



# RADIOECOLOGY OF MOUNTAIN BEGINNINGS OF THE TISZA RIVER: UKRAINIAN PART



**N. Svatiuk<sup>1</sup>, O. Symkanych<sup>2</sup>, O. Pop<sup>1</sup>, V. Roman<sup>1</sup>, V. Maslyuk<sup>1</sup>**

<sup>1</sup>Institute of Electron Physics of the NAS of Ukraine

<sup>2</sup>Uzhhorod National University

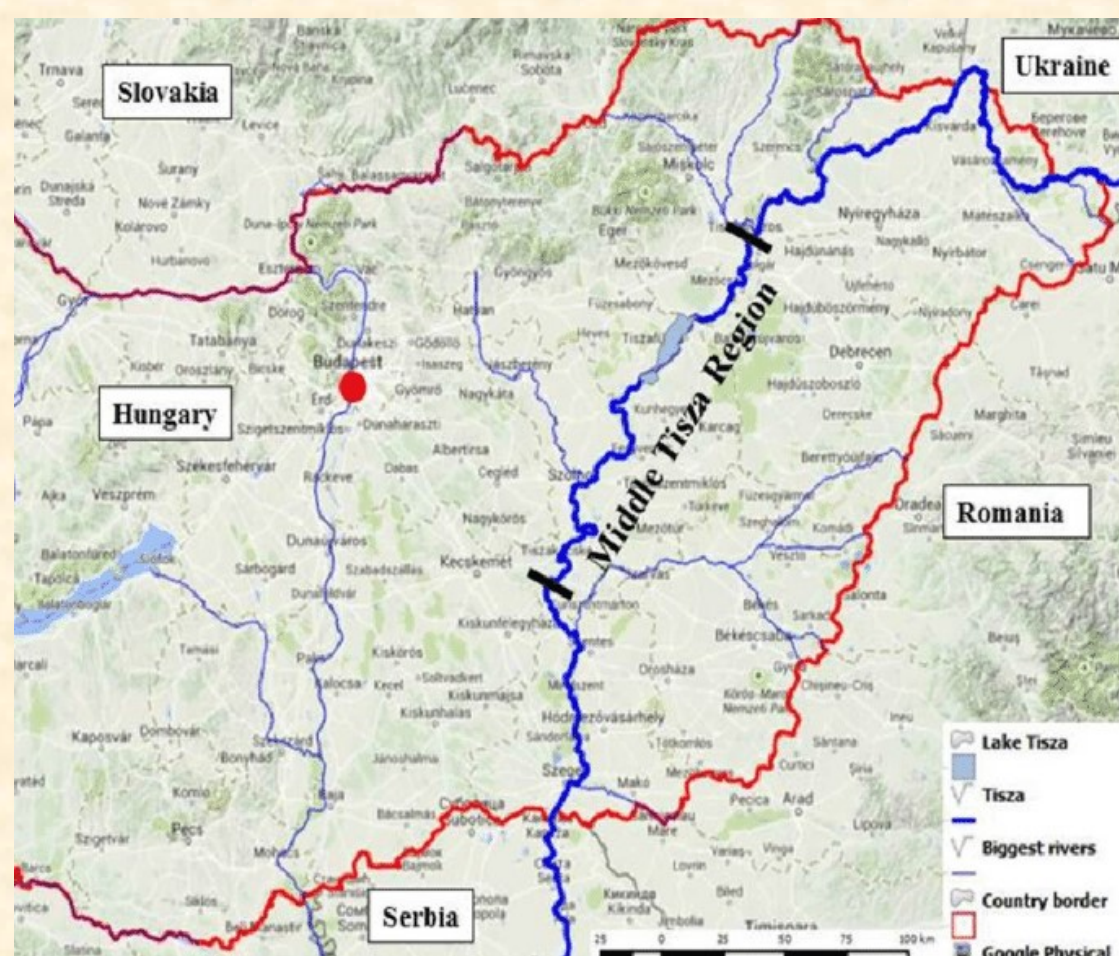
**svatiuknatalia@gmail.com**



## Relevance of the research:

Tisza river sediments The Carpathians are important for forming water resources, and air flows in Central and Eastern Europe. Their ecological condition is essential for the well-being of the population of the Eurocarpathian region;

R. Tisza - a vital waterway of the Eurocarpathian region. It is formed by water runoff from Transcarpathia (Ukraine), Slovakia, Hungary, and Romania.



