INAA and XRD investigation of the Serbian sector of Danube River and its tributary sediments

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Introduction

Danube River – the second river in Europe of 2,850 km length, passes through or borders of 10 countries covering a catchment basin of 801,463 km² and transporting annually about 145 10^6 t of sediments

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Introduction

Besides Danube, important sources of depositional material in Serbia are transported by it tributary: Tisa, Sava, Velika Morava, Timis

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Introduction

At the same time, Danube crosses a multitude of urban centers and well developed industrial centers representing important sources of anthropogenic contamination

Main goals of project

Under these circumstances, and given the expertise of our team in similar investigations, this project has two main goals:

- To collect a significant volume of experimental material i.e. unconsolidated sediments from the Serbian sector of Danube, to analyze it using both XRD and INAA.

- To interpret thus obtained data in elucidating the geochemistry and mineralogy of sentiment as well as their degree of pollution with most important presumably contaminating elements.

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Materials and Methods

Accordingly, 54 samples of unconsolidated sediments were collected from the river bed at depth between 1.5 and 7 m below the sediment surfaces from Novi Sad to Kusjak.

Collected material was room temperature dried and divided into more aliquots for further XRD and INAA determinations

For XRD investigations, 10 aliquots were selected to cover the most representative areas and investigated at the Geological Institute of Romania.

In the case of INAA measurements, all 54 samples were studied at the Frank Laboratory of Neutron Physics, Dubna.

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Materials and Methods

Sampling points

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Results and Discussion

XRD and optical microscopy permitted evidencing the major mineralogical components of the investigated sediments such as different clay minerals - ilite, smectite, montmorillonite, quartz, calcite, small amount of dolomite, phyllosilicates (mostly micas).

Besides them, more heavy minerals of which average abundance varying between 1.5 and 3.5%, such as garnets, green hornblende, or other opaque minerals, e.g. magnetite, hematite and chromite, as well as epidote were evidenced too.

Results and Discussion

Another group of minerals, the ZTR (zircon, tourmaline, rutile) one characterized by a remarkable resilience to physical factors such as abrasion was also present, but in small amount.

This fact was in good correlation with the presence of incompatible Sc, Zr, La, Hf and Th, good proxies of the origin of sedimentary materials well as their relative age or the degree of revoking and re-circulation

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Results and Discussion

INAA permitted determining the mass fraction the all 9 major, rock forming SiO_2, TiO_2, Al_2O_3, MnO, FeO, MgO, CaO, Na_2O, and K_2O as oxides, the incompatible Sc, Th, U, as well as seven REE together with Presumably Contaminating Elements (PCE) V, Cr, Co, Ni, Zn, and As.

In the case of major, trace as well PCE we have used, as reference, the Upper Continental Crust (UCC) as one of the most universal reference system. The UCC data concerning almost all elements provides reliable baselines for assessing any geochemical anomalies, including the anthropogenic ones.

