

Micro- and Nanoplastic Analysis in Soils

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Microplastic (MP) and nanoplastic (NP) particle pollution in the environment are of great concern. Even if the amount of MP applied to soils being greater than the yearly load to the ocean, terrestrial systems are much less studied in terms of MP and NP concentrations and characteristics. The main reason for the very limited number of MP analysis in soils, is the lack of an established method to perform this kind of analysis. We separate the MP particles 1-5 mm by sieving of the dry sample and identify the plastics by attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR). The particles <1mm are separated by wet chemical methods i.e. by density separation from the mineral soil matrix, natural organic substances (with a similar density) are oxidized, and a second density separation is used for the final cleanup. Finally, the sample is filtered -on a filter transparent at wavelength between 1250 and 4000 cm⁻¹- and the single particles are analyzed by FTIR microscopy in transmission mode. The quantification is done by precisely measuring the size of the single particles and calculating their weight using an empirical relationship between particle size and weight (Scheurer and Bigalke, 2018).

While the number of MP analyses in soils is limited, there is no single publication that analyzes NP in soils. The lack of NP research is mostly due to the fact that the analytical techniques applied to MP research (e.g. FTIR and Raman spectroscopy) do not work for nanoscale particles, and that other methods established for nanoparticles (e.g. transmission electron microscopy) cannot distinguish plastic from natural soil organic matter. We have recently begun testing the use of scanning transmission X-ray microscopy (STXM) to analyze NP in soils. The STXM method can display NP with a resolution of about 30 nm and identify the plastics via near edge x-ray absorption fine spectra (NEXAFS) at the carbon K-edge.

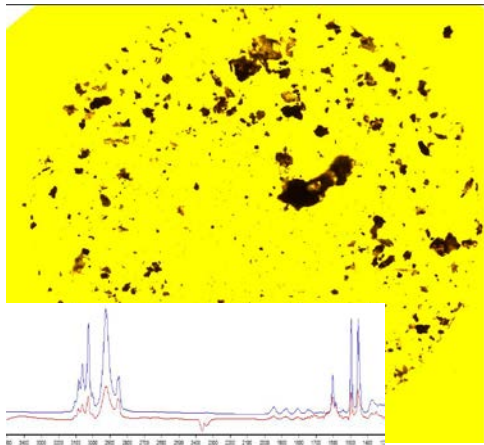
MP and NP particles in soils can be analyzed by wet chemical sample preparation, FTIR microscopy and STXM to investigate their occurrence and fate in the environment.

Reference

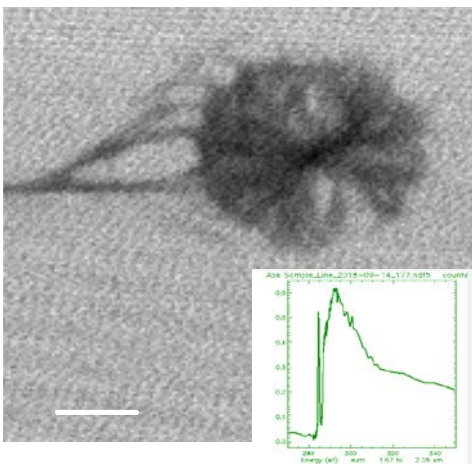
M. Scheurer, M. Bigalke, *Environmental Science and Technology* **2018**, 52(6), pp. 3591-3598.



Sieve with particles >1mm from Swiss floodplain soils. Many of the particles are plastics, as confirmed by ATR-FTIR spectroscopy.



Filter with particles <1mm from a Swiss floodplain soil and FTIR spectra of a particle from the soil (in red) and the spectra of polystyrene from a polymer database (in blue). Size of the filter = 13 mm.



STXM image of polystyrene fibers recorded at 320 eV and corresponding NEXAFS spectra from 270-350 eV. Scale bar = 1 μ m.