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## Influence of pore fluid chemistry on the state of stress in sedimentary basins

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Pressure solution is an important mechanism of porosity reduction in sediments undergoing gravitational or tectonic compaction. Porosity reduction is achieved by redistribution of material from grain contacts into the adjacent pore spaces. This process is driven by a gradient in chemical potential that arises from the difference in normal stress acting on different parts of the grain surface. The magnitude of this gradient, and hence the rate of pressure solution, is reduced if the pore fluid is overpressured, or if the fluid is oversaturated with respect to the dissolving mineral. The overall rate depends also on the kinetics of dissolution, diffusion, and precipitation.

We consider the case of a 1D column of sandstone undergoing gravitational compaction by pressure solution. The column forms part of a larger body of sandstone that is constrained laterally, i.e. it is undergoing uniaxial strain, with no horizontal movement of solid or fluid. The horizontal stress at a given depth must balance exactly any driving force for lateral expansion of the column. It can be shown that this driving force is equal to the fluid pressure, plus an extra term dependent on the concentration of solute in the pore fluid. Consequently, there is a relationship between pore fluid saturation and stress in sediments undergoing pressure solution.

A numerical model is used to simulate the evolution of porosity, fluid pressure, and stress due to pressure solution in a vertical, 1-D column of quartz sandstone. The model predicts a smooth decrease in porosity with depth, until a minimum porosity (<1%) is reached. At this point the pore fluid becomes overpressured and inhibits further compaction. The concentration of dissolved silica in this overpressured region is close to the equilibrium value, implying a balance between addition of solute by

grain contact dissolution, and removal of solute by precipitation on the free faces of grains. The horizontal stress in this region is equal to the fluid pressure, which is approximately lithostatic. Above the overpressured region, the concentration of solute, and hence the horizontal stress, depends on the precipitation rate. If precipitation is fast relative to grain contact dissolution, the solute concentration stays close to equilibrium and the horizontal stress is equal to the fluid pressure. Conversely, if precipitation is slow relative to grain contact dissolution, e.g. due to grain coatings, the pore fluid becomes oversaturated and the horizontal stress is increased.

We conclude that pore fluid saturation can have a significant impact on the stress state within sedimentary basins, and that the feedback between stress and chemistry should not be ignored. We have focused on the evolution of pore fluid composition due to pressure solution with varying rates of dissolution and precipitation, but any process that influences pore fluid chemistry could impact on the stress state within sedimentary basins.