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THE RADIOACTIVE ELEMENT CONTENT OF LAKE MUD OF SEVERAL HYPERSALINE LAKES OF THE DANUBE-TISZA INTERFLUVE, SOUTH HUNGARY

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ABSTRACT

According to sparse samples, the radioactivity of young sediments of some lakes on the Danube-Tisza Interfluve was remarkably high compared to that of their environment and the average of such formations. Many of these lakes are utilized by tourism and fisheries, that is why it is important to examine how reliable the results of previous measurements are.

We have performed in situ and laboratory analyses on two typical lakes. Our aim was to determine the degree of radiation and the areal distribution of the radioactive element content in their sediment.

INTRODUCTION

In 1985 analyses of eutrophication on the Vadkerti Lake, Soltvadkert, Hungary, revealed several times occasionally an order higher radioactivity in case of some samples (mainly from areas covered by reeds) originating from the thick, organic matter rich mud layer of the bottom than that of the background value (KEDVES, SZEDERKÉNYI 1985, 1987). Based on preliminary analyses, the radioactive element content was believed to be in correlation with the decaying vegetal debris and the pollen content. Trial analyses on some other hypersaline lakes have reinforced these results.

The two lakes which were chosen to examine more detailed regarding radiological features, the permanent Vadkerti Lake (Soltvadkert) and the temporary Kolon Lake (Izsák) are located on the blown sand covered Danube-Tisza Interfluve, where in the lakes, according to MOLNÁR (1980), in an alkali environment hypersaline carbonate formation takes place. This process is characteristic in the first place in case of the bottom of the Kolon Lake, which is covered by water temporarily. A more than 0.5 m thick sediment with a fairly rich carbonate content can be observed some 10 cm under the muddy-sandy water of the lake. Under this sediment a thick layer of blown sand can be found. In the Vadkerti Lake this carbonate-rich layer is thin and it can be observed only sporadically. Hidrodynamically, the basin of the Vadkerti Lake is a part of the territory dominated by ascending ground waters, consequently, it is filled with water permanently and there is even an outflow for the excess water (ERDÉLYI 1990). Years ago in the SW corner of the lake on the territory of the beach the lake mud was dredged.

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METHODS

Double samples were collected from each point of sampling with an instrument constructed especially for this occasion. One of the samples was taken from the surface of the bottom, the other was collected from a position 40-50 cm deeper. Samples were collected from points 25 m far from each other along the longitudinal and the cross axis of the lake by divers due to the 1.4-3.0 m depth of the water. Since the past two years have brought a rainy weather the basin of the temporary Kolon Lake was pretty full, therefore, only its shores could be handled as areas of periodic water cover, and sampling was restricted to these areas. In all, 75 samples were collected from the two sites. The samples weighting 1-2.5 kg were dried on free air, then 800 g of each was ground to a grain size of 100 μ. Measures were performed on samples processed like above.

For the laboratory radiometry NP-424P, four channelled, nuclear spectrometer, ND-424L scintillation detector, NZ-490 lead tower, and Marinelli bowl were used. In case of every 10th sample a control measure was performed at the Mecsekurán Ltd. Deviations remained under 5%.

Field measurements were carried out with an NC-483, portable, nuclear analyzer equipped with an ND-493 scintillation detector. Field measurements were made only in the narrow shore zone of the Kolon Lake, because the currently high level of water did not allow other possibilities. Field measurements provided less information than those made in laboratory, therefore, the results of these will not be published.

