INFLUENCE OF DISSOLVED ORGANIC MATTER IN THE TRANSPORT OF MICROPLASTICS IN SOIL

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INTRODUCTION

Leaching plays an important role in translocation of microplastics into deeper soil. Dissolved organic matter (DOM) present in soil can interact with polystyrene plastic (PSP) colloids and affect its mobility. Besides surface charge modifications and steric repulsion forces, DOM adsorption leads to a reduction of the strong surface hydrophobicity that uncoated plastic colloids exhibit. Effects of DOM on PSP mobility can potentially be predicted with the XDLVO approach, which includes the changes in surface wettability.

The main **objective** of this work is to study and predict the influence of ionic strength and, more importantly, DOM in the vertical translocation of PSP in a soil-alike matrix.

MATERIALS AND METHODS

Colloid transport in water-saturated sand was studied by carrying out breakthrough experiments in sand-packed columns, at different ionic strengths (IS, $CaCl_2$ from 0.5 to 2.5 mM, pH 4), without and with DOM (5 mg/L). Polystyrene microspheres of 1 µm of diameter were used at an initial concentration of 16.5 mg/L and passing concentration was measured using UV/Vis spectrophotometry (λ=433 nm). Modifications in surface charge, wettability and aggregation behavior were analyzed measuring zeta potential (ZP), mean hydrodynamic diameter (HDD) and contact angle (CA). These parameters were later used to calculate interactions energies when applying DLVO and XDLVO theories.

RESULTS AND DISCUSION

Breakthrough experiments of PSP (Fig. 1) showed an increase in colloid retention with higher IS, due to reduced surface charge caused by Ca^{2+} charge compensation. Presence of DOM caused decrease in retention at same IS levels, suggesting that DOM increases PSP mobility and decreases aggregation between particles, as is also observed in microscope-obtained images (Fig. 2)