## What do we know about the Tisza River?

⇒ The Tisza is a river, the largest left tributary of the Danube (Black Sea basin).

⇒ It begins in the upper reaches of the Ukrainian Carpathians (Transcarpathian region).

⇒ The main part of the Tisza River runoff is formed on the territory of four states: Romania - 51%, Ukraine - 25.6%, Hungary - 10%, and Slovakia - 13.4%

⇒ Length - 966 km (within Ukraine - 201 km).

## Ukrainian Carpathians: an important beginning of the Tisza River!

⇒ The Tisza River is formed by the confluence of the Black Tisza and White Tisza 4 km above the city of Rakhiv;

⇒ The territory of Ukraine contains the upper, primarily right-bank part of the Tisza basin, which lies on the southwestern slopes of the Ukrainian Carpathians and the Transcarpathian lowlands.

## Structure of work: selection of the object of research, the scheme of sampling, and low background measurements:

• Tisza river sediments - an important marker of the ecological condition of the water basin and drainage areas of the Tisza river; the content and distribution of radionuclides of natural (U/Th/K) and technogenic origin were studied.

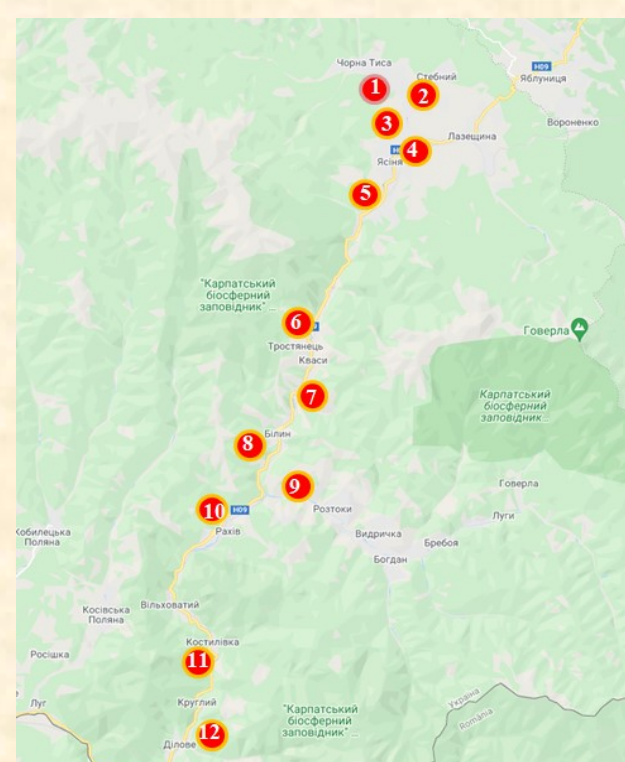
• Sample sampling scheme: sources of the Tisza River, highland and lowland regions of the Carpathians;

• Low-background and gamma/neutron activation experiments on the M-30 microtron.

