

The Department of
Mechanical Engineering
 PRESENTS

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 WCH Room 205/206
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Double-diffusive Sedimentation

Abstract:

When a layer of particle-laden fresh water is placed above clear, saline water, both double-diffusive and Rayleigh-Taylor instabilities may arise. We investigate the nonlinear dynamics of these processes by means of two- and three-dimensional direct numerical simulations.

The simulations show that the presence of particles with a Stokes settling velocity modifies the traditional double-diffusive fingering by creating an unstable 'nose region' in the horizontally averaged profiles, located between the upward moving salinity and the downward moving sediment interface. The ratio of nose height to salinity interface thickness initially grows and then plateaus, at a value that is determined by the balance between the flux of sediment into the nose region from above, the double-diffusive/Rayleigh-Taylor flux out of the nose region below, and the rate of sediment accumulation within the nose region. For small values of this ratio, double-diffusive fingering dominates, while for larger values the sediment and salinity interfaces become increasingly separated in space and the dominant instability mode becomes Rayleigh-Taylor-like. A scaling analysis based on the results of a parametric study indicates that the ratio is a linear function of a single dimensionless grouping. The simulation results furthermore indicate that double-diffusive and Rayleigh-Taylor instability mechanisms cause the effective settling velocity of the sediment to scale with the overall buoyancy velocity of the system, which can be orders of magnitude larger than the Stokes settling velocity.

Biosketch

1985	Ph.D., University of Karlsruhe, Germany.
1986-87	Postdoctoral Fellow, Stanford University.
1987-90	Assistant Professor, Brown University.
1990-2000	Associate Professor and Professor, USC.
2000-present	Professor, Mechanical Engineering, UCSB.

Awards and Honors

1990	Presidential Young Investigator Award.
2005	Humboldt Senior Research Award.
2005	Fellow of APS.
2008	Senior Gledden Fellowship, University of Western Australia.
2013	Fellow of ASME.