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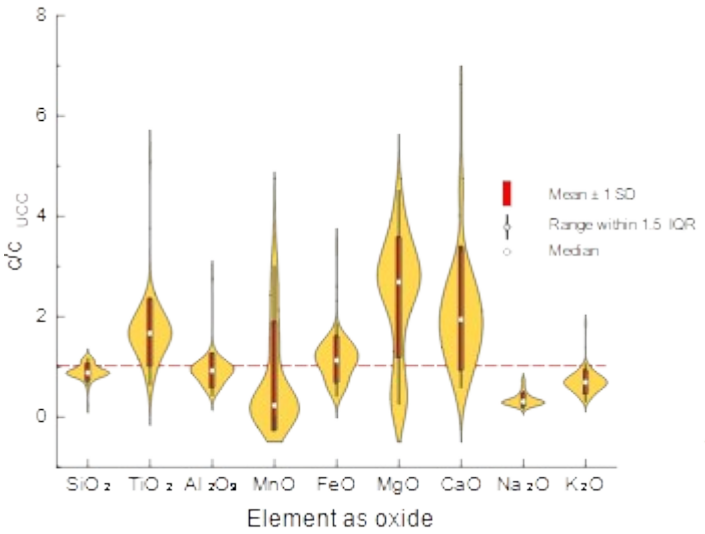
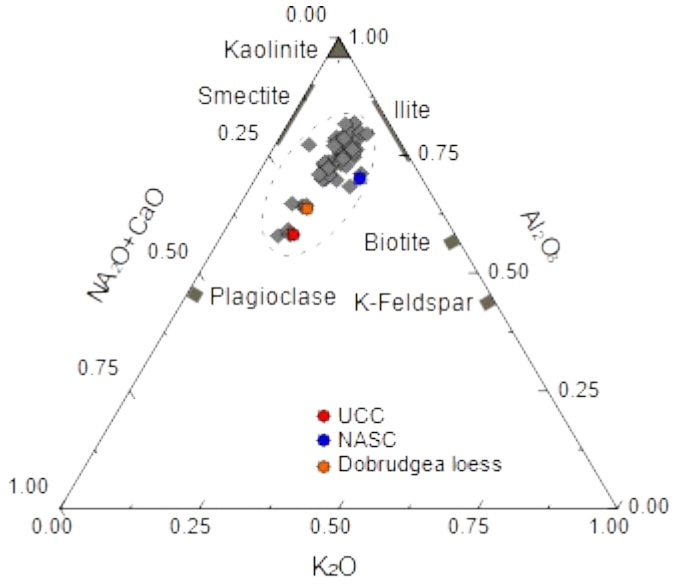
Results and Discussion

Major, rock forming elements





Closer to UCC, different sources and significant degree of weathering

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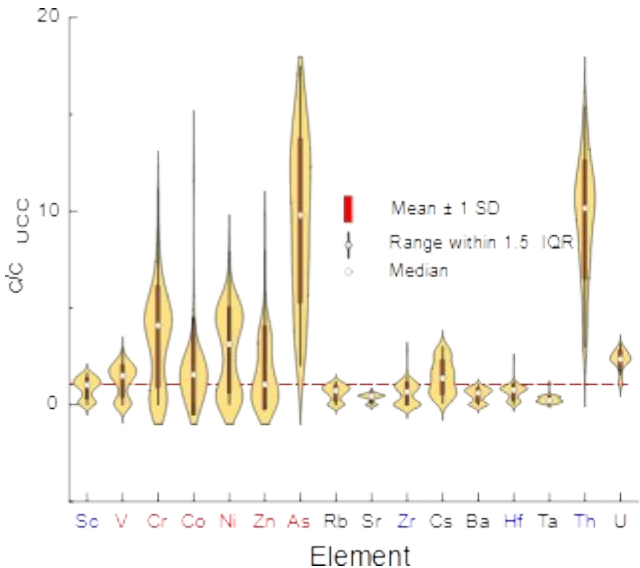
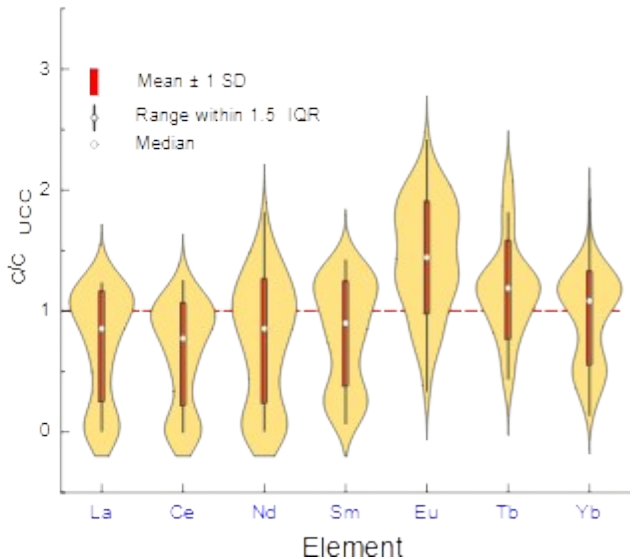
Results and Discussion

