



## **Characterisation of sand transport in gravel-bed rivers using iron slag dated by historical studies**

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Considerable quantities of iron-smelting slag are present in the bed of the Ardennian rivers. These waste products come from hundreds of ironworks (mainly blast furnaces and finery forges) built close to different-sized rivers between the 14th and the 19th centuries. In general, slag was crushed by hammers, sorted and piled up in heaps around the furnaces, generally onto the floodplains. Furthermore, some archives mention that they were sometimes thrown out directly into the rivers. This means that for centuries, slag elements have been swept away by floods, mixed with the sediment and spread out along river courses. Due to their distinctive appearance, slag particles are easily recognizable among the natural elements.

Thanks to many historical studies conducted on the early iron industry, we are able to date quite precisely the inception and the periods of activity of the different sites established in the catchments. These data are indispensable in order to use slag as a tracer to quantify the particles' velocity in rivers.

Downstream of ironworks, samples of sand have been collected in the surface layer of many gravel-bed rivers. Then, the slag concentration of each sample has been measured in the coarse sand fraction. The representation of the longitudinal evolution of slag concentration in these rivers permits the dispersion of slag to be analysed, the relative bed-material discharges at confluences to be quantified and the velocity of coarse sand to be determined. A survey of the bedload discharge in the Ardennian rivers established that more than 90 % of the bedload transport consists of coarse sand grains that are transported on the bottom of the bed. However, in the literature, this grain-size fraction is generally not considered in bedload discharge estimations because the sandy particles are very difficult to tag and to recover. Consequently, the huge amounts of slag injected in rivers several centuries ago can be considered as a very useful opportunity to characterise the sand transport in gravel-bed rivers.