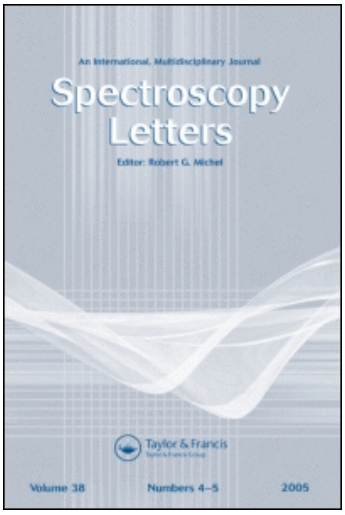

Spectroscopy Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597299

Determination of Uranium in Natural Waters by Laser-Excited Fluorescence for Uranium Exploration

Meral Eral[a]; Selman R. Kinaci[a]
[a] Ege University, Institute of Nuclear Sciences, Bornova - Izmir, Turkey

To cite this Article Eral, Meral and Kinaci, Selman R.(1989) 'Determination of Uranium in Natural Waters by Laser-Excited Fluorescence for Uranium Exploration', Spectroscopy Letters, 22: 7, 855 — 867
To link to this Article: DOI: 10.1080/00387018908053942
URL: http://dx.doi.org/10.1080/00387018908053942

SPECTROSCOPY LETTERS, 22(7), 855-867 (1989)

DETERMINATION OF URANIUM IN NATURAL WATERS BY LASER-EXCITED FLUORESCENCE FOR URANIUM EXPLORATION

Meral Eral and Selman R.Kınacı

Ege University, Institute of Nuclear Sciences,
35100 Bornova - İzmir, Turkey

ABSTRACT

The uranium concentrations of the natural water samples collected from Northern Aegean Region, were measured by laser-excited fluorescence technique for hydrogeochemical prospecting. The reconnaissance survey measurements were made using external standards and detailed analysis realised with internal standard method to correct the quenching. Uranium concentrations for waters of all types range from below the detection limit of 0.05 ppb to 309.09 ppb and have a mean of 16.07 ppb. The precision of the method as shown by standard deviation is satisfactory. The laser-induced fluorescence method was applied easily and successfully

in the uranium prospecting program and the data might indicate a uranium deposite in Saricaoğlu Region.

INTRODUCTION

The determination of uranium concentrations in geological samples is very important in the exploration of the natural resources of this element. Among these geological samples, natural waters have a special importance indicating the uranium enrichments not only at the surface but also at the depth. Because, an enrichment of uranium in the soil and rocks should show up as an increase in the uranium concentration of its groundwater[1,2].

Water samples may be analysed for uranium by any of the following methods: extraction or direct fluorimetry, neutron activation and fission tract[3]. In the past, fluorimetry has been the most widely used method. Laser-induced flurescence is similar to that based on conventional fluorescence but differs mostly in the way the fluorescence is produced. These differences provide some real advantages in the ease and simplicity of direct measurement of uranium[4,5].

In this work, the samples collected from Northern Aegean Region were analysed using a Scintrex UA-3 laser fluorimetric uranium analyser-an instrument designed

for direct analysis of uranium in water and which can be conveniently used in the field--

EXPERIMENTAL

Investigation Area

The uranium concentrations of natural water samples collected from Northern Aegean Region where detailed radiometric investigations have been carried on by the Institute of Nuclear Sciences, were measured for hydrogeochemical prospecting. Geochemical surveys were divided into two main groups; reconnaissance and detailed. The reconnaissance surveys were applied to the large area, Kozak Granodioritic Massive and its environments, as shown in Fig. 1.

The geological units in the area are; massive limestones, fine grained clastics which are metamorphosed, granodiorite, granodiorite-porphyr, dacite, andesitic volcanites, conglomerates, lacustrine sedimentary series, andesitic agglomerates and alluvion (Fig. 1). The sedimentary series is consists of claystone, sandstone, limestone, carbonate-shale and; mudstone, coal, partially coalified claystone, bituminous-shale and shale bonds including uranium.