DISCUSSION

Based on the gamma spectrometric analysis of the specific activity and the U, Th and K concentrations of the samples (*Fig.1.*) taken from the Vadkerti Lake's (Soltvadkert) North-South and West-East cross-sections, the following statements can be made:

A) The mean specific activity of the so-called lower samples, collected from under the mud along the N-S cross-section is 45.38 Bq/kg. The variation of results is considerable, the minimum value is 16.78 Bq/kg, the maximum is 114.31 Bq/kg. The summed gamma values increase northward along the profile (*Fig. 2.*). The only exception is the local anomaly – reason is unknown yet – in sampling point 2. The specific activity of upper samples (71.13 Bq/kg in average) which were collected along the same axis but from the bottom of the lake exceeded that of lower samples in almost all cases, nevertheless, their organic material content was generally higher, too. The minimum of specific activity in their case is 22.95 Bq/kg, while the maximum is 215.82 Bq/kg, and there is a significant increase in the values along the profile toward the North. At the border of the dredged area and the vegetated water surface the value of specific activity increased by one and a half times in average. Parallely with the northward increase of specific activity the concentration of U to some extent also increases. Similarly to the value of specific activity a remarkable change can be detected in U concentration at the border of the dredged area with open water surface and the vegetated area with higher organic material content.

The U concentration values of lower samples are lower than that of upper samples: 1.82 and 2.01 g/t in average. These average U concentrations correspond to that of the average of arenaceous-argillaceous-carbonate sediments. Results are quite disperse in value (lower samples: 0.58-3.83 g/t, upper samples: 0.45-4.03 g/t), real difference can only be experienced in the number of samples with high U concentration, which is higher in case of the upper sequence (*Fig. 3.*).

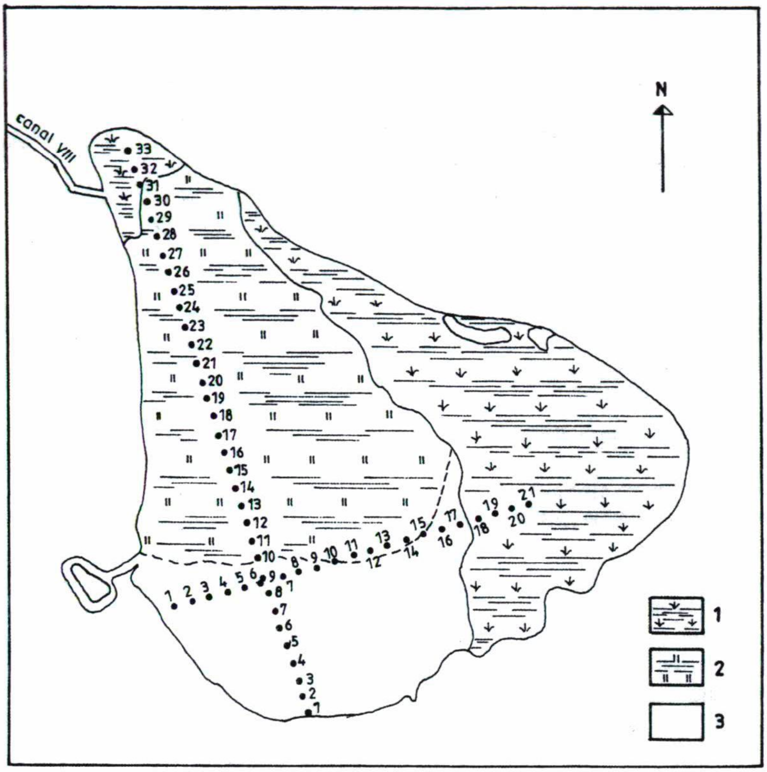


Fig. 1. Vadkerti Lake, sampling points per 25 m (M: 1:7500)

