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Characterisation of magnetic particles in the Seine river system : Implications for the determination of natural versus anthropogenic input

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The presented study seeks new proxy parameters and techniques to trace geological and anthropogenic processes in the Seine river system in France, already largely investigated within the framework of the PIREN-SEINE program. We develop finger prints for mechanical and chemical weathering processes, the regionalisation of the suspended material, the influence of fluvial transport mechanisms, and the comparison of natural input versus anthropogenic pollution.

Therefore we apply a combination of straightforward rock magnetic and advanced electron microscopic techniques. This interdisciplinary approach allows for the rapid analysis of a relatively high number of sediment trap samples with standard methods such as magnetic hysteresis measurements on the bulk material.

Clear trends can be identified from those results, concerning the magnetomineralogy, magnetic grain size and concentration of magnetic material in the samples. Each river (stretch) shows its specific trend line depending on the regional input and weathering conditions, its catchment area, potential pollution, and its seasonal changes and geochemical environment. Two major downstream profiles (the Seine and the Marne) are chosen to demonstrate this.

Detailed analyses are performed on magnetic concentrates for representative sample locations, which were recovered using heavy liquid separation. Absolute quantification of the various types identified in the magnetic microparticle assemblage are achieved by automatic visualisation and particle classification in scanning electron miroscopy. Mössbauer spectroscopy is applied to quantify the delicately countable nanoparticle fraction, for example fine grained hematite, goethite, and ferrihydrite. Low-temperature thermomagnetic remanence measurements give additional information on the presence or absence of specific mineral phases and their crystallinity. The rock magnetic and electron microscopic studies are further completed by geochemical ICP analyses performed on bulk samples and magnetic extracts.