Detailed surveys were focused on Sarıcaoğlu Region situated in the western part of Sarıcaoğlu Village

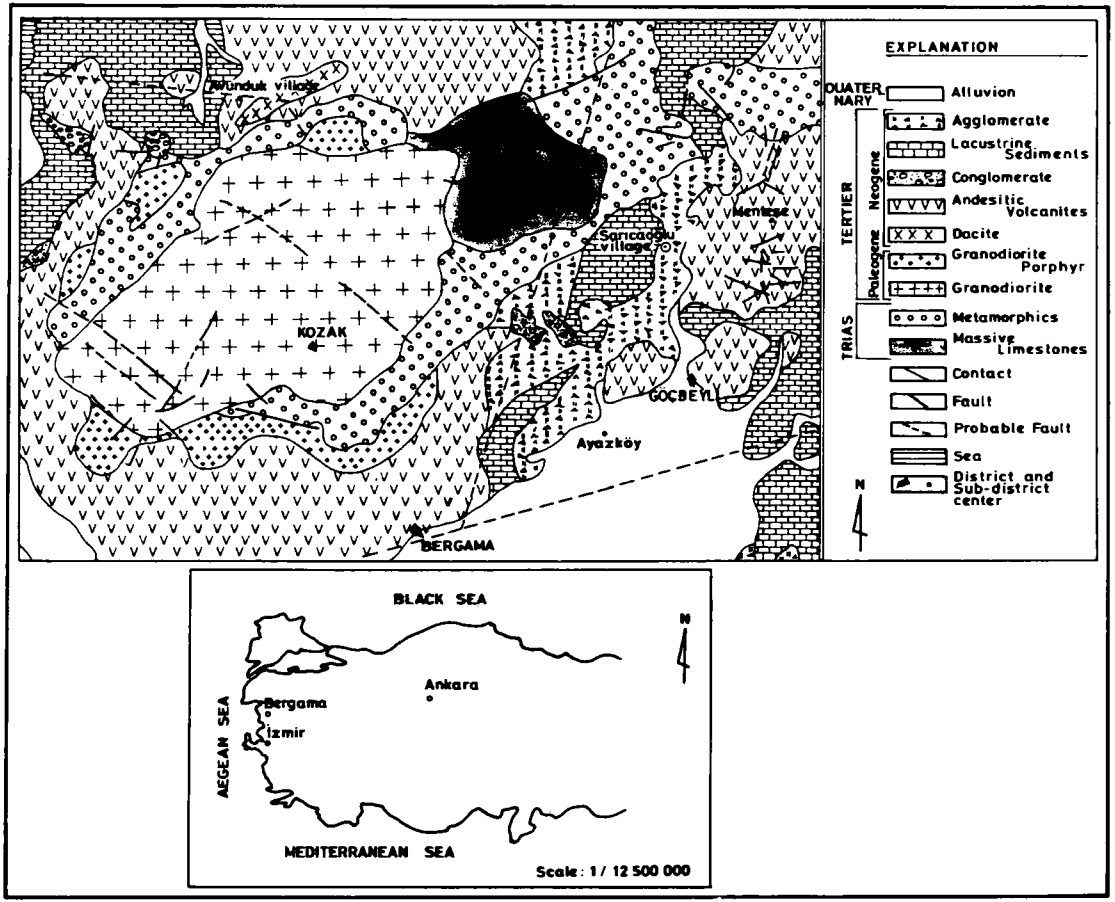

FIG. 1 Geological map of the study area at the regional scale[6]

(Bergama-İzmir) as shown in Fig. 3. The region is between Sakla and Sarıcaoğlu Stream.

Calibration was made by measuring the response of the instrument to uranyl standards in the range of interest. The water samples collected from Sarıcaoğlu Region were analysed by internal standard method to correct the quenching.

Conductivities and pH values of natural water samples were measured by Chemtrix 700 portable conductivitymeter and by Chemtrix 600 pH-meter, respectively.