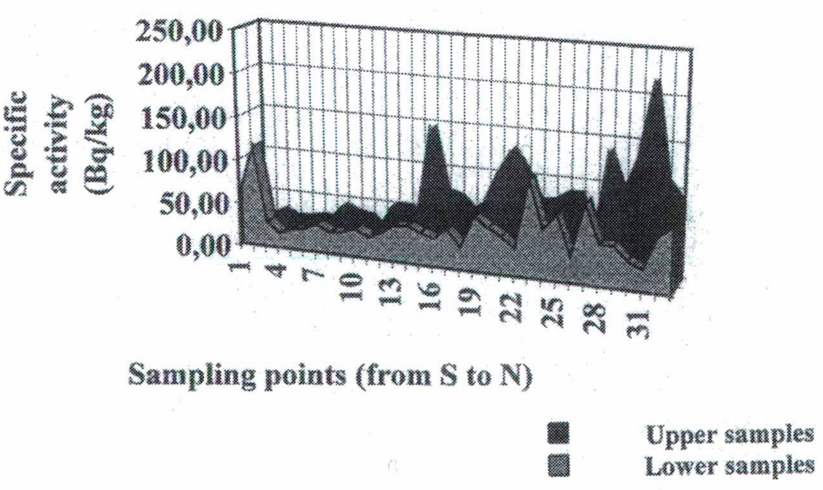


Fig. 2. Soltvadkert, S-N profile, specific activity (Bq/kg)

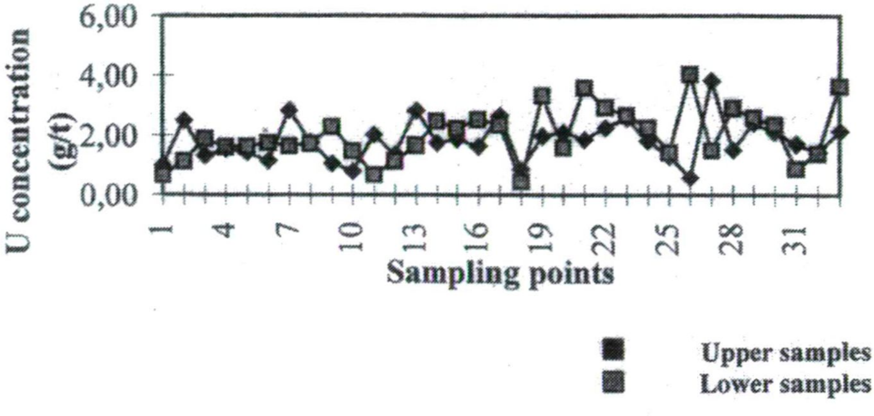


Fig. 3 Soltvadkert, S-N profile, U concentration (g/t)

The Th concentration along the N-S section is quite balanced. Only the upper sequence shows an increasing tendency of concentration from sample No. 10 northward, at the same time the Th concentration of lower samples is practically constant. The mean Th concentration of upper samples (rich in organic material) is almost twice as much (3.29 g/t) than that of lower ones (1.73 g/t). To explain this tendency further researches would need. Similarly, more thorough examinations might throw light on the unusually high Th concentration of the 2nd sampling point's lower sample (11 g/t) which is perhaps responsible for the relatively high specific activity (*Fig. 4.*) of this sample.

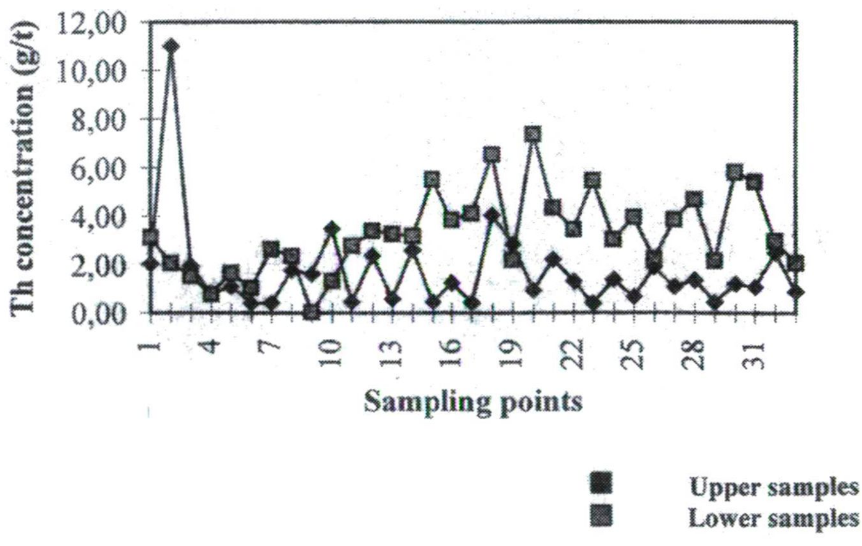


Fig. 4 Soltvadkert, S-N profile, Th concentration(g/t)

The mean K concentration of samples along the N-S axis corresponds well to the mean K concentration of feldspar-poor calcareous-argillaceous marly sediments. There is no considerable difference between the K concentration of lower and upper sequences (0.86 and 0.78 g/t), and no real tendency can be defined along the section either. Disregarding some extreme results the values vary between 0.6 and 1.1 g/t. No significant changes were detected at the border of areas of high and low organic material content (*Fig. 5.*).

