration (μg/l)	
		Rubidium	Strontium
Na^+	500	102.1	202.6
	1000	106.0	209.5
Ca^{2+}	100	101.3	201.3
	250	101.7	202.4
K^+	50	101.7	205.3
	100	104.9	207.9
K^+	25	100.9	201.0
	50	101.3	201.8
Cl^-	500	102.4	204.1
	1000	102.9	206.9
SO_4^{2-}	500	101.0	201.2
	1000	101.9	203.9

Table 2. Recovery data for the determination of Rubidium and Strontium from artificial mineral spring water (sample volume: 500 ml)

Element	μg added	μg found*	Recovery; %
Rb	25	25.9 ± 0.3	103.6
	50	53.2 ± 1.4	106.4
	100	106.1 ± 2.2	106.1
	200	208.9 ± 3.1	104.5
Sr	50	52.4 ± 1.3	104.8
	100	105.3 ± 2.1	105.3
	200	207.3 ± 2.0	103.7
	300	310.6 ± 2.9	103.6

* Average of 5 experiments with 95% confidence interval

Rb and Sr concentrations in mineral spring waters were determined after five-fold dilution.

Because the concentrations of the major ions of the drinking waters collected from Niğde and Kayseri are below the interference level of these ions, rubidium and strontium contents of these samples were determined directly.

The recovery of Rb and Sr from the artificial water sample was also studied. For that purpose, an artificial mineral spring water sample was prepared that contained Na^+, Ca^{2+}, K^+, Cl^- and SO_4^{2-} ions at the same levels as Yeşilhisar Dutluk Spring. To 500 ml aliquots of the artificial water sample, various amounts of Rb and Sr were added. These aliquots were then diluted five-fold. The concentrations of Rb and Sr in the resulting solutions were determined by FAES. The results are given in Table 2. The recoveries of rubidium and strontium were quantitative (>95%).

The detection limits of Rb and Sr found by FAES in distilled water and artificial mineral water based on three times the standard deviations of the blank (k = 3, N = 21) are given in Table 3.

RESULTS AND DISCUSSION

Rb and Sr contents of water samples were determined by FAES in six mineral spring water samples and in five drinking water samples collected from the Central Region of Anatolia. The results are given in Table 4 for rubidium and Table 5 for strontium.

The concentrations of rubidium in the mineral springs were in the range of 58–147 μg/l. Rubidium contents of drinking waters are in the range of 52–122 μg/l

Table 3. Detection limits for Rb and Sr by FAES

Element	Detection Limit (μg/l)*	
	in Distilled Water	in Artificial Water
Rubidium	4.1	8.3
Strontium	25.3	43.8

* $X_L = X_b + 3\sigma$ (N = 21)
X_L : Limit of Detection
X_b : Blank Value

Table 4. Rubidium contents of the water samples (N = 9)

Sample Location	Concentration (μg/l)*	
	FAES	TXRF
Mineral Springs		
Yeşilhisar Dutluk	147 ± 2	160
Yeni Sarıkaya	80 ± 1	70
Eski Sarıkaya	75 ± 1	60
Sorgun	122 ± 2	110
Cavlak	58 ± 1	50
Kozaklı	118 ± 1	100
Drinking Waters		
Kayseri	52 ± 1	—
Hisarcık	48 ± 1	—
Yeşilhisar	122 ± 2	—
Niğde	70 ± 1	—
Niğde Ün.	73 ± 1	—

* $\pm t.s/\sqrt{N}$ (P : 0.95)
— not determined

(Table 4). The relative standards deviations of the results for Rb are in the range of 0.01–0.02.

As can be seen in Table 5, the concentrations of strontium in the spring water samples were found in the range of 1.63–3.38 mg/l except Yozgat Sorgun Spring (4.28 mg/l). Sr contents of drinking waters are in the range of 0.68–0.99 mg/l. The relative standard deviations of the results for Sr are in the range of 0.012–0.071.

For the verification of the results found by FAES, the determinations of rubidium and strontium in mineral spring water samples were also performed by total reflection x-ray fluorescence spectrometry (TXRF). Rb and Sr contents of the drinking

Table 5. Strontium levels of the water samples (N = 8)

Sample Location	Concentration (mg/l)*	
	FAES	TXRF
Mineral Springs		
Yeşilhisar Dutluk	2.92 ± 0.05	2.73
Yeni Sarıkaya	1.92 ± 0.03	2.17
Eski Sarıkaya	1.63 ± 0.02	1.76
Sorgun	4.28 ± 0.16	4.90
Cavlak	3.11 ± 0.20	2.93
Kozaklı	3.38 ± 0.14	3.76
Drinking Waters		
Kayseri	0.68 ± 0.04	—
Hisarcık	0.83 ± 0.02	—
Yeşilhisar	0.79 ± 0.04	—
Niğde	0.99 ± 0.07	—
Niğde Ün.	0.93 ± 0.06	—

* $\pm t.s/\sqrt{N}$ (P : 0.95)
— not determined

waters were not determined by TXRF. The results are shown for rubidium in Table 4 and for strontium in Table 5. The results found by using FAES and TXRF agree quite well with each other.

A linear regression correlation test was performed to investigate correlations between the concentrations of Rb and Sr. The correlation coefficient was 0.497 for mineral spring waters and 0.049 for drinking waters. However, these correlation values are not significant.

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سويات الروبيوم والسترونسيوم في عينات المياه الطبيعية المأخوذة من المنطقة الوسطى بالأناضول

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خلاصة

لقد تم تحديد محتويات عينات المياه في المنطقة الوسطى بالأناضول من الروبيديوم والسترونشيوم وذلك بالاعتماد على مطياف الانبعاث الذري (FAES) . وجرت مقارنة النتائج التي حصلنا عليها بهذه الطريقة بتلك النتائج التي اعتمدت على الانعكاس الكلي المطيافي الفلورنسي للأشعة السينية (TXRF). وقد وجدنا أنه ليس ثمة ترابط مهم بين تركيزات الروبيديوم والسترونشيوم في تلك العينات من المياه.