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INAA and XRD Investigation of the Serbian Sector of the Danube River and Its Tributary

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To get more data concerning the geochemistry and mineralogy of the Danube River tributaries mainly from the Eastern Serbian sector and to elucidate the status quo of sedimentary material, Instrumental Neutron Activation Analysis (INAA) and X-Ray Diffraction (XRD) were used in tandem to investigate 10 samples of unconsolidated bottom sediments, two samples collected at 1.5 and 7.5 m below the river bed, respectively.
The high sensitivity of INAA coupled with a high accuracy achieved at the IBR-2 reactor, Joint Institute for Nuclear Research (JINR) allowed the determination of the mass fractions with accuracy up to 0.5 mg/kg and lower. In this regard, the mass fraction distribution of 22 elements from Sc (Z= 21) to U (Z=92), including 10 Lanthanides permitted to characterize not only the nature of sedimentary material but also the degree of anthropogenic contamination with seven Presumably Contamination Elements (PCE) V, Cr, Co, Ni, Zn, As, and Sb. The Upper Continental Crust (UCC) was considered as a reference environment for both sediment origin and the contamination degree. The XRD performed at the Geological Institute of Romania (GIR) enabled the determination of the main mineralogical component of the sediments.
Among the investigated trace elements, the incompatible and litophilic elements Sc, Zr, the lanthanides, as well as Hf, Th, and U were used to determine the global nature of sedimentary material. On this matter, more descriptors such as La/Th, Th/U ratios or the Sc-La-Th discriminant ternary diagram pointed towards a remarkable similarity between the depositional material and the UCC, also expressed by the felsic origin as proved by the La/Sc ratio vs. Hf biplot. At their turn, the Th/Sc. vs. Zr/Sc suggested a relatively new, less recirculated material. The similarity to UCC was also documented by the distribution of the lanthanides mass fraction normalized to chondrite, showing the characteristic Eu negative anomaly.
As mentioned before, the mass fractions of the investigated PCE normalized to the corresponding UCC mass fraction, which was considered a pristine, uncontaminated environment, presented increased values of the Contamination Factors (CF) of which values monotonously increased from V of which CF was of 0.91 ± 0.28 to 7.71 ± 4.2 in the case of Sb. As a consequence of this fact, the global Pollution Loading Index (PLI) varied between reached values from 1.24 to 4.04 with an average value of 2.32 ± 0.95, pointing towards a moderate to locally high contamination level.
The XRD results were in good agreement with the INAA ones as the main mineralogical component of sedimentary material consisted mainly of quartz, clay minerals (smectite, illite, and more or less montmorillonite), calcium carbonate, plagioclase feldspars with traces of iron minerals such as magnetite, hematite, and goethite.

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