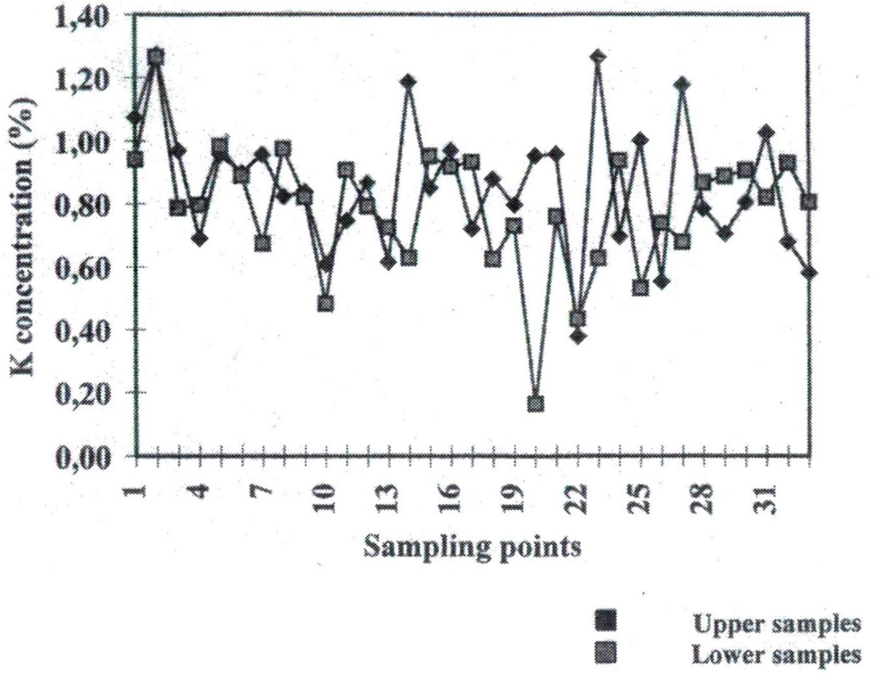


Fig. 5. Soltvadkert, S-N profile, K concentration(%)

B) Regarding the samples of the W-E profile of the Vadkerti Lake also the upper samples show the higher specific activity (49.99 Bq/kg in average), the lower samples' specific activity is slightly lower (37.14 Bq/kg). The axis of sampling mostly ran along the border of the opened and the vegetated water surfaces, that is why from the West to the East till the sampling point No. 15 the variation of specific activity is relatively low, and the upper samples originating from the dredged bottom provided low values as well. The specific activity of the upper sequence booms (maximum: 180 Bq/kg) at areas of high organic material content, i.e. areas of rich vegetation, reeds. Although by lower values, lower samples follow this tendency too (*Fig. 6.*).

Along the W-E profile the samples' mean U concentration is 1.73 and 1.88 g/t in average (*Fig. 5.*). Samples from the dredged zone (samples No.1-5) can be characterized with a lower concentration, while those originating from the vegetated zone – both the lower and the upper sequence – have a slightly higher U concentration. Samples from areas of rich vegetation have a remarkably high U concentration (maximum: 4.20 g/t) (*Fig. 7.*).