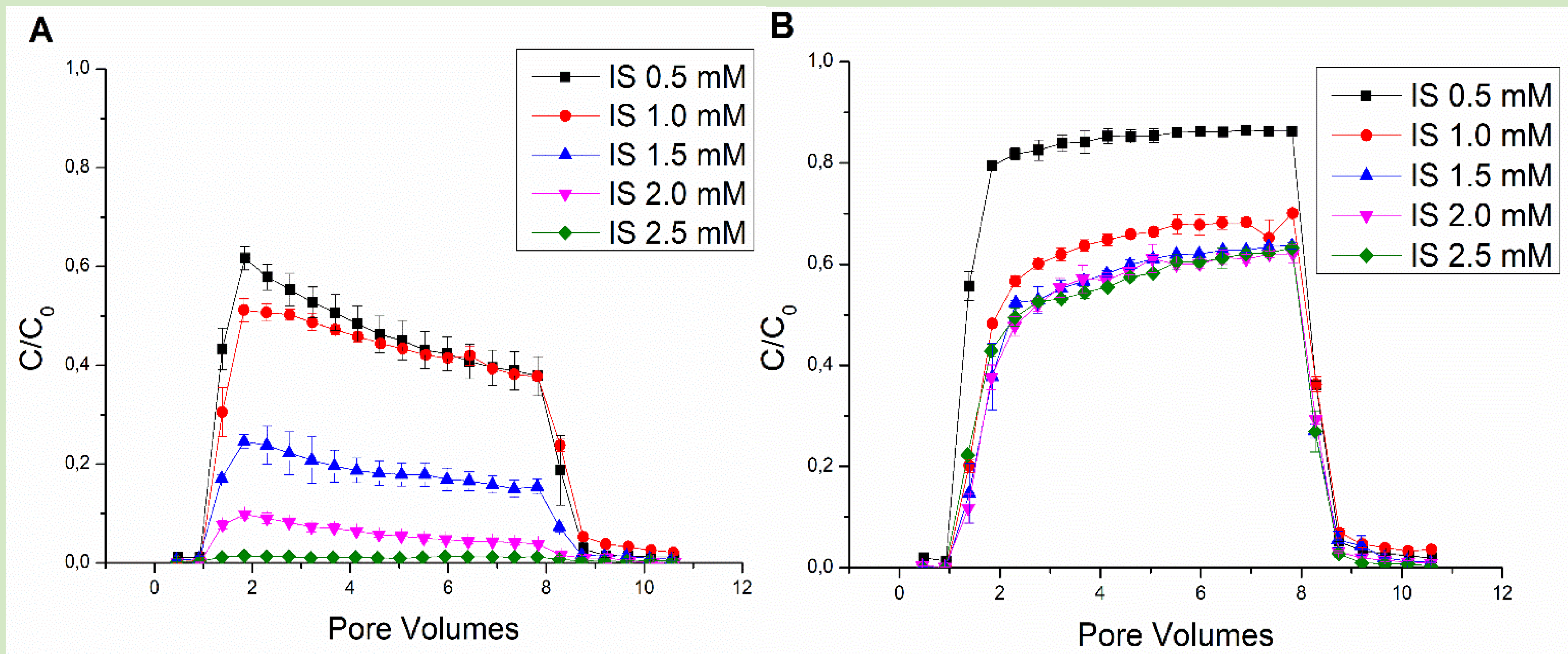
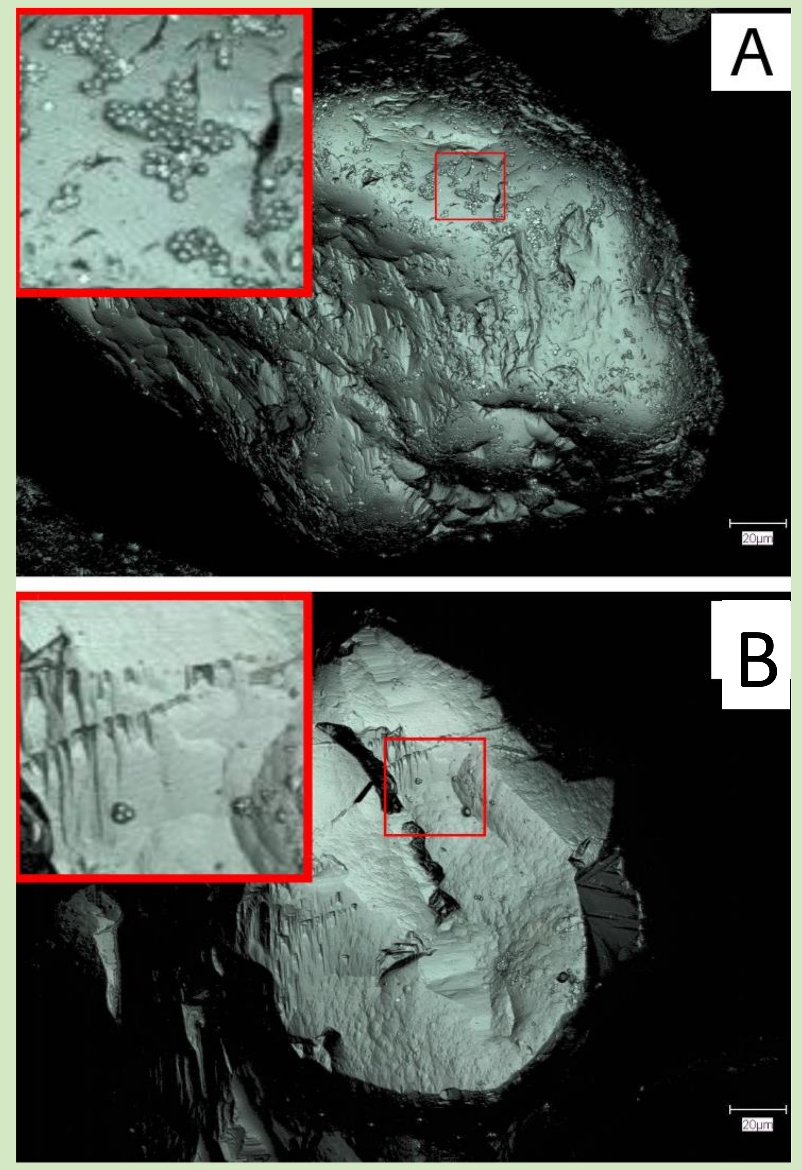


Fig. 1: Breakthrough curves of column experiments for aqueous colloid suspensions at different IS in absence (A) and presence (B) of DOM

Fig. 2: Laser scanning microscopic images of quartz grain samples after percolating (IS 2.5 mM) in absence (A) and presence (B) of DOM. Fig. 2.A shows a higher number of PSP clusters than Fig. 2.B.