RESULTS AND DISCUSSION

A total of 267 water samples were collected and analysed in the summer and fall of 1986 and 1987. This total includes 169 spring samples, 68 well samples, and 30 stream samples. Semilogarithmic histograms for the uranium concentrations in all waters, spring waters, well waters and stream waters are shown in Fig. 2. Uranium concentrations for waters of all types range from below the detection limit of 0.05 parts per billion (ppb) to 309.09 ppb and have a mean of 16.07 ppb.

The concentration of uranium in natural waters varies between 0.1-10 ppb and previous experiences confirm that more than 10 ppb uranium concentration

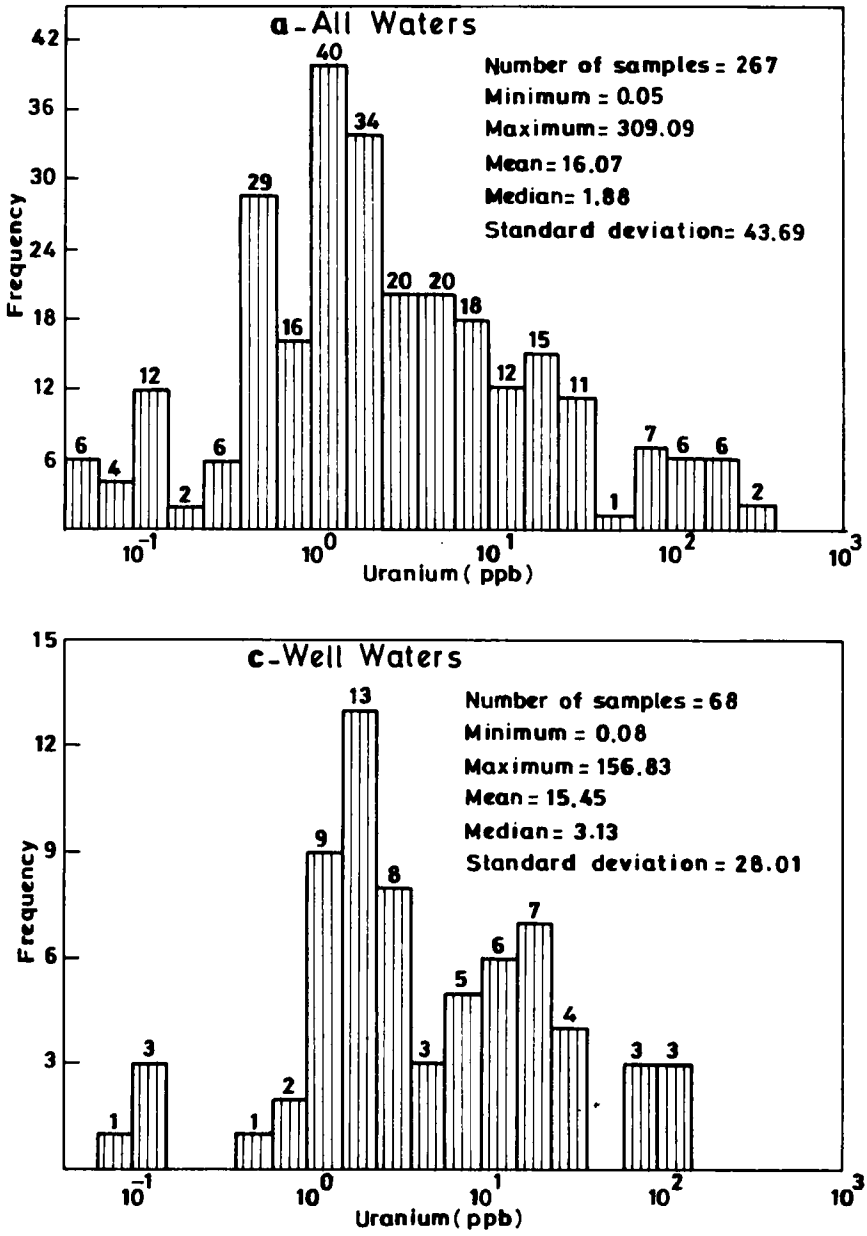

FIG. 2 Semilogarithmic histograms for uranium concentrations in different types of water samples