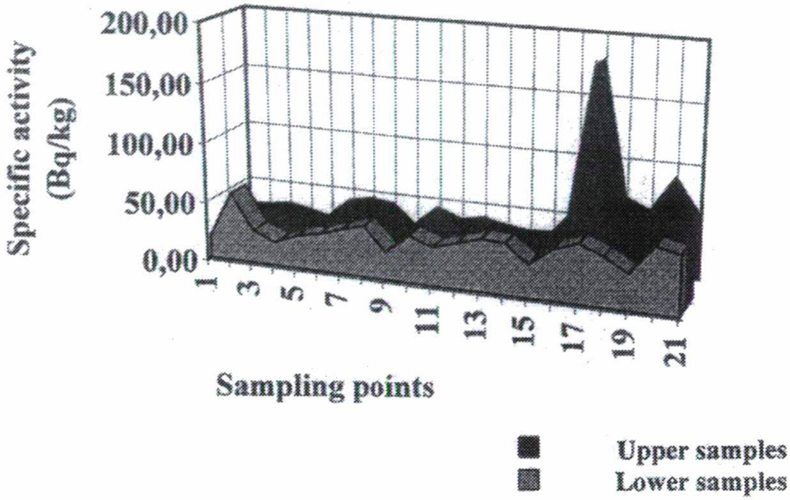


Fig. 6 Soltvadkert, W-E profile, specific activity (Bq/kg)

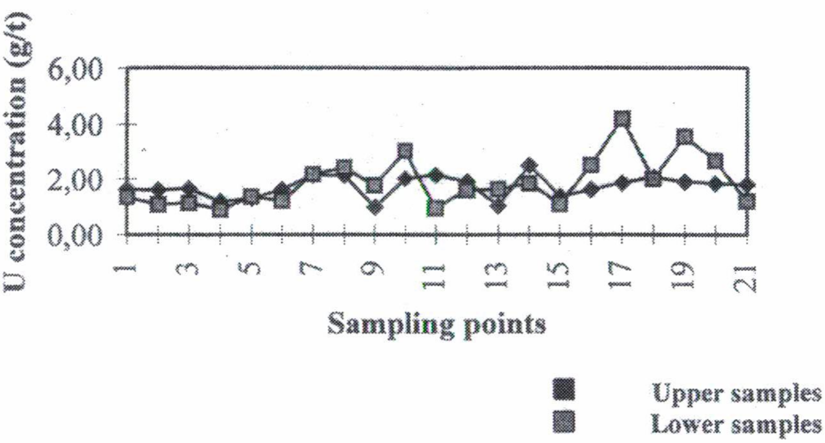


Fig. 7 Soltvadkert, W-E profile, U concentration(g/t)

The Th concentration also increases along the profile eastward, though, this tendency is striking only in case of the upper sequence, the Th distribution of lower samples can be regarded even. (The Th concentration is at its maximum at the edge of reeds: 3.5-3.8 %.) The Th content of the lower sample in sampling point No. 2 – similarly to sampling point No. 2 of the N-S axis – is remarkably high (4.1 g/t). Further examinations would need to determine whether there is a connection between these two anomalies, and whether there is a higher concentration of Th everywhere in the 25-30 m zone of the beach (*Fig. 8.*).

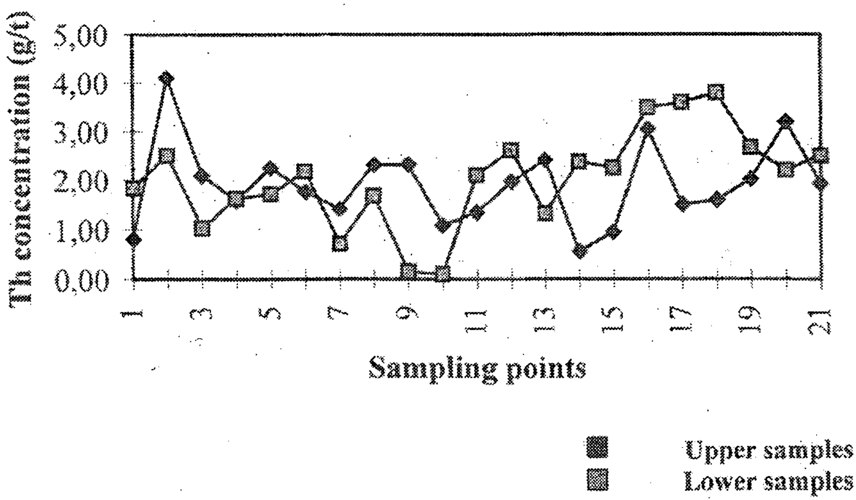


Fig. 8 Soltvadkert, W-E profile, Th concentration(g/t)