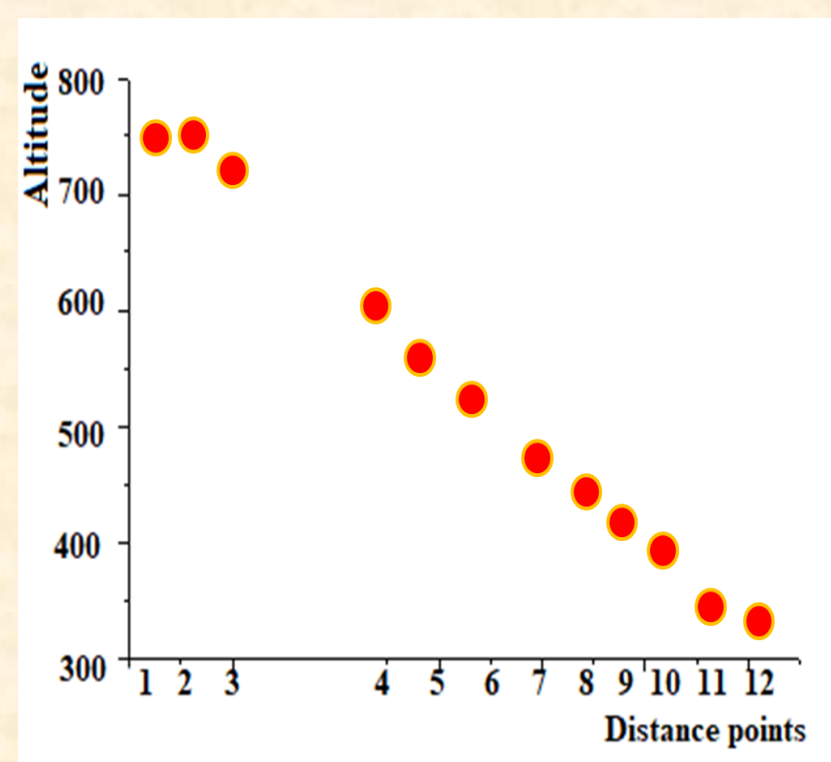
• Methods of statistical cluster/factor analysis for systematization of measurement results.

## Stages of work:

- Sampling procedure;
- Low-background measurements;
- Nuclear-activation experiments on the M-30 microtron;
- Statistical analysis.



a)



b)

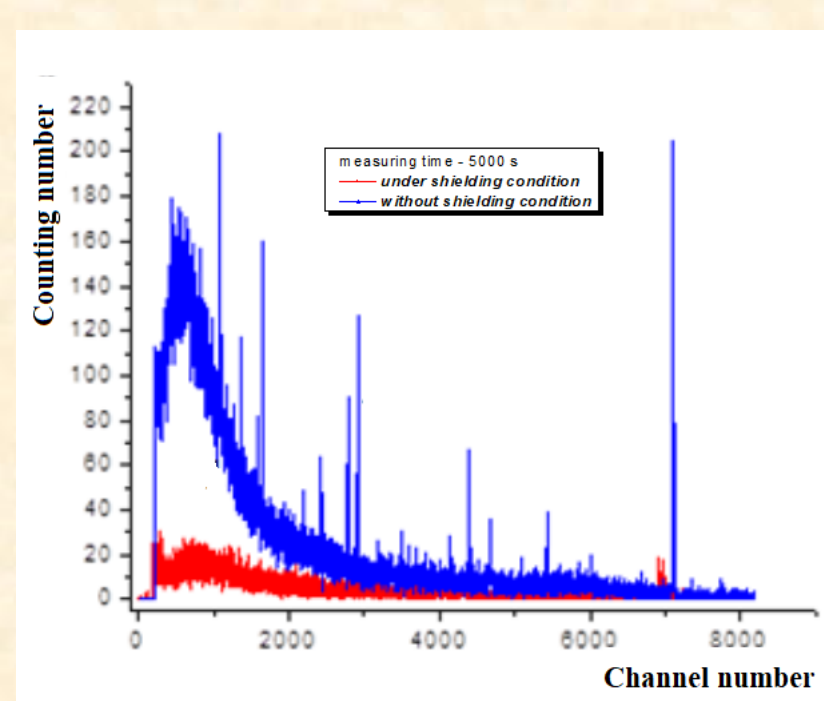
Sampling scheme of the bottom sediments of the sources of the Tisza River: a) their geographical location, b) the height of the sampling points above sea level. The inequality interval between sampling points has complied.

## Sampling procedure:

- distances between sample points were 5-20 km along the river-bed;
- changes of altitude – 200-400 m.



a)



b)

The low-background gamma – spectrometry measurements: a) HP Ge 150 sm<sup>3</sup> detector, b) examples of the gamma spectrum with - and without protection