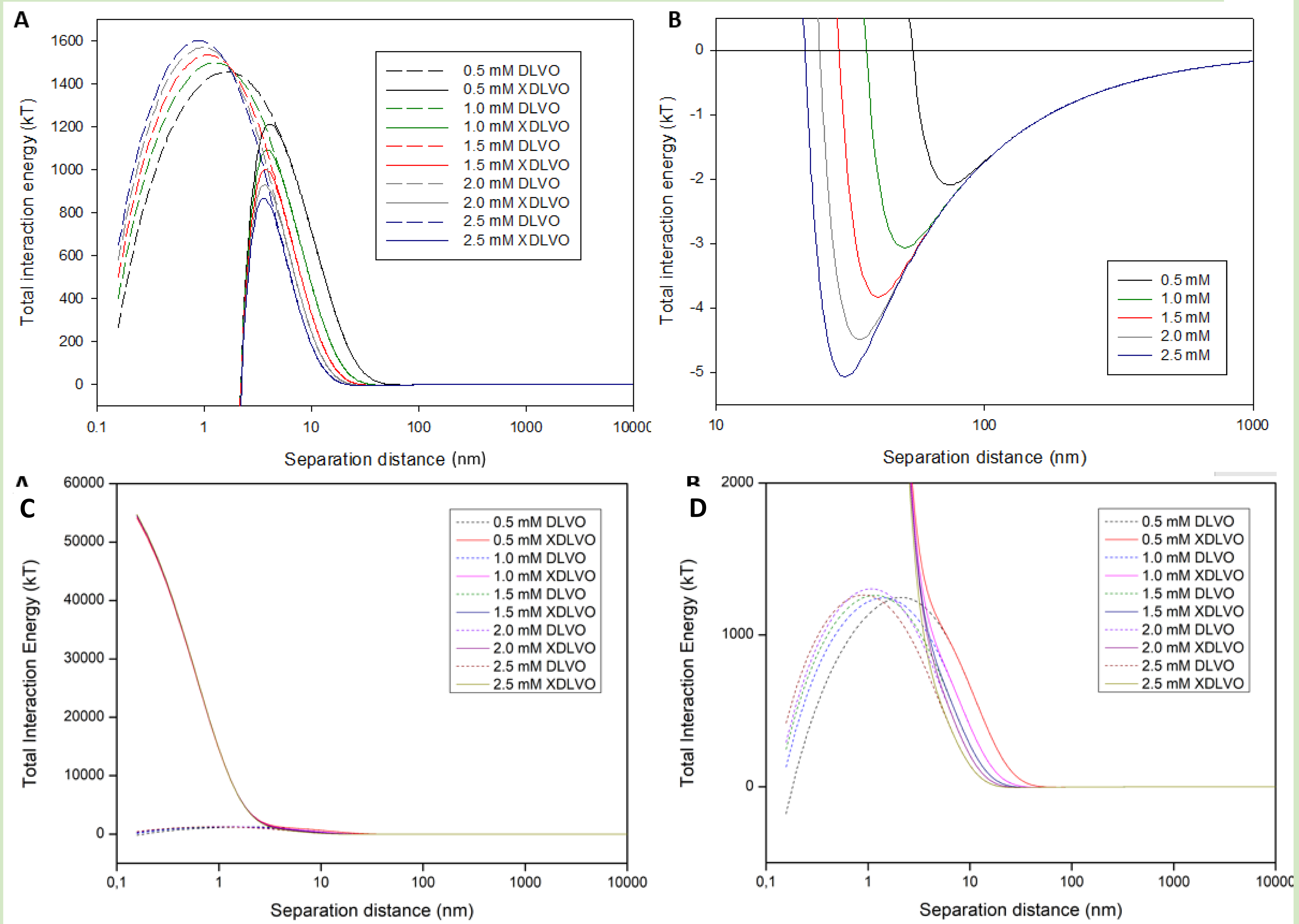
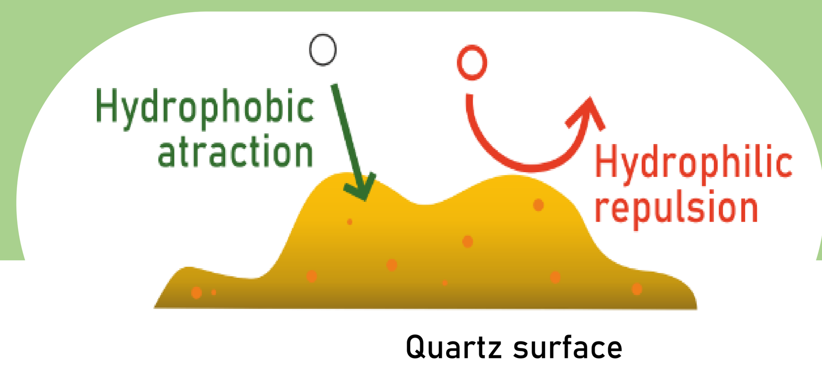


Fig. 3: Total interaction energy vs separation distance between microparticles and sand grains at different ionic strength of the colloidal suspension, as predicted by DLVO and XDLVO theories, in absence (A and B) and presence (C and D) of DOM.

While classic DLVO approach was not capable of predicting the strong increase in PSP mobility, the inclusion of Lewis acid-base forces in the XDLVO approach clearly enabled the accurate prediction of the effects of DOM. As seen in Fig. 3, XDLVO allowed to predict deep primary minima in absence of DOM due to strong hydrophobic attraction between PSP and quartz. On the contrary, the adsorption of DOM onto PSP increased wettability and generated short-range repulsive hydrophilic interactions, leading to the presence of energy barriers.



CONCLUSIONS

Presence of OM proved to be essential in decreasing retention and particle aggregation through modification of particle surface chemical properties. This could qualitatively be well predicted with the XDLVO theory, which proposed strong hydrophobic attraction between individual microplastic particles and between the particles and the quartz grains, and the increase in hydrophilic repulsion due to the adsorption of DOM onto PSP. Thus, DOM may play an important role in translocation of microplastics to deep soil levels and even groundwater.