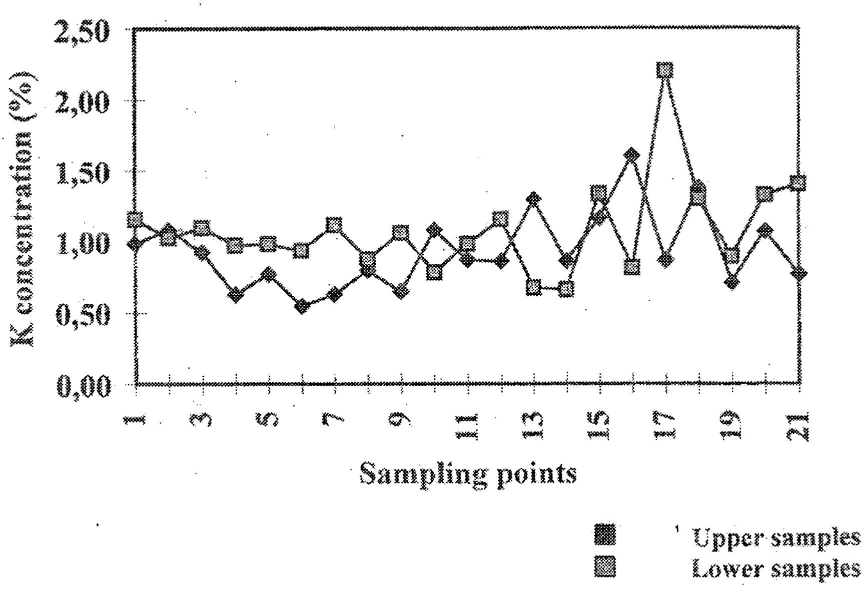


Fig. 9 Soltvadkert, W-E profile, K concentration(%)

The concentration of K along the W-E section is relatively even (mean value of lower samples: 0.93 g/t, of upper samples: 1.08 g/t). To the East the dispersion of values increase (*Fig. 9.*).

The area related mean concentration of radioactive elements are presented in Table 1., 2. and 3. and on *Fig. 10.*

TABLE 1

The mean values of radioactive elements in the samples collected from the SW part of the Vadkerti Lake, Soltvadkert (based on 16 samples)

Samples	**U (g/t)**				**Th (g/t)**				**K (%)**			
	min.	max.	mean	disp.	min.	max.	mean	disp.	min.	max.	mean	disp.
Lower samples	1,0	2,84	1,67	1,84	0,4	11	2,24	10,6	0,54	1,28	0,87	0,74
Upper samples	0,66	2,41	1,48	1,75	0,71	3,14	1,79	2,43	0,67	1,27	0,97	0,6

TABLE 2

The mean values of radioactive elements in the samples collected from the middle part of the Vadkerti Lake, Soltvadkert (based on 12 samples)

Samples	**U (g/t)**				**Th (g/t)**				**K (%)**			
	min.	max.	mean	disp.	min.	max.	mean	disp.	min.	max.	mean	disp.
Lower samples	0,8	2,83	1,7	2,03	0,46	3,5	1,63	3,04	0,61	1,19	0,85	0,58
Upper samples	0,67	3,01	1,81	2,34	0,02	5,53	2,32	5,51	0,48	1,15	0,85	0,67

TABLE 3

The mean values of radioactive elements in the samples collected from the NW, N, E part of the Vadkerti Lake, Soltvadkert (based on 26 samples)

Samples	**U (g/t)**				**Th (g/t)**				**K (%)**			
	min.	max.	mean	disp.	min.	max.	mean	disp.	min.	max.	mean	disp.
Lower samples	0,58	3,83		3,25								
Upper samples	0,45	4,2		3,75								