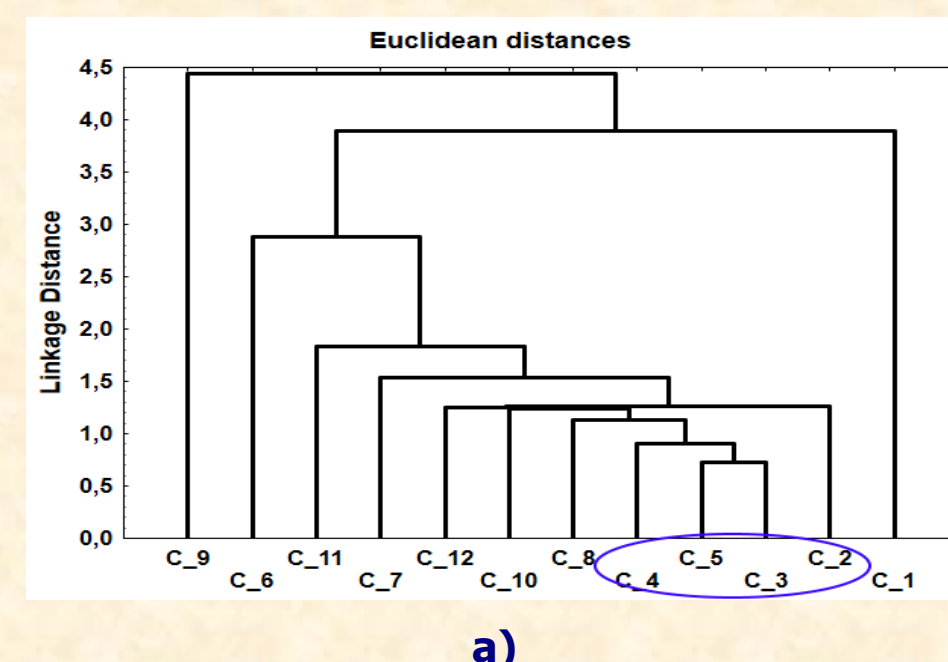
## The following were studied:

gamma-active radionuclides (GAS) to characterize global / local factors:

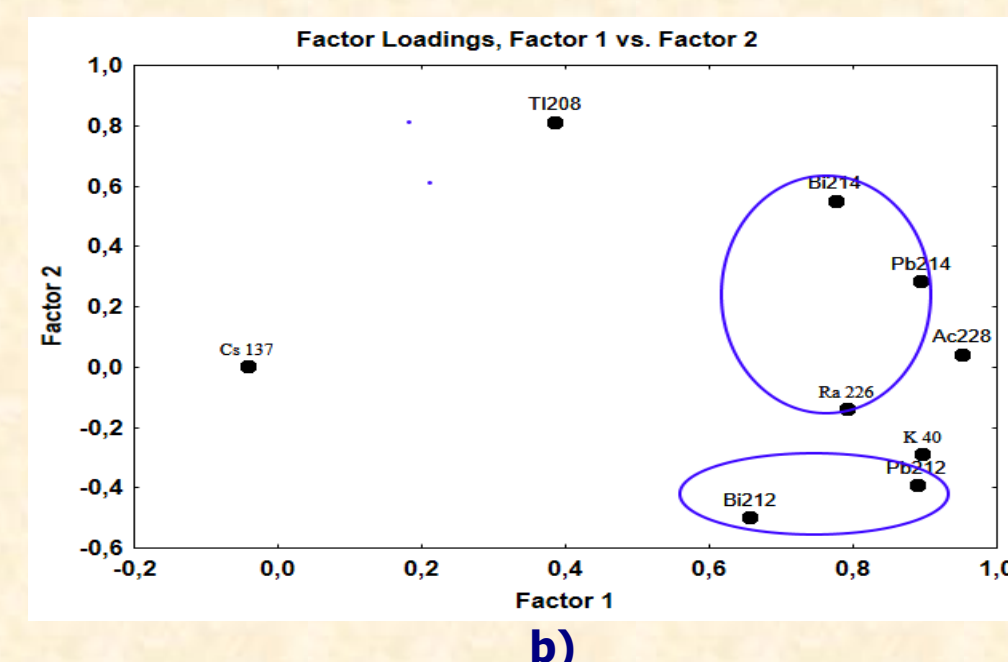
Global GAN, U-Th components:

• <sup>238</sup>U series: <sup>226</sup>Ra, <sup>214</sup>Pb, <sup>214</sup>Bi;  
• <sup>232</sup>Th series: <sup>228</sup>Ac, <sup>212</sup>Pb, <sup>212</sup>Bi, <sup>208</sup>Tl;  
• <sup>40</sup>K;

