Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29458

Understanding the diverse roles of clay coats in water-rock interactions in sandstones: Review and advancement

HUAN LI[1,2], QINHONG HU[3], STUART JONES[4], JON GLUYAS[4], ERIC ANSAH OWUSU[5], SAJU MENACHERRY[6], QIQI WANG[7] AND TAO YE[8]

[1]Yangtze University
[2]The University of Melbourne
[3]China University of Petroleum (East China)
[4]Durham University
[5]University of Queensland
[6]University of Adelaide
[7]The University of Texas at Austin
[8]Chengdu University of Technology

In the context of water-rock interactions, past studies have been mainly focusing on elaborating the influence of grain-coating clay minerals on inhibiting secondary quartz cements. However, clay coats may play diverse roles in affecting mineral dissolution and precipitation. In this study, we first reviewed the current understanding of clay coats and subsequently employed mathematical formulations and reactive transport modelling to advance our knowledge. Firstly, clay coats can reduce the accessible surface area of detrital grains being coated, which is controlled by the coat coverage, clay platelet thickness, and the width of gap between neighbouring clay platelets. A higher coat coverage does not necessarily result in a higher reduction in the accessible surface area of detrital grains. The maximum reduction extent is consistently smaller than coat coverage, and it is highly likely that the commonly observed grain-coating clays can scale down the accessible surface area of detrital grains by up to one order of magnitude. Secondly, the porous attribute of clay coats may significantly retard mass diffusion rate across the coating layer, which is controlled by the microporosity, tortuosity, and thickness of the coating layer. For example, the diffusion rate of silica across the coating layer may be decreased by up to four orders of magnitude compared to uncoated surface, given a maximum coat thickness of 30 μm. Thirdly, above two effects may together significantly decelerate the dissolution rate of detrital reactive grains, e.g., feldspar, and inhibit the precipitation of secondary quartz. Fourthly, in addition to the above two effects, the width of gap between neighbouring clay platelets and the solid barrier created by clay platelets themselves also contribute to the inhibition of secondary quartz. It is not correct to simply state that clay coats inhibit quartz cements through reducing the surface area of detrital quartz. Fifthly, clay coats can be significantly dissolved and therefore change water-rock interactions, while whether this phenomenon is ubiquitous remains largely underexplored. Throughout this study the multiple roles of clay coats in water-rock interactions in sandstones are emphasized. However, a fact is that there are still significant gaps towards a true understanding of clay coats.