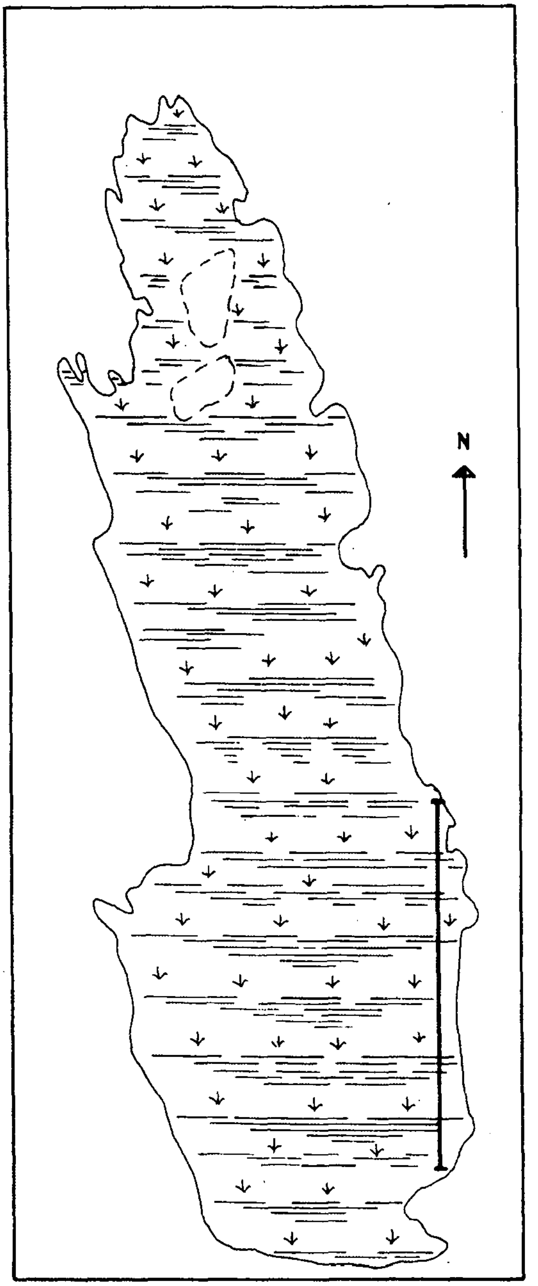
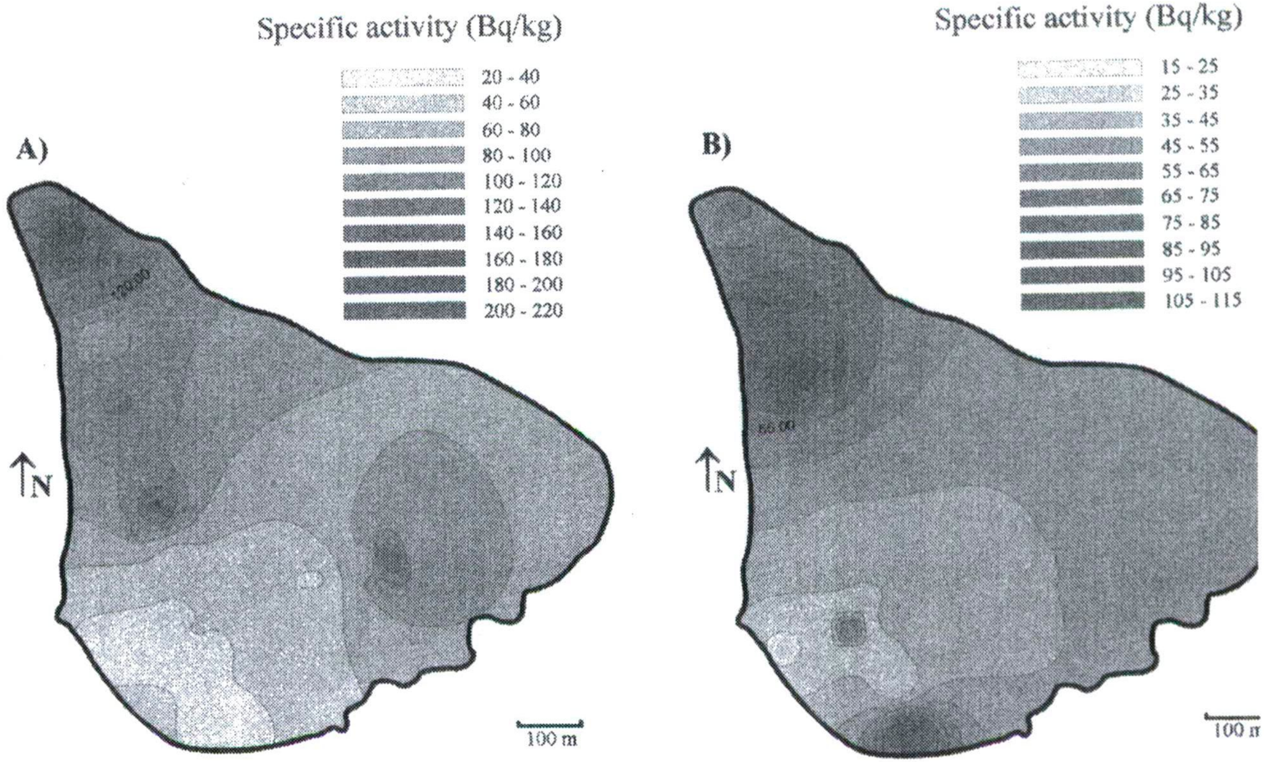