Trace elements including PCE and REE





More or less closer to UCC, but different sources as some multimodal distribution functions suggest

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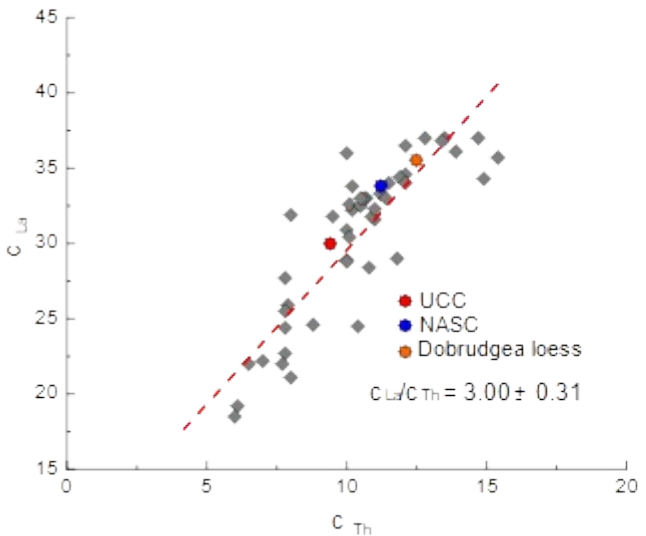
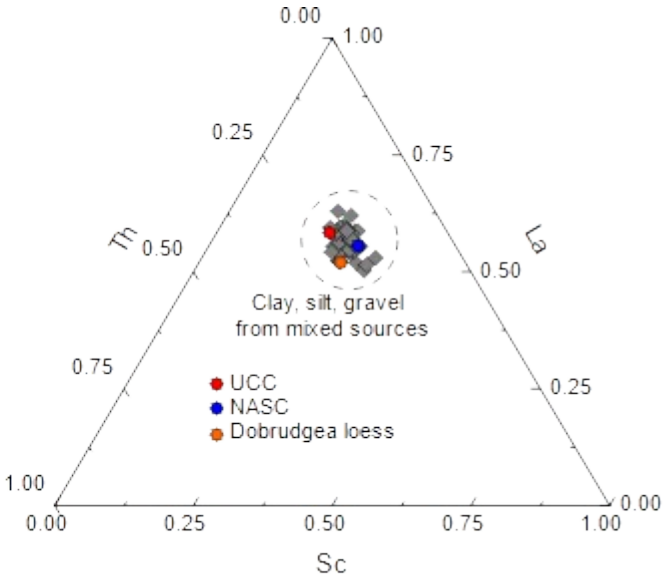
Results and Discussion

Trace incompa-tible elements





Closer to UCC

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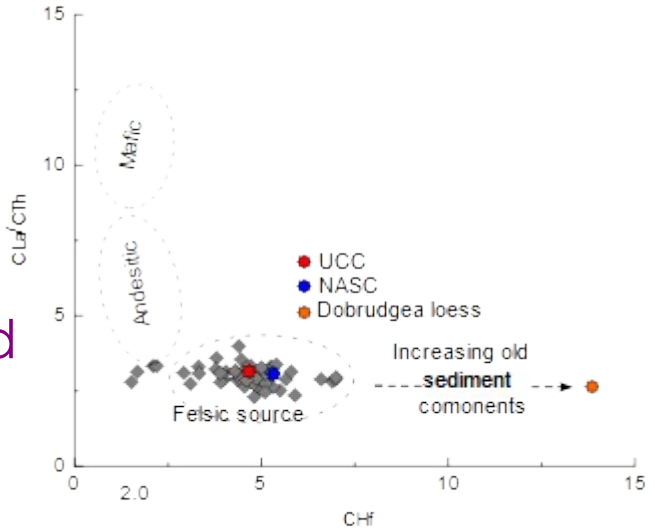
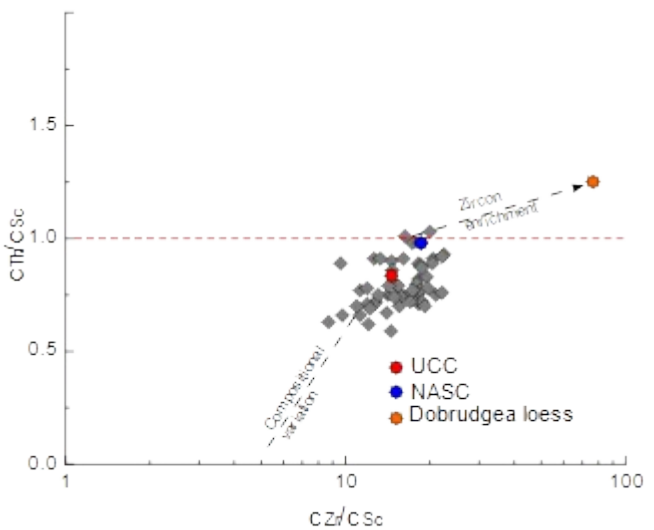
Results and Discussion