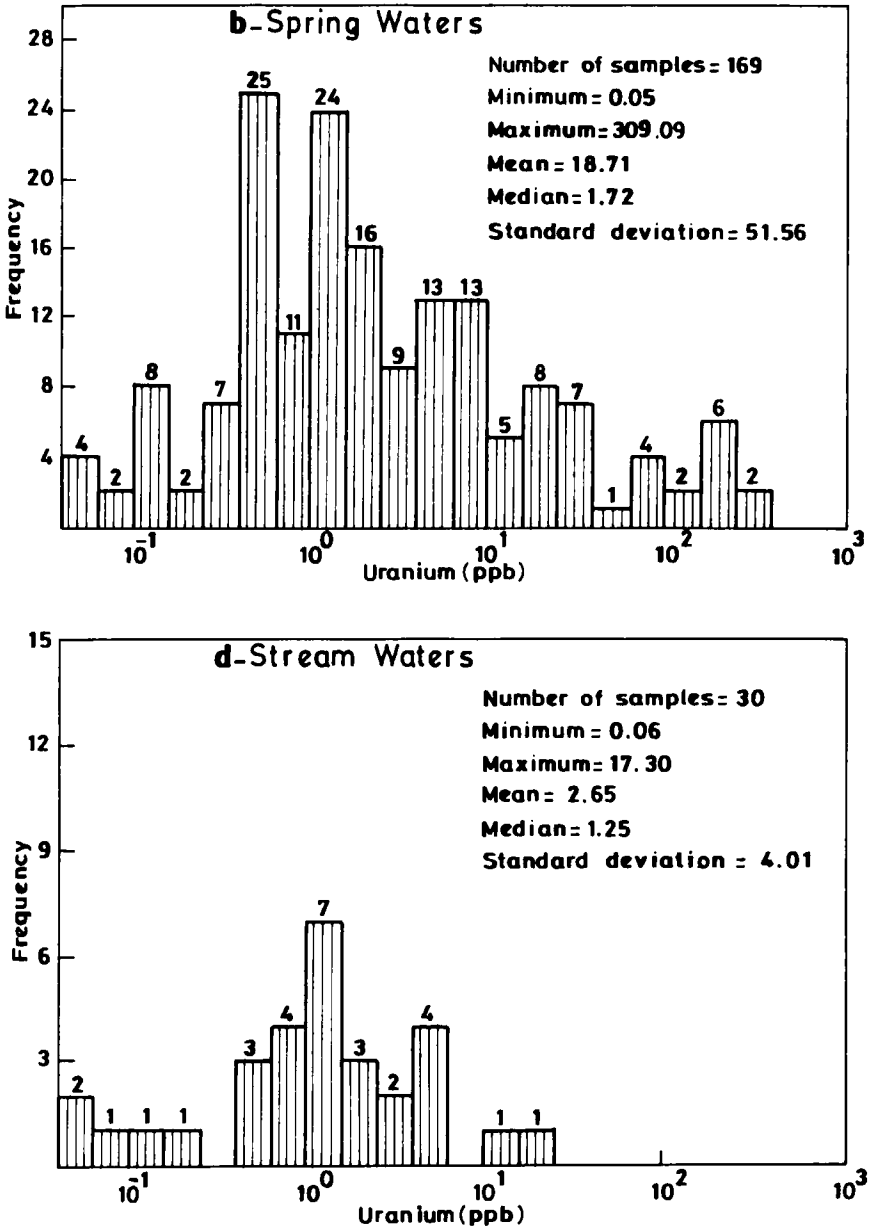

Fig.2 (cont.)

definetely requires follow-up[10]. So, Bergama-Sarıcaoğlu Region having waters with 10 ppb and higher uranium concentrations was selected as detailed survey area.

Laser Fluorimetric Analysis

The water samples were analysed using a Scintrex UA-3 uranium analyser. The determination is based on the fluorescence of the uranyl complex formed by the addition of the reagent, Fluran (Scintrex), to the sample during analysis. Fluran has several functions; it enhances the fluorescence of the uranium (by a factor of about 80), acts as a buffer (best results are obtained at pH 5.5-7) and is able to mask some quenchers such as iron and manganese (the presence of the quencher reduces the uranium fluorescence)[7,8]. In the absence of the proprietary reagent, a dilute solution of sodium hexametaphosphate can be substituted to establish optimum conditions for uranium fluorescence[5]. Some authors have suggested the possible use of polysilicates instead of Fluran[9].

