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Assessment of particulate Zn and Pb sources in the Orne watershed (North-East of France) using mineralogical, chemical and isotopic fingerprints

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To assess the sources of particulate Zn and Pb transported as suspended sediment in the Orne River, different kinds of soil and sediment samples were collected within the Orne watershed. The land use is highly contrasted from the source to the junction with the Moselle River. Indeed, during more than one century, the downstream part of the Orne valley was dedicated to steel production. Such an intense industrial activity left behind tons of steel making wastes (SMW) on land surface and within the Orne riverbed. Three sets of samples were constituted as potential sources, theoretically representing detrital, urban and inherited industrial particles. To characterize al the fingerprint of each kind of samples, mineralogy, element contents, Zn and Pb isotope compositions were investigated. Soil samples were collected on soils with different uses. They all display detrital minerals assigned to the geological background. Urban dusts and steel making residues display specific mineral phases (sulfates and iron oxides respectively). Beside mineralogy, element compositions present strong discrepancies between the distinct sets of samples. SMW are particularly enriched in iron, zinc and lead and exhibit δ^{66}Zn values ranging from -0.67‰ to 1.66‰. Urban samples display δ^{66}Zn values between -0.11 and 0.13‰, and soils present δ^{66}Zn values between -0.24 and 0.47‰. The ^{206}Pb/^{204}Pb ratios range from 18.361 to 18.735 for soils, from 17.973 to 18.219 for urban samples and from 18.313 to 18.826 for SMW. For each of the three sets of samples, variations of geochemical fingerprint were discussed. For soils, the relative low variations of δ^{66}Zn and ^{206}Pb/^{204}Pb were assigned to land use and atmospheric deposition. For industrial samples, the variations were more intense and could be attributed to distinct industrial processes in the production of cast iron. The three sets of samples could be distinguished on the basis of Zn and Pb contents and isotopes. Finally, this study not only highlighted (1) the sources that could release particulate Zn and Pb into the river system but also (2) demonstrated that the urban particles are well constrained in terms of Zn and Pb isotopic signatures that could be used as universal source for particles.