Fig. 10. Kolon Lake ———— sampling profile (M: 1:15.000)



Based on samples from the bottom (upper samples)

Based on samples from under the mud (lower samples

Fig. 11 Radiological map of Vadkerti Lake

Since in the case of the Kolon Lake the samples (*Fig. 11.*) were collected along the present shore line their radiological results are monotonous. Surface samples have a higher activity but it is slightly lower than the similar data of the Vadkerti Lake. Deeper level samples have also a lower activity than the corresponding Vadkerti results, thus, it is characteristic that the radioactive element content of surface samples is higher than that of samples from a deeper position. The reason of this character is explained by the difference in carbonate content. Samples under the surface represent organic material poor carbonate sediments characterized by low activity. Both in case of the surface and the deeper level samples it is characteristic in the Kolon Lake as well as in the Vadkerti Lake that the U concentration exceeds the Th concentration (Table 4.).

TABLE 4

The mean values of radioactive elements in the samples of the shore section of the Kolon Lake, Izsák (based on 21 samples)

Samples	U (g/t)				Th (g/t)				K (%)			
	min.	max.	mean	disp	min.	max.	mean	disp	min.	max.	mean	disp
Surface	0,8	2,34	1,56	3,2	0,78	2,48	1,5	3,42	1,02	1,38	1,18	2,26
40cm depth	0,92	1,87	1,17	2,8	0,8	1,77	1,21	2,78	0,6	0,88	0,7	1,76

CONCLUSIONS

The essential result of this research is that it has been proved that in the mud of hypersaline lakes of the southern part of the Danube-Tisza Interfluve even 4-5 times higher U and Th concentrations can be detected than that of the formational average. On the other hand, an order or much higher concentrations have not been found. Nevertheless, because of the fact that these lakes are actively used by tourism (beaches) and fisheries, dosimetric analyses seem to be necessary.

Th and U are bound to organic material and clay minerals, thus, their amount is in direct proportion to the amount of these components.

In the mud of hypersaline lakes the Th/U ratio is mainly dominated by the U, which fact has not been explained yet. Probably, ascending ground waters transport U here in a dissolved form.

Based on our researches at the two typical lakes, we suggest that the radiological analysis of the sediments of lakes, temporarily water covered areas, dead and outflowing waterflows which are located on the territory influenced by the ascending waters of the deep hydrodinamic water system would be important. According to the results of this research, on the above mentioned territory there is a real chance for the formation of much higher radioactive element concentration than those we have detected currently.

ACKNOWLEDGEMENT

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