The concentration of the buffer was generally sufficient to correct the pH values of the water samples. The acidified water samples were neutralised with 5N NaOH. Sometimes the addition of fluran caused the formation a white precipitate, insoluble calcium

or magnesium phosphates and this interfering effect was eliminated by the dilution of the sample. At low uranium concentrations, the precipitate was dissolved using concentrated ortho-phosphoric acid.

The uranium concentrations, pH and conductivity values of some typical natural water samples collected from Sarıcaoğlu are shown in Table 1. $\bar{x}$ is the arithmetic mean of four measurements made by standard addition method and σ is the related standard deviation. The precision of the method as shown by the related standard deviation in Table 1, is satisfactory. Generally, waters with high uranium concentrations also have higher conductivities and pH's.

The location and uranium concentrations of well and spring water samples collected from Sarıcaoğlu Region are shown in Fig. 3. The water samples with high uranium concentrations were collected from the springs in the sedimentary series. Since, it is very well known that values greater than 50 ppb uranium concentration in natural waters indicate a strong uranium source nearby[10], these data might indicate a uranium deposite in the region.

The laser fluorescence method was applied rapidly, easily and successfully in the uranium prospecting

Table 1. The uranium concentrations of some natural water samples collected from Sarıcaoğlu Region.

Sample No	Description	Date	pH	Conductivity (μmho cm^{-1})	$\bar{x}$(ppb)	σ
S-829	Apanlı, spring water	June 17, 986	7.01	1150	4.40	± 0.10
S-825	Avcılar, spring water	June 17, 986	6.55	975	13.20	± 0.37
S-787	Cambaşı Hill, spring Water (I)	May 13, 986	7.11	1500	80.00	± 4.30
S-632	Duğla Way, spring water (I)	Jan. 1, 986	7.92	1600	98.35	± 4.35
S-830	Sarıcaoğlu Way, spring water	June 17, 986	6.85	2025	185.46	± 3.66
S-630	Duğla Way, spring water (II)	Jan. 1, 986	7.14	1820	223.65	± 1.76
S-786	Çambaşı Hill, spring water (II)	May 13, 986	7.30	1950	301.80	± 3.66
S-707	Çambaşı Hill, spring water (III)	May 26, 986	7.94	2050	309.10	± 1.90

