

Smart Reactive Barriers: Deep ... and deeper understanding of multiphase reactive porous media

by Xiaohui Chen

Wednesday 14 August, 10.00-11.00, Room 02.110, Faculty CEG

Abstract:

Fundamental and applied research of reactive, multiphase, multi-component porous media has attracted attention in recent decades due to many contemporary engineering applications (e.g. waste management, flooding barriers, carbon capture and storage, and shale gas). Many studies have been conducted based on existing theoretical frameworks from either geochemistry or geomechanics. However, (i) existing modelling tools fail to sufficiently consider the physical-chemical couplings, and (ii) the strong multiscale-couplings between water, temperature, reactive chemicals and deformation of the solid frame in a porous medium have made existing theoretical foundations inapplicable (e.g. Darcy's law, Fick's law and Fourier's law), presenting a significant hurdle to the understanding of the mechanism of multiple reactive phases in a porous medium. These have resulted in unnecessary high costs, unsuccessful predictions of failure or degradation of the Reactive Barriers (RB) in a complex environment (e.g. high temperature or multiple chemistry), and limitations to novel designs of Smart-Reactive Barriers (SRB) for radioactive waste disposal.

All these challenges are caused by the lack of a fundamental unified theoretical framework to adequately capture multiphase-multiscale couplings in porous media. Therefore, answering the scientific question "Can we have a unified theoretical framework for complex porous media" becomes the attention of research in reactive porous media.

This talk will focus on the newly developed Mixture-Coupling Theory, which is well-constrained theoretical framework for the coupled analysis of multiple phases and multiple components in geo-porous media. This talk will also introduce a reactive transport modelling package and a future plan for Artificial Intelligence at the Geo-Coupling Group at the University of Leeds.

Bio:

Dr Chen is an Associate Professor in Geotechnical Engineering at The University of Leeds, a Chartered Environmentalist in the UK, and the Academic Leader of the Geo-Coupling Group at the University of Leeds. Dr Chen obtained his PhD at The University of Manchester (2010). He is one of the pioneers in the research of Mixture-Coupling Theory.

Key References:

Chen X; Wang M; Hicks MA; Thomas HR (2018) A new matrix for multiphase couplings in a membrane porous medium. *International Journal for Numerical and Analytical Methods in Geomechanics*, 42 (10), pp. 1144-1153.
Chen, X., Pao, W., Thornton, S., & Small, J. (2016). Unsaturated hydro-mechanical-chemical constitutive coupled model based on mixture coupling theory: Hydration swelling and chemical osmosis. *International Journal of Engineering Science*, 104, 97-109.
Chen X; Thornton SF; Pao W (2018) Mathematical model of coupled dual chemical osmosis based on mixture-coupling theory. *International Journal of Engineering Science*, 129 , pp. 145-155.