

Hydraulic fracturing and the creation of hydraulic breccias

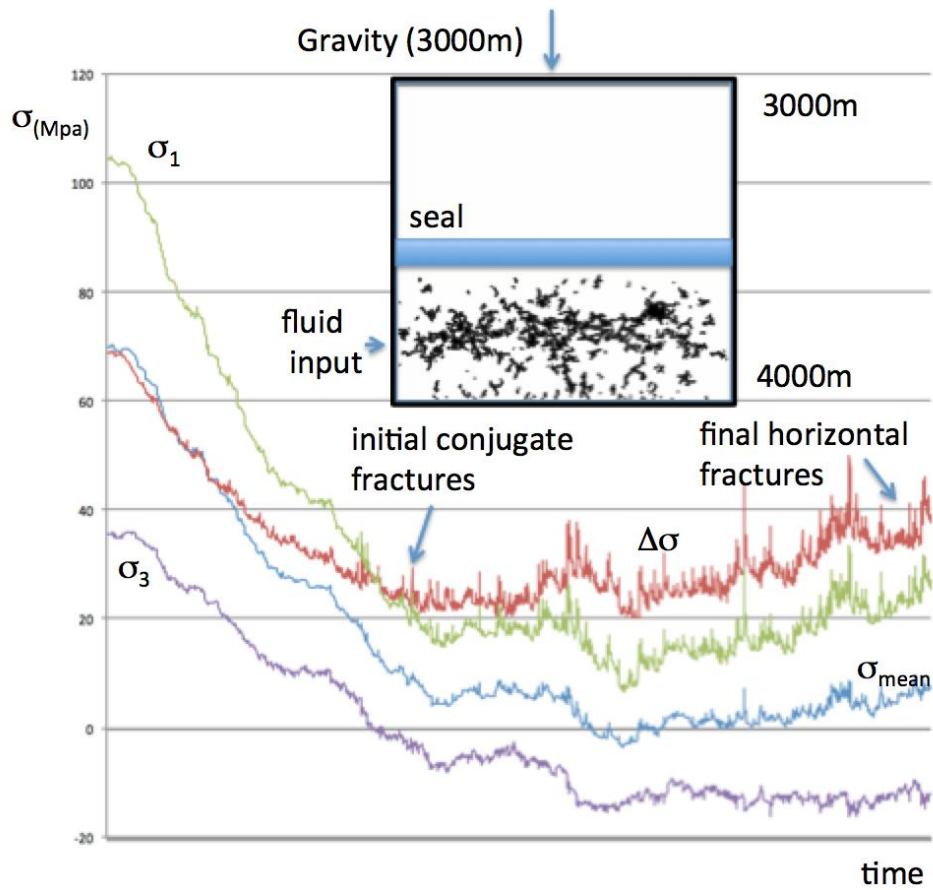
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ABSTRACT

Vein systems that indicate paleofracture geometries can be found in variable settings including typical layer perpendicular and layer parallel veins. Some natural examples show layer parallel and perpendicular veins that appear to form synchronously. Thin-section observations of these systems indicates that the veins formed at the same time. Layer parallel veins can form as a function of seepage forces that develop due to fluid pressure gradients in an over-pressurized system. In order to understand the interaction of fluid pressure, effective solid stress and fracturing we use a hydrodynamic numerical model. The solid in the numerical model is represented by elements connected with linear elastic springs with normal and shear forces and the fluid is represented by fluid pressure that evolves throughout the model as a function of time, permeability and boundary conditions. Fluid pressure gradients can exert forces on the solid network and the solid network defines the permeability and porosity for the fluid.

Overpressures in geological systems can produce anisotropic effective stresses that lead to a decrease of differential stress as well as the development of seepage forces and a switch in the orientation of the least principal stress. In a sedimentary basin resulting fractures can vary in direction, from an initial vertical to sub-vertical orientation to horizontal fractures. The resulting network shows either a switch between bedding perpendicular and bedding parallel fractures/veins or represents a hydraulic breccia with no distinct direction of fracturing.



Effective stress evolution (average of stress below blue seal) and final fracture pattern in the numerical model. Graph shows evolution of stress through time. Fractures are shown in black in the inset.