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Impact of Microplastic Aggregation on Their Accumulation in Soil Pores

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Microplastics (MPs) are increasingly recognized as an emerging threat to the geosphere environment, and their movement behaviors should be clarified. In this study, column percolation tests were conducted.

The columns were filled with silica sand with an average particle size of 230 µm. A pressure gauge was placed beneath the column and hydraulic conductivity was calculated. Polystyrene (PS) MPs with average particle sizes of 1.094 µm and polyethylene (PE) MPs with an average particle size of 0.605 µm were used. The column was saturated with distilled water and then left to stand for 24 hours. Subsequently, distilled water was passed through for 1 hour, followed by an MPs suspension (100 mg/L) for 2 hours, and then distilled water for another 2 hours at a flow rate of 1 pore volume per hour. Additionally, the size and zeta potential of MPs in the suspension were measured to confirm the MPs aggregation.

The results demonstrated that almost all PSMPs passed through the column (Table. 1). The effect of PSMPs on permeability was minimal. The zeta potential of PSMPs was -46.3 mV, and no PSMP aggregation was observed in the suspension (Fig.1). Since the zeta potential was highly negative, PSMPs were considered to repel each other and were less likely to aggregate. The PSMPs used in this study were significantly smaller than the silica sand particles and did not accumulate in the soil pores. The maximum PEMP concentration in the effluent was high (Table. 1); however, this increase was temporary, and only 31.4% of the PEMPs passed through the column. A permeability peak was observed, corresponding to the peak of maximum PEMP concentration in the effluent. The zeta potential of PEMPs was -16.9 mv and PEMP aggregation was observed in the suspension (Fig.1). PEMPs were more likely to aggregate because the absolute value of the zeta potential was relatively low. These results indicate that PEMPs aggregated in the suspension may have accumulated in soil pores, blocking the flow path. Since MPs may aggregate depending on their surface properties and material composition, their aggregation should be considered when evaluating their mobility.

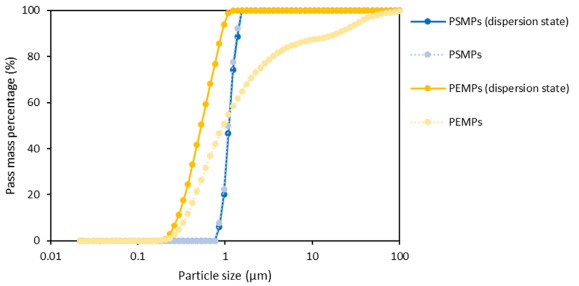

Fig.1 Particle-size distribution of PSMPs and PEMPs. A dispersant and ultrasound were used to measure the particle size of MPs in the dispersed state.

Table. 1 Migration behavior of MPs in the column percolation tests.

Sample	Maximum MP concentration (C/C_0) in the effluent (%)	Cumulative amount of MPs passed through the column (%)
PSMPs	97.5	93.4
PEMPs	88.5	31.4