

PHAST FOR ENVIRONMENTAL GEOSCIENCES

MSc Thesis Topics in Reactive Transport, Carbon Storage & Hydrogeology

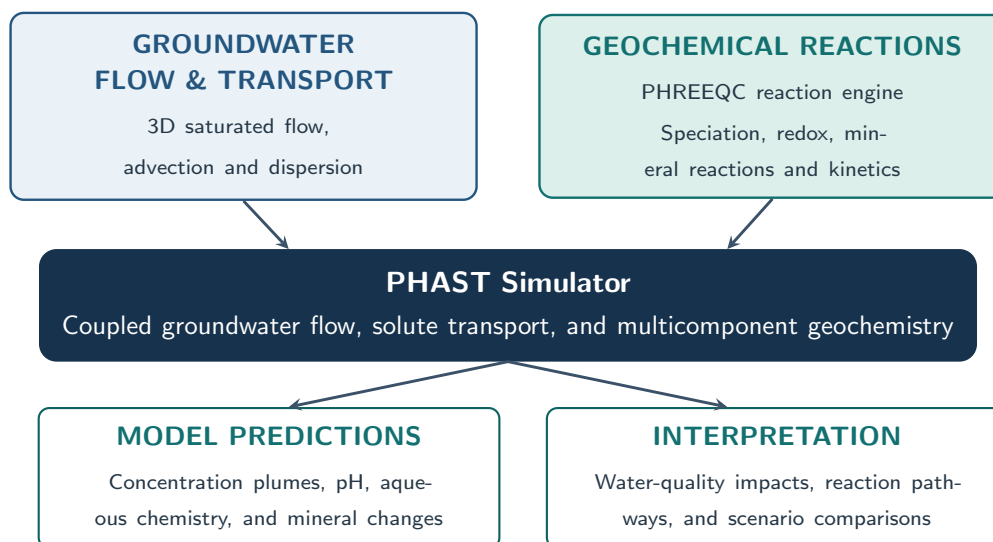
Groundwater Modelling • Carbon Mineralisation • Water-Rock Interactions

PHAST three-dimensional simulator developed by the U.S. Geological Survey (USGS) for saturated groundwater flow, solute transport, and multicomponent geochemical reactions. It couples an HST3D-based flow and transport model with the PHREEQC geochemical engine.

This research direction is suited to MSc students interested in hydrogeochemistry, reactive transport, hydrogeology, and environmental risk assessment.

Core Capabilities

- **Groundwater Flow & Transport:** Three-dimensional saturated flow, advection, and dispersion under steady or transient conditions.
- **Aqueous Geochemistry:** Speciation, redox reactions, ion exchange, and surface complexation.
- **Mineral Reactions:** Equilibrium and kinetic mineral dissolution and precipitation, including carbonate reactions and silicate weathering.
- **Environmental Applications:** Simulates changes in solute concentrations, pH, and mineral reactions to assess water-quality impacts.



Broad Research Suggestions

PHAST serves as an efficient and robust tool for specialized environmental and geoscientific research:

1. **Shallow Aquifer CO₂ Intrusion:** Modeling how dissolved carbon leakage lowers pH and mobilizes trace heavy metals from subsurface sediments.
2. **Enhanced Rock Weathering (ERW):** Quantifying alkalinity generation and carbon sequestration potential when silicate dusts interact with shallow groundwater flow.
3. **Water-Rock Interaction Feedbacks:** Assessing long-term mineral trapping, porosity evolution, and secondary precipitation boundaries along regional flow paths.
4. **Mine Waste Geochemistry & Remediation:** Examining water-rock interactions in sulfide tailings or reactive barriers, modeling acidity attenuation and pathways.

Getting Started & Supervision

PHAST examples cover contaminant decay and sorption, microbial reactions, ion exchange, and sewage plumes. Projects may involve model testing, reactive-transport simulations, or calibration against laboratory or field data.

Model scope: Single-phase, constant-density saturated groundwater flow; not free-phase CO₂ migration.

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