MORPHOLOGY-DEPENDENT DEGRADATION AND FRAGMENTATION OF PVC MICROPLASTIC PARTICLES IN SATURATED QUARTZ SAND COLUMNS

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BACKGROUND

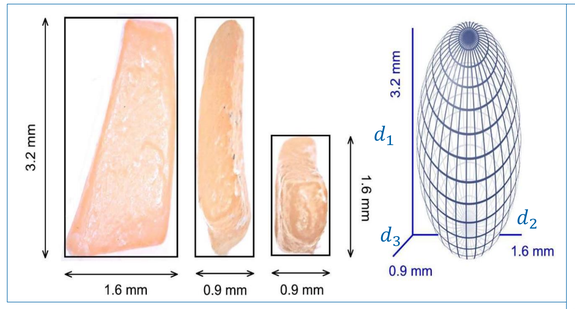
Laboratory studies on the transport of microplastics in porous media observed that decreasing the size of microplastics increased their vertical migration[1].

It is essential to analyse the morphological changes experienced by the microplastics, as they may prove to be indicators of the plastic pollution source and its fate in the natural environment[2].

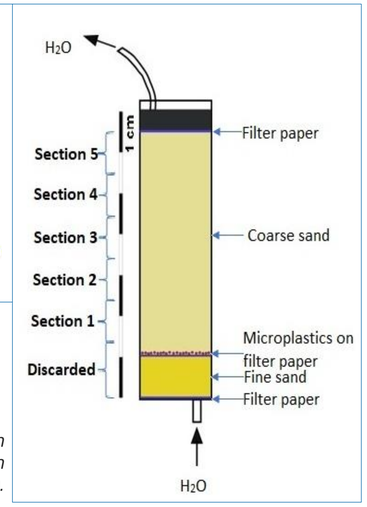
In most studies, shape and size characterization of microplastics is based on projected 2-D microscopy images, therefore offering limited relevant morphological information required for a correct transport behaviour analysis[3].

METHOD

The microplastic particles were characterized based on light microscopy images The length of the fragments was measured (longitudinal, d_1), width (longest dimension perpendicular to d_1, d_2), and height (shortest dimension perpendicular to d_1, d_3).



Parameterization of microplastic particles based on multiple 2D images defining d_1, d_2, and d_3 by the lengths of an ellipsoid with the same orthogonal dimensions as axes[2].

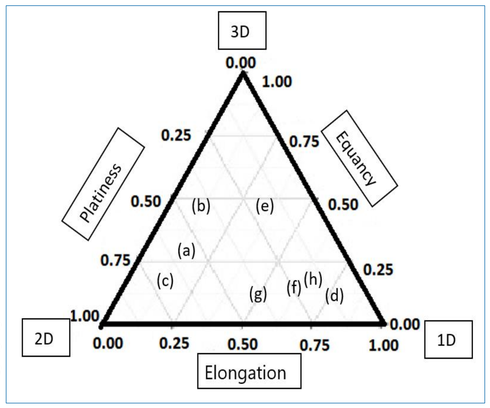


Schematic representation of the soil column experimental setup(right).

RESULTS

The PVC microplastic particles (125 – 200 µm) were categorized into three basic shapes, spheres (3-D), plates and films (2-D) and fibers and rods (1-D), by defining the dimensionless parameters equancy, platiness and elongation.

- Equancy = $\frac{d_3}{d_1}$ (1)
- Platiness = $\frac{d_2-d_3}{d_1}$ (2)
- Elongation = 1 - $\frac{d_3}{d_1}$ (3)



A barycentric triangular plot indicating the corresponding morphological shapes of the particles (a) to (h) as identified through equations: (1), (2), and (3) (left).

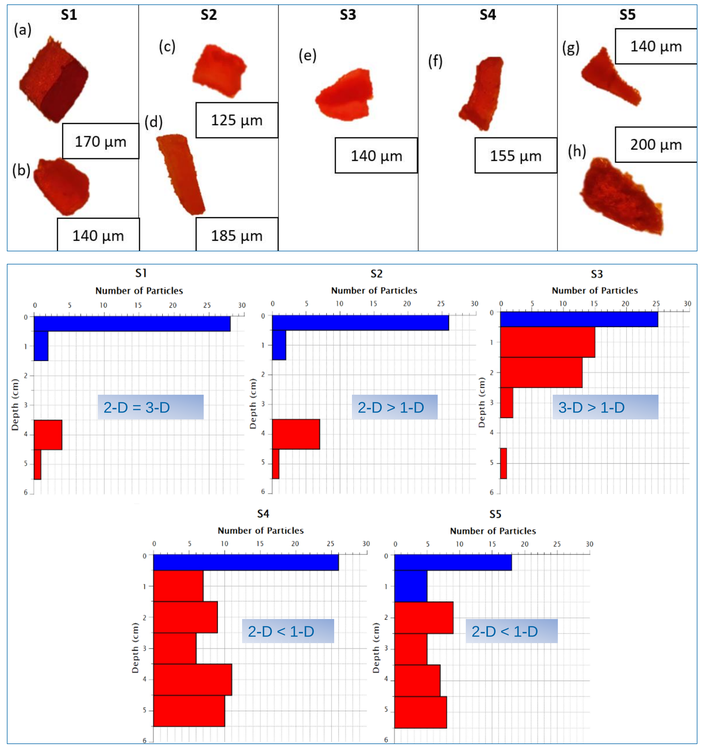


Image of some of the smallest-sized PVC particles representing the morphologies of particles studied in each column S1, S2, S3, S4, and S5 out of 27 column tests (top). Retention profiles of 5 columns out of 27[4].

CONCLUSION

- Microplastic degradation into fragments play an important role in improving the movement of particles.
- 1-dimensional PVC particles were more susceptible to fragmentation within the column, promoting transport.

LITERATURE

[1] **Gao**, Jing, Shizhen Pan, Pengfei Li, Liuwei Wang, Renjie Hou, Wei-Min Wu, Jian Luo, and Deyi Hou. 2021. "Vertical migration of microplastics in porous media: Multiple controlling factors under wet-dry cycling." Journal of Hazardous Materials 419: 126413.

[2] **Rosal**, Roberto. 2021. "Morphological description of microplastic particles for environmental fate studies." Marine Pollution Bulletin 171: 112716.

[3] **Gray**, A.D., Weinstein, J.E.. 2017. "Size- and shape-dependent effects of microplastic particles on adult daggerblade grass shrimp (Palaemonetes pugio)." Environmental Toxicology and Chemistry 36, 3074-3080.

[4] **Tumwe**t, Faith Chebet, Rebecca Serbe, Tomas Kleint, and Traugott Scheytt. 2022. "Effect of fragmentation on the transport of polyvinyl chloride and low-density polyethylene in saturated quartz sand." Science of the Total Environment 836: 155657.

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