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Dissolution Front Instabilities in Reacting Porous Media

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The main objective of this research is to gain a better understanding of the relation between regime of reaction and dissolution front instability, leading to formation of channels or wormholes. Potential applications are geological sequestration of CO_2 and acid-gas injection during enhanced oil recovery.
The microscopic pore space is modeled using a multi-directional pore network, allowing for a distribution of pore coordination number, together with distribution of pore sizes. In order to simulate transport of multi-component chemical species, mass balance equations are solved within each element of the network (i.e. pore body and pore throat). We have considered advective and diffusive transport processes within the pore spaces together with multi-component chemical reactions, including both equilibrium and kinetic reactions.
Using dimensionless scaling groups (such as Damköhler number and Péclet-Damköhler number) we characterized the dissolution front behavior, and by averaging over the network domain we calculated the evolution of porosity and permeability as well as flux-averaged concentration breakthrough curves. We obtain constitutive relations linking porosity and permeability, under conditions relevant to geological storage of CO_2. Effect of distribution of reactive minerals is also evaluated and regime of reaction is shown to play a key role.