

Precipitation of CaCO_3 in pressure solution experiments: the relative importance of damage and stress

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ABSTRACT

Pressure solution (PS) is a widespread phenomenon in the Earth's upper crust, which influences many important natural processes, including porosity evolution of sedimentary rocks and fault healing. PS is a creep process effecting porous rocks, involving microscale dissolution and precipitation reactions mediated by diffusion of solutes in the fluid phase. We present an experimental study in carbonates, aiming to advance basic understanding of the physical chemistry controlling PS. The experiments utilize a newly developed method which enables imaging the precipitation stage of PS with a confocal microscope, via a fluorescent marker that binds to precipitating carbonate. We use this method to study the relative role of the various driving forces and the dominant mechanisms controlling the amount and spatial distribution of precipitation in carbonates undergoing PS.

Using a clamping apparatus we performed dozens of experiments in which carbonate samples were indented by quartz grains in the presence of water. Carbonate precipitation was observed to occur relatively fast (hours), within and around all indented pits, irrespective of the imposed experimental conditions such as stress and fluid saturation, yet the amount and distribution of the precipitation varies between experiments. Two major factors were found to control the amount of precipitation: degree of damage inflicted by pitting and the application of stress. Fluid saturation was seen to affect the spatial distribution of precipitates. In light of these results, we reexamine the traditional chemical potential equations of PS in order to explain the comparable effects of damage and stress on precipitation.