Technogenic GAN: <sup>137</sup>Cs.



a)



b)

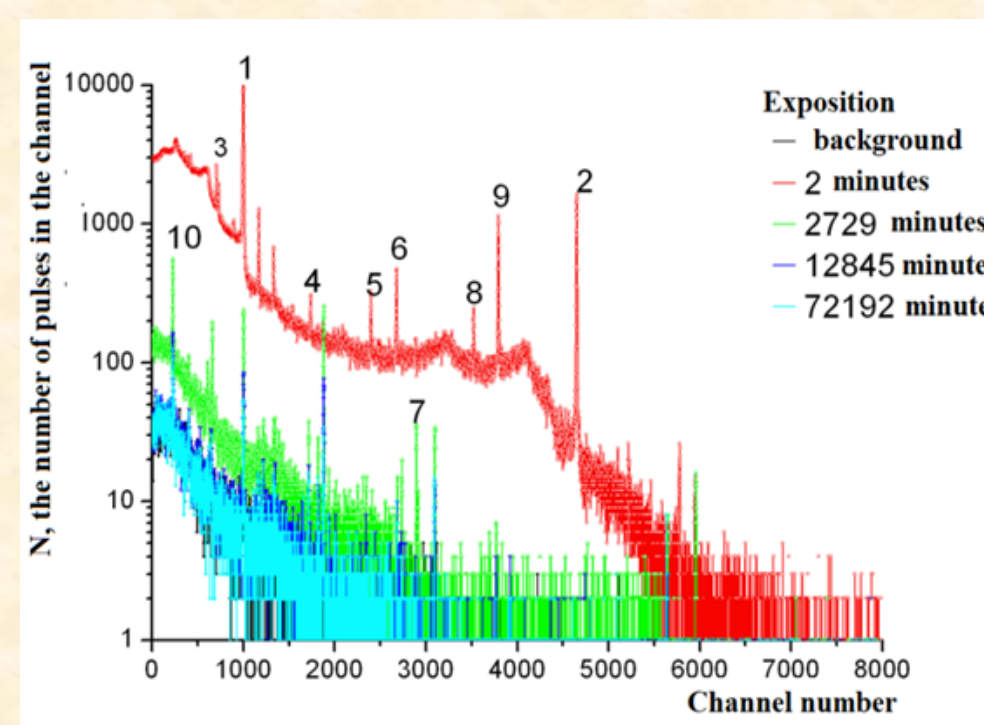
The results of statistical analysis of radiological indicators of the Tisza River sediments: a) Dendrograms of cluster analysis assess the statistical proximity of sampling points along the Tisza riverbed by radionuclides of the U / Th series. A lower value of the aggregation parameter indicates a greater degree of statistical proximity to the sampling points.; b) - 2D graphs of factor loads, demonstrating the different nature of the statistical grouping of radionuclides of natural and artificial origin in the silt of the Tisza River when choosing two factors scheme with the weight of factors 1 with 59% and other 17.3%

