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Reactive transport processes in porous rock sample: role of local heterogeneities.

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The percolation of acidic fluids through natural rocks (e.g. CO2 storage, Karst formation, geothermal formation) induces chemical reactions of dissolution and/or precipitation, which consequently alter the structural and hydrodynamic properties of the rock. These reactions are not uniformly distributed but instead become localized based on various local parameters, such as fluid velocity heterogeneities, chemical or mineralogical composition, and petrophysical properties. Understanding the influence of these local heterogeneities is crucial for predicting the evolution of rock properties in natural and engineered systems.
This study presents laboratory experiments involving the percolation of reactive fluids through rock samples. The primary objective is to elucidate the role of local heterogeneities in governing reaction rates, the type of reactions occurring, their spatial localization, and the resultant impacts on structural and hydrodynamic properties. The experiments are designed to simulate natural conditions, allowing for controlled variations in fluid flow rates, chemical composition, and rock mineralogy.
Key findings from these experiments reveal that local variations in fluid velocity significantly influence the distribution and intensity of dissolution and precipitation reactions. Zones of higher fluid velocity tend to exhibit more pronounced dissolution due to increased fluid-rock interaction time and reactant supply. Conversely, areas with slower fluid movement often show precipitation as a result of reactant saturation and limited transport away from the reaction sites. Chemical composition and mineralogical heterogeneity further modulate the reactions. Petrophysical properties, such as porosity and permeability, also play a critical role. High-porosity regions facilitate fluid flow and enhance reaction rates, whereas low-porosity areas impede fluid movement, reducing reaction rates. These variations result in differential alterations in rock properties, creating a heterogeneous structure that affects overall permeability and fluid flow patterns.
The results underscore the complexity of fluid-rock interactions in heterogeneous systems. They highlight the importance of considering local heterogeneities when predicting the behavior of natural and engineered systems subjected to reactive fluid percolation. The insights gained from these laboratory experiments contribute to a better understanding of geological processes such as diagenesis, reservoir stimulation, and carbon sequestration, where fluid-rock interactions are crucial.

Country

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References

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