Trace incompa-tible elements

Nature and history of sediment material





Felsic rocks sources and new, less recirculated depositional material

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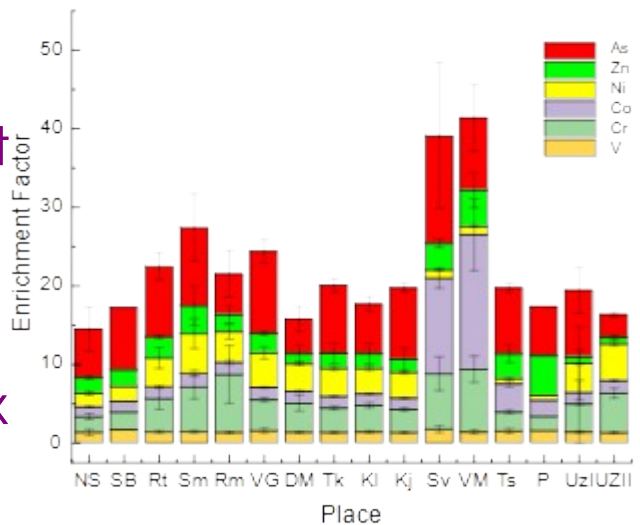
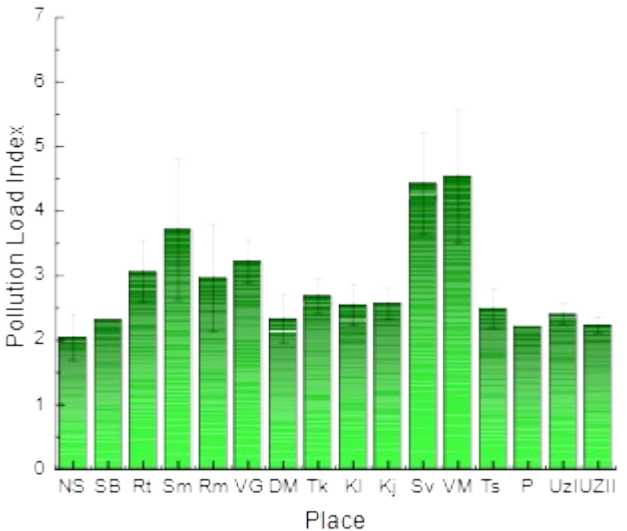
Results and Discussion

PCI

Enrichment Factor

Pollution Load Index





Moderate contamination, due mainly to As and in some places to Cr and Co

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Concluding Remarks

•- i. A complex investigation of 54 samples of unconsolidated bottom sediments collected along the Serbian sector of Danube river showed that sedimentary material mainly consists mainly of clay minerals, quartz, calcite,dolomite, micas as well as small amount of heavy minerals.

•- ii. These fact are in good correlation with the data concerning the distribution of major, rock forming elements and more incompatible ones which pointed towards a felsic origin of sedimentary material.

•- iii. Complementary to these findings, the presence of six presumably contaminating elements of which mass fractions exceed the Upper Continental Crust ones, considered as a reference for a clean environment, evidenced a certain degree of environmental pollution.

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