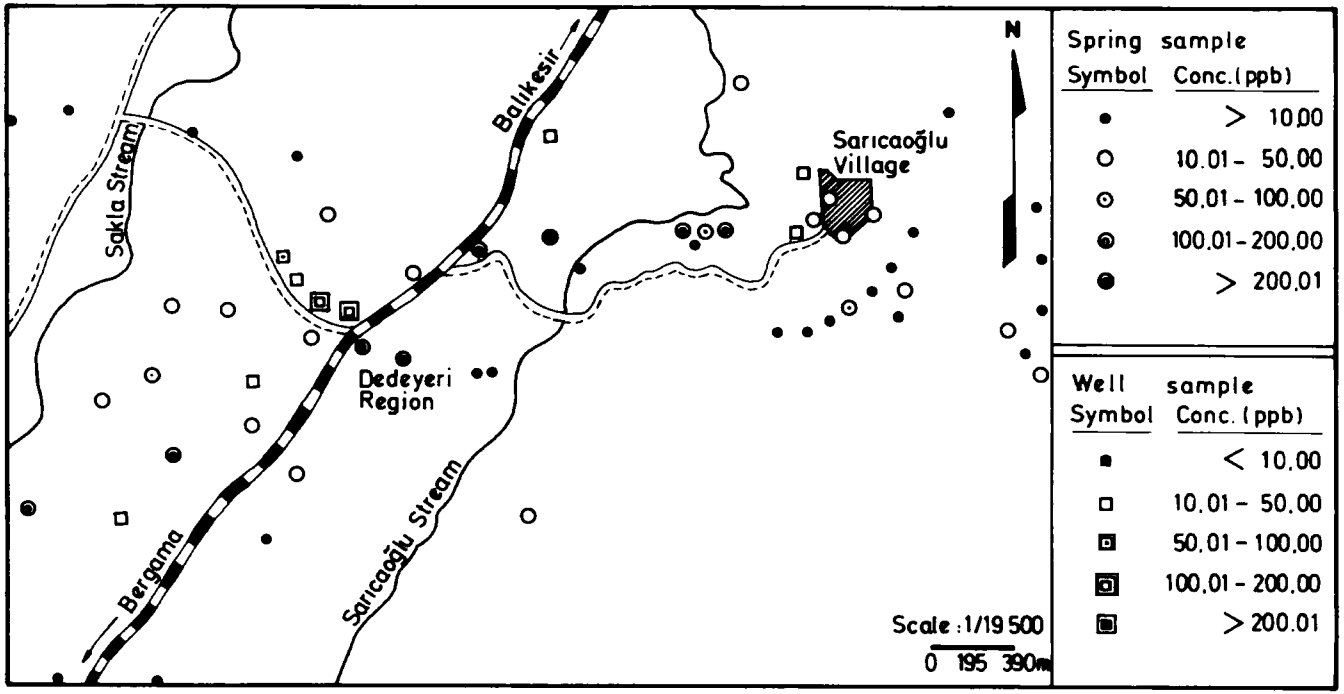

FIG. 3 Locations and uranium conce[illegible] and spring water samples co caoğlu Region

program of the Institute leading to further radiometric investigations. It is necessary to drill holes at some localities in the area in order to define and evaluate the distribution and quantity of uranium.

REFERENCES

1. Dall'Aglio M., Planning and Interpretation Criteria in Hydrogeochemical Prospecting for Uranium, In: Bowle S.H.U., M. Davis, D.Ostle eds. Uranium Prospecting Handbook, Inst. Min. Metall., London, 1972, 121-134.

2. Bolivar S.L., E.H. Dwight, Uranium hydrogeo-chemical and Stream Sediment Reconnaissance of the Craig NTMS Quadrangle, Colorado, Including Concentrations of Forty-Three Additional Elements, Los Alamos Scien. Lab., New Mexico, Informal Rep., LA-7506-MS, 1979.

3. Wenrich-Verbeek K.J., Geochemical Exploration for Uranium Utilizing Water and Stream Sediments, U.S. Geol. Surv., Open-File Rep. 80-359, 1980.

4. Robbins J.C., Field Technique for the Measurement of Uranium in Natural Waters, Mineral Exploration Techniques, CIM Bull., May 1978, 61-68.

5. Harm T.F., F.N. Ward, J.A. Erdman, Laser Fluorometric Analysis of Plants for Uranium Exploration, J.Geochem. Expl., 1981, 15, 617-623.

6. Akyürek B., Y. Soysal, Biga Yarımadası Güneyinin (Savaştepe-Korucu-Bergama-Ayvalık) Temel Jeolojik Özellikleri, MTA Dergisi, Ankara, 1983,95/96, 1-12.

7. Scintrex Instruction Manual UA-3 Uranium Analyser, Scintrex, Ontario, 1982.

8. Robbins J.C., Analytical Procedures for UA-3 Uranium Analysis, Application Brief 79-2, Scintrex, 1979.

9. Veselsky J.C., B. Kwiecinska, E.Wehrstein, O. Suschny, Determination of Uranium in Minerals by Laser Fluorimetry, Analyst, 1988, 113, 451-455.

10. King J., M. Tauchid, D.Frey, M.Basset, İ.Çetintürk, F.Aydonoz, B.Keçeli, Exploration for Uranium in Southwestern Anatolia, Exploration for Uranium Ore Deposits, Proc. IAEA and NEA (OECD) Symp., 1979, 501-529.

Date Received: 03/29/89
Date Accepted: 05/04/89