Cement Paste Degradation in CO_2-Saturated Brine: Highlighting Some Crucial Mechanisms Using a Reactive Transport Model

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The long-term integrity of CO_2 storage in geological formations is assumed to be limited by the presence of leaky wellbores. This work aims at modeling wellbore cement carbonation. First, a single phase reactive transport model is developed. Then the code is used to highlight some crucial parameters for cement degradation. Concerning transport, the chemical activity coefficient gradient appears to be negligible compared to diffusion, electrical coupling and porosity change. Two thermodynamic models are used to describe the decalcification of calcium silicate hydrates (C-S-H): 1) only two types of C-S-H (jennite and tobermorite) or 2) a discontinuous equilibrium model, which describes the logK value of C-S-H as a function of Ca/Si ratio. Different cement degradation rates and mineral zoning are obtained according to the chosen model. Finally we show how optimizing the initial transport properties (diffusivity, porosity) of the cement paste may delay the propagation of the degradation fronts.