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

C. Franke (1,2,*), C. Kissel (1), E. Robin (1), P. Bonté (1), and F. Lagroix (3)

(1) Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA-CNRS-UVSQ, Campus du CNRS, Bâtiment 12, Avenue de la Terrasse, 91198 Gif-sur-Yvette Cedex, France, (2) Ecole des Mines de Paris, Centre des Géosciences, 35 rue St. Honoré, 77305 Fontainebleau, France, (3) Institut de Physique du Globe de Paris (IPGP), CNRS et Université Paris-Diderot, Equipe de Paléomagnétisme, 4 place Jussieu, 75252 Paris Cedex 05, France, (*) christine.franke@lsce.ipsl.fr

This study presents an innovative application of well-established environmental magnetic proxy parameters on fluvial sediments with the aim to trace geological and human induced processes in the complex Seine river drainage system in northern France. We determine the regional distribution of the suspended material and search for environmental fingerprints of the influence of fluvial transport mechanisms, changes in the balance of natural input versus anthropogenic pollution and mechanical and chemical weathering processes.

To achieve these goals, we apply a combination of straightforward rock magnetic and advanced scanning electron microscopic (SEM) techniques. This interdisciplinary approach allows the analysis of a relatively large number of sediment trap samples with standard methods such as room temperature magnetic hysteresis measurements as well as detailed low-temperature remanence measurements on the bulk sediment material. The absolute quantification of the various components identified in the magnetic assemblage is derived using a SEM automated chemical classification technique.

As a general pattern we observe an increase in magnetic concentration coupled with a fining in magnetic grain-size downstream the Seine river system. Additionally we see a general change in the major magneto-mineralogy from high-coercivities in more rural upstream areas to magnetite-dominated assemblages further downstream. Each river (stretch) shows its specific trend line depending on the regional initial input, weathering conditions, drainage area and potential pollution sources.

One major highlight of the developed method is the significant correlation (r2=0.9) of anthropogenic antimony containing iron oxide particles with the magnetic concentration. This shows the excellent potential of the magnetic proxy for the recognition of specific heavy metal pollution concentrations. Hence, the applied method serves to identify major trends as well as local particularities and leads to quantitative evidence of the contributions of individual tributaries in the Seine river system.

Keywords: Seine river system, environmental magnetism, suspended particulate matter, anthropogenic and natural input, magnetic hysteresis, scanning electron microscopy (SEM), automated chemical classification (ACC), heavy metal pollution