## The experimental equipment: electron accelerator Microtron M-30:



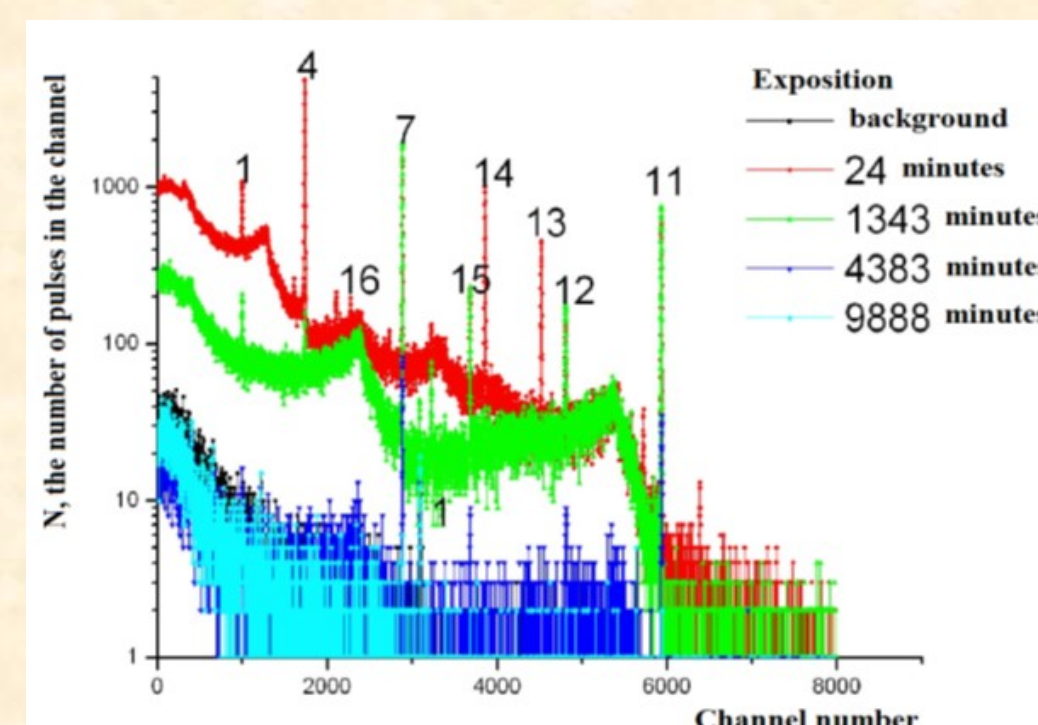
- accelerated electron energy within the 1–25 MeV range;
- electron currents up to 50 mA;
- Ta-, Be-, U-, Pb- based gamma-neutron converters, “neutron-stop” blocks to produce the intense fields of electron, g and neutron radiation for the g- and photo neutron activation methods

## Gamma-neutron activation analysis of samples of bottom sediments of the Tisza river basin, mass - 628 g



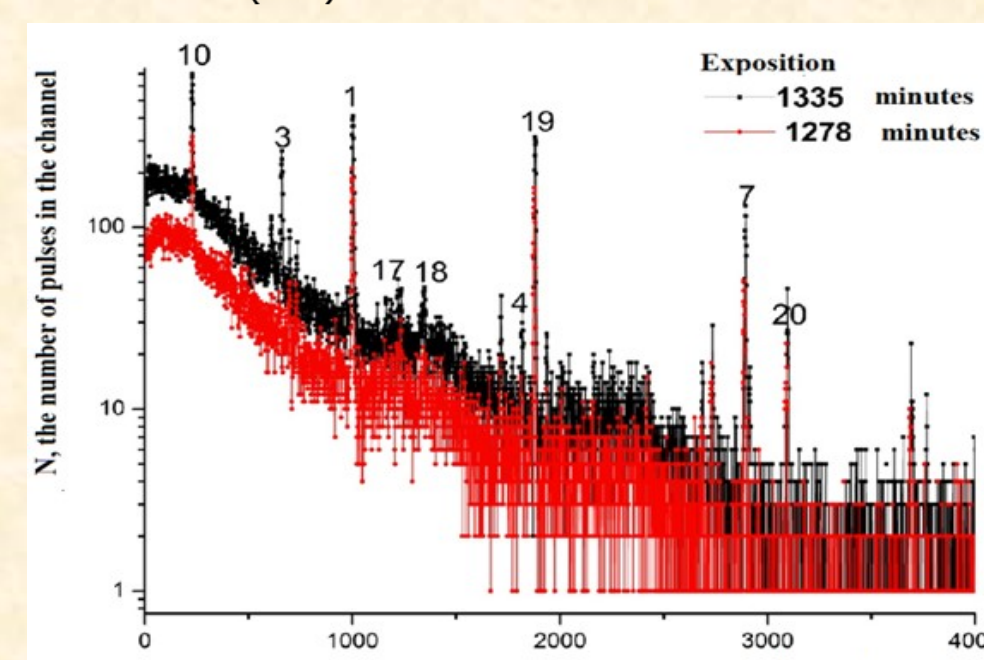
a) γ-n

2 - 2167,5 keB (<sup>38</sup>Cl, <sup>38</sup>K),  
3-389,1 keB (<sup>87</sup>Sr, <sup>126</sup>I),  
4-846,75 keB (<sup>56</sup>Mn),  
5-1145 keB (167,5),  
6-1273 keB (<sup>26</sup>Al, <sup>22</sup>Na),  
7-1368 keB (<sup>24</sup>Na),  
8-1655,5 keB (2167,5),  
9-1778(<sup>28</sup>Al), keB  
10-160 keB (<sup>47</sup>Sc)



