
Contribution ID: **440** Type: **Poster Presentation**

# Buoyancy-driven dissolution instability in a horizontal Hele-Shaw cell

*Wednesday, 15 May 2024 16:10 (1h 30m)*

The dissolution of minerals within rock fractures is fundamental to many geological processes. Previous research on fracture dissolution has highlighted the significant role of buoyancy-driven convection leading to dissolution instability. Yet, the pore-scale mechanisms underlying this instability are poorly understood, primarily due to the challenges in experimentally determining flow velocity and concentration fields. Here, we integrate pore-scale simulations with theoretical analysis to delve into the dissolution instability prompted by buoyancy-driven convection in a radial horizontal geometry. Initially, we develop a pore-scale modeling approach incorporating gravitational effects, subsequently validating it through experiments. We then employ pore-scale numerical simulations to elucidate the 3D intricacies of flow-dissolution dynamics. Our findings reveal that a simple criterion can delineate the condition for the onset of buoyancy-driven dissolution instability. If the characteristic length falls below a critical threshold, dissolution remains stable. Conversely, exceeding this threshold leads to two distinct regimes: the unstable regime of the confined domain affected by the initial aperture, and the unstable regime of the semi-infinite domain independent of the initial aperture where the instability is no longer influenced by the lower boundary. We demonstrate that the pore-scale mechanism for this instability is due to the concentration boundary layer attaining a gravitationally unstable critical thickness. Through theoretical analysis of this layer and the timescales of diffusion and advection, we establish a theoretical model to predict where the dissolution instability occurs. This model aligns closely with our numerical simulations and experimental data across diverse conditions. Our work improves the understanding of buoyancy-driven dissolution instability in radial horizontal geometry. It is also of practical significance in understanding cavity formation in karst hydrology and preventing leaks in geological $CO_2$ storage.

## Acceptance of the Terms & Conditions

Click here to agree

## Student Awards

## Country

中国

## Porous Media & Biology Focused Abstracts

## References

## Conference Proceedings

I am not interested in having my paper published in the proceedings

**Primary authors:** LI, Kai; HU, Ran (Wuhan University); CHEN, Yi-Feng (Wuhan University); YANG, Zhibing (Wuhan University); WANG, Ting

**Presenter:** LI, Kai

**Session Classification:** Poster

**Track Classification:** (MS03) Flow, transport and mechanics in fractured porous media