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Precipitation and dissolution of cement minerals in sandstone: Opportunities and limitations of pore and plug scale flow analysis for reactive transport modelling approaches

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Reservoir properties of sandstones are controlled by precipitation and dissolution reactions at the pore walls. Both, the formation and dissolution of cement minerals are responsible for the complex pattern formation of porosity and permeability in reservoir rocks.
At the scale of drilled core sections (plugs), experimental and analytical approaches utilize positron emission tomography (PET) with radiotracers (Kulenkampff et al. 2016). Resulting spatiotemporal concentration distributions provide quantitative insight into fluid flow and diffusion parameters. The sensitivity is in the picomolar range of the utilized radiotracers and the spatial resolution is about 1 mm. Thus, mechanistically-important surface features such as etch pits or growth hillocks and their evolution during reaction are not yet part of the direct analysis of the flow field.
Here, we present an approach based on existing information about the complex crystal surface morphology and rate evolution (Fischer& Luttge 2017). We utilize artificial materials that are produced by 3D printing capabilities. Such an approach using PET analysis of sequences of machined surfaces in flow-through experiments provides quantitative insight into the local stability vs. temporal heterogeneity of fluid flow close to reacting surfaces. The measured flow velocity data from PET are implemented into reactive transport models and compared to calculations focusing on small-scale surface reactivity. We discuss the resulting size and complexity of surface rate patterns.

References

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