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Micro- and Nanoplastic Analysis in Soils

Moritz Bigalke*[a], Montserrat Filella[b], Daniela Fischer[a], Anna Muntwyler[a], Michael Scheurer[a], and Benjamin Watts[c]

*Correspondence: Dr. M. Bigalke[a], E-mail: moritz.bigalke@giub.unibe.ch. [a]Institute of Geography, Hallerstrasse 12, CH-3012 Bern; [b]Department F.-A. Forel, University of Geneva, Boulevard Carl-Vogt 66, CH-1205 Geneva; [c]Paul Scherrer Institute, CH-5232 Villigen PSI.

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Microplastic (MP) and nanoplastic (NP) pollution in the environment are of great concern. Even though the amount of MP applied to soils is 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 analyses in soils is the lack of an established method to perform this kind of analysis. We separate the 1–5 mm sized MP particles by sieving the dry sample and identifying the plastics by attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR). The particles of <1 mm size 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 wavelengths 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.

While the number of MP analyses in soils is limited, there is no single publication that analyses 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.

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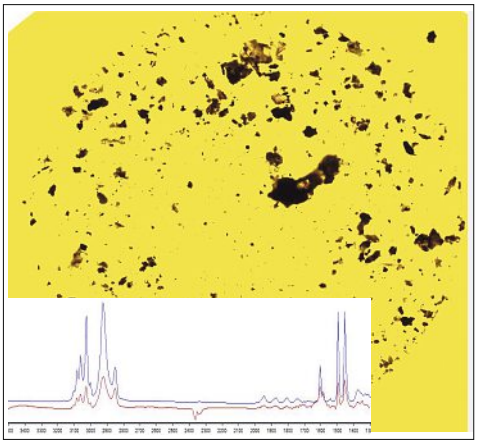
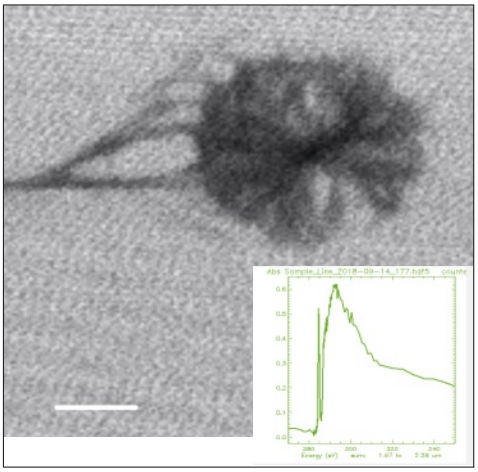
Reference

M. Scheurer, M. Bigalke, *Env. Sci. Technol.* **2018**, *52*, 3591.



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

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



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

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Please contact: Dr. Veronika R. Meyer, Unterstrasse 58, CH-9000 St. Gallen
Tel.: +41 71 222 16 81, E-mail: VRMeyer@bluewin.ch