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Geochemical “testimonies” of fine sediments’ origins in a lithologically complex and coal mining disturbed Romanian river basin

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Fine sediments supplied by rivers retain the imprint of the lithological and geochemical characteristics of their zones of origin and sometimes intermediate storage, as well as of the influence of human activities. Advancing the management of watersheds could thus be achieved by taking into account natural and anthropogenic sediment sources, representing the other “half” of the material carried by rivers. In European watersheds, a less common approach to comply with the EU Water Directive is to track sediment sources and pathways within a watershed using the mineralogical and geochemical features of alluvial sediments. Difficulties arise when quantifying sediment budgets at any spatial or temporal scale especially for watersheds exhibiting complex sediment origins and transfer pathways.

Our study tackles the issues of different fine sediments sources, little-known residence times and the "competition" between natural processes and anthropogenic forcings responsible for sediment suspension delivery, transport, and accumulation. We seek to identify, through a geochemical approach, the relative sources of fine sediment in the Jiu River basin (10,080 km^2), a major tributary of the Danube River, located in SW Romania. The study area stands out for its complex morphology and lithology (with in-river sediment footprints attributed to crystalline, limestone, and detrital facies) and its ongoing coal mining. Jiu River is an important alluvial supplier to the Danube River, especially during floods.

The research aims to identify the sub-catchments supplying the most sediments, by analyzing coaly matter from the watershed’s two coal basins, as well as the fine sediment’s heavy minerals and lanthanides content. To meet this objective, alluvial samples were gathered from potential upstream source areas and from an alluvial riverbank deposit, on Jiu river’s lower sector. The coal species (lignite and bituminous coal) and their ratio in the upstream and downstream sediment samples were determined through apparent density differentiation, using solutions of heavy liquids, and by quantifying the volatile matter and ash content. Lanthanum elements and heavy metals samples were analyzed using Rigaku Supermini X-ray Fluorescence Spectrography. Based on their abundance in upstream and downstream samples, the main geochemical indicators (Zr/Si,

Ti/Fe, Cu/Fe, Cu/S, Ca/Mg, Na/K, Lanthanides/P ratios), as well as the two coal species, were further correlated with the underlying lithology and hydrological features of the source sub-basins.

The analysis of the upstream-downstream geochemical relationship was carried out at two spatial scales, to assess the potential upstream alluvial sources in 6 main sub-catchments, and to relate the geochemical composition of the upstream (source areas) samples with that from the downstream alluvial deposit. For the upper sediment layers making up the riverbank alluvial deposit, the information provided by the geochemical indicators was provided, where data was available, with hydrological information on the flood events having generated their accumulation.

As key geochemical indicators for the main areas of sediment production, coal content, heavy metals and lanthanides could improve the control and planning of watershed management and conservation. The results may also provide a holistic understanding of the upstream to downstream coal pollution transfer in watersheds still affected by coal mining.