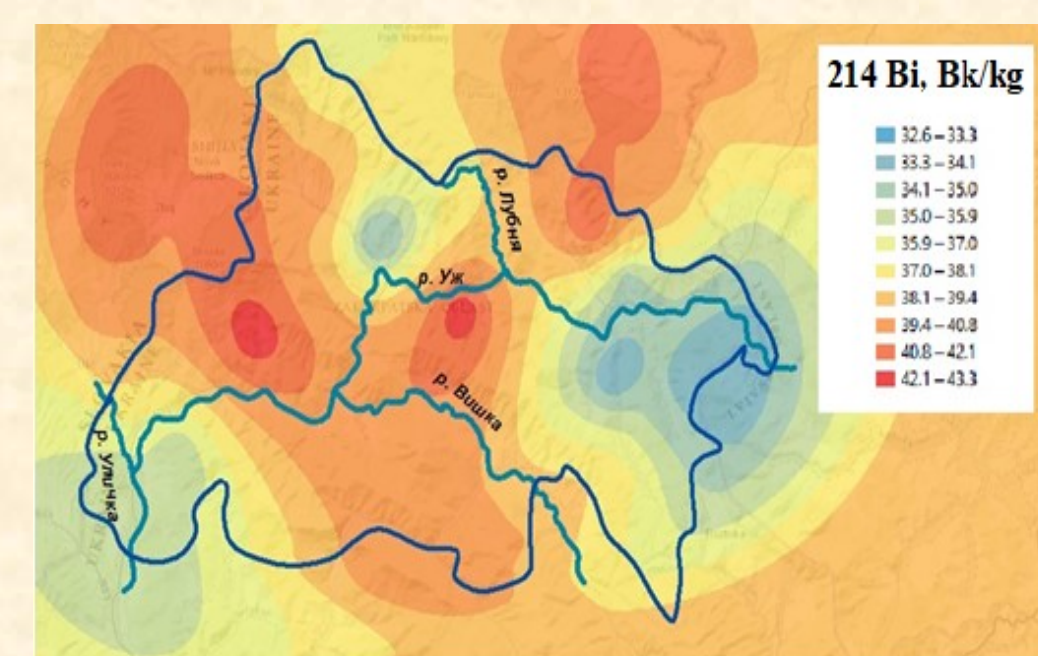
b) γ-n

4-846 keB (<sup>56</sup>Mn),  
7-1367 keB (<sup>24</sup>Na),  
17-583 keB (<sup>208</sup>Tl),  
18-669 keB (<sup>63</sup>Zn),  
19-909 keB (<sup>89</sup>Zr, <sup>28</sup>Ac),  
20-1460 keB (<sup>40</sup>K)



b) n-n

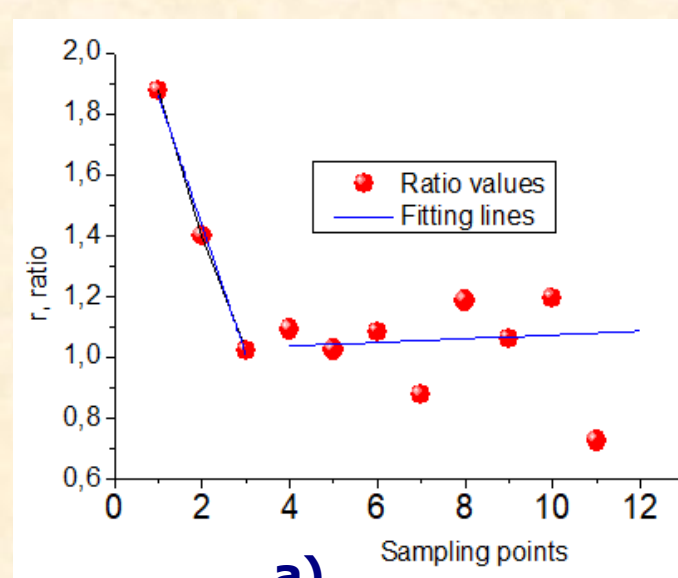
4-846 keB (<sup>56</sup>Mn),  
7-1368 keB (<sup>24</sup>Na),  
11-2754 keB (<sup>24</sup>Na),  
12-SE 2754 keB (<sup>24</sup>Na),



