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Density instabilities due to evaporation from porous media

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We consider a porous medium in a semi-infinite domain, saturated with saline water. The top boundary is subject to evaporation of water but where the solute stays behind, while the bottom boundary has an inflow of water with the background solute concentration. This leads to an accumulation of solute near the top boundary. As the density of the water increases with larger solute concentration, this setup is gravitationally unstable. Hence, convective instabilities in the form of fingers can occur due to the arising density difference. However, these instabilities will only occur if the density difference is large enough to overcome the stabilizing effects from diffusion and viscous forces. In certain cases the solute could precipitate before instabilities manage to develop.

We address this instability problem by applying the well-known Boussinesq approximation and performing a linear stability analysis. Through solving the arising eigenvalue problem, we obtain criteria for when instabilities can develop. For given parameters as evaporation rate, permeability of the medium and initial solute concentrations, we can give criteria for when - or whether - instabilities develop. The criteria coming from the eigenvalue problem is compared with results from numerical simulations.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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