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Investigation of dissolvable gases transport in vadose zone by using micromodel experiments

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Dissolved gases in soil pores play a crucial role in soil pollutant transport, subsurface carbon sequestration, and soil greenhouse gas emissions. The transport of dissolved gases interacts with trapped soil air. Trapped air in soil impedes the transport of dissolved gases in porous media. Meanwhile, the exchange of dissolved gases between liquid and gas phases alters bubble volume and surface area, thereby changing the exchange characteristics of dissolved gases and the migration of bubbles.

Although previous studies have explored the interactions between dissolved gases and trapped air bubbles, soil air not only exists as trapped bubbles but also includes free air connected to the atmosphere (e.g., in the vadose zone). Compared to the former, the latter exists under low water content. The transport behavior of dissolved gases differs between these two types of soil air. Furthermore, the behavior of dissolved gas transport under significant variations in water content remains one of the unresolved research challenges.

Through experiments using micromodels with simple and complex pore structures, we quantified the effects of free air on trapped bubbles. Simple pore experiments examined the influence of increasing the number of trapped bubbles on gas diffusion and how the size of trapped bubbles changes with injection rates. Experiments involving lotus root-like flow channels investigated bubble formation and size. Complex pore micromodels were used to explore the differences in bubble trapping and movement with and without dissolved gases.

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References

Primary authors: LEE, Yung-Wei (National Taiwan University Department of Bioenvironmental Systems Engineering); Mr ZHAN, Kai-Xiang (National Taiwan University Department of Bioenvironmental Systems Engineering); Mr HUANG, Qun-Zhan (National Taiwan University Department of Bioenvironmental Systems Engineering); Mr HSU, Shao-Yiu (National Taiwan University Department of Bioenvironmental Systems Engineering)

Presenter: LEE, Yung-Wei (National Taiwan University Department of Bioenvironmental Systems Engineering)

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