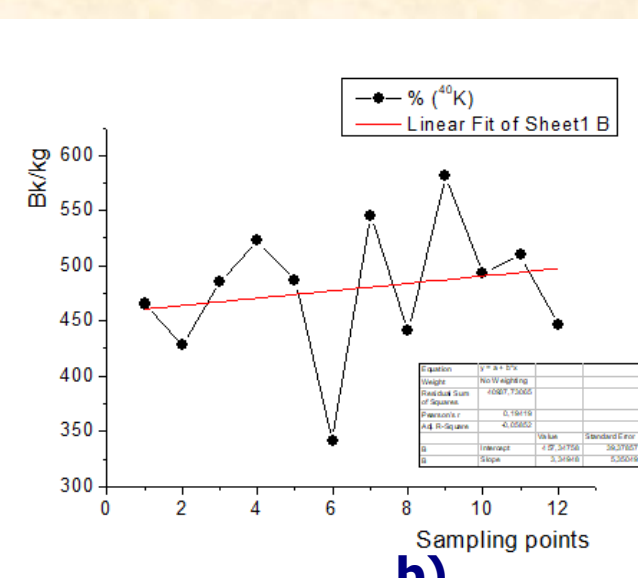
Map of the distribution of the total activity of natural GAN (except <sup>40</sup>K) in the bottom sediments of the Tisza river basin

## Conclusions:

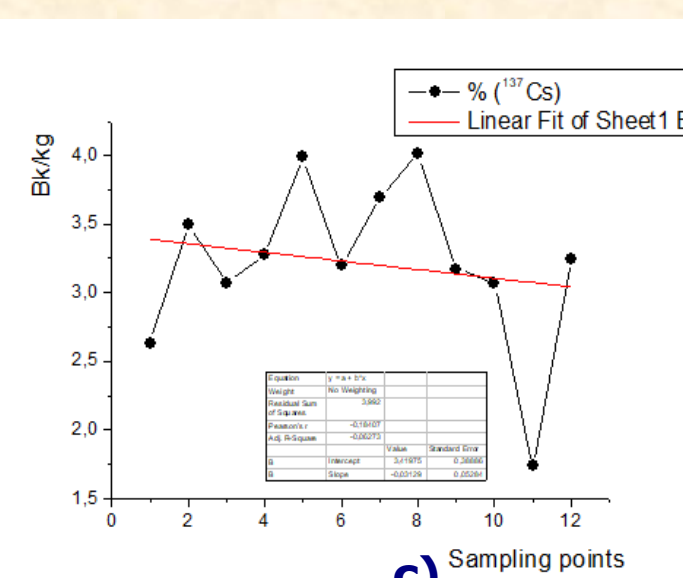
- Peculiarities of radionuclide distribution (U / Th / K / Cs) in the area of the source of the Tisza River and the transition from highland to lowland Carpathians have been established;
- The nature of the influence of the tributaries of the Tisza River (Lazeshchyna-Mala, Bila and Chorna Tysa, Visheu, Kosovska) on the radionuclide state of its siltstones has been studied;
- Gamma/neutron activation experiments on the M-30 microtron are essential to control the isotopic and chemical composition of silt;
- Statistical correlations on sampling points and content of U / Th / K / Cs radionuclides in the silts of the Tisza River were studied.
- The research results on the distribution, migration, and accumulation of GAS silt water resources of the Tisza river basin make it possible to build maps of natural radioactivity.
- A joint cross-border project on the Tisza River (Tisa Project) with teams of radioecologists from Serbia, Romania, Slovakia, and Hungary is desirable!



a)



b)



c)

Spatial distribution of radionuclide content in sediments along the Tisza River: a) relative content of uranium / thorium series components,  $r = {}^{214}\text{Bi}/{}^{212}\text{Pb}$ ; b) - content of <sup>40</sup>K, and man-made <sup>137</sup>Cs, all in Bq/kg