

Repulsion between calcite crystals causes grain detachment during fluid-rock interaction

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The interaction of carbonate rocks with meteoric water is usually thought to be dominated by chemical dissolution. However, recent studies have shown that tiny calcite grains can become physically detached from rock surfaces and mobilized in the fluid phase. Whether this detachment is due to shear forces acting at the rock surface, or repulsive forces acting between grains, was not known. We used atomic force microscopy to examine the mechanism of grain detachment, and we show that it occurs even in the absence of shearing fluid flow. This result suggests that the removal of particles from rock surfaces is due to repulsive forces between calcite grains. Although these repulsive forces are expected to be sensitive to the ionic strength of the solution, we found no clear relationship between salinity and the frequency of grain detachment events. Importantly, our findings indicate that grain detachment should occur during fluid-rock interaction under low flow conditions in a range of salinities, and this could impact processes as diverse as limestone weathering and pollutant transport.