

How good is the glue? An integrated investigation of the mechanical properties of rocks undergoing crack-seal processes, using field, experimental and numerical methods.

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An exhumed high-pressure cell in outcrops of Cretaceous carbonates on the southern flank of Jabal Shams in the Oman Mountains shows a complex and rapidly changing mechanical structure during the evolution of multiple generations of fault and fracture sets. Deformation in a high fluid-pressure cell led to the formation of multiple fracture and vein generations. This was followed by bedding parallel shear under lithostatic fluid pressure conditions at a minimum temperature of 134-191°C deduced from primary and pseudosecondary fluid inclusions in quartz. The high pressure cell was drained along dilatant normal faults that were also repeatedly cemented and reactivated in strike-slip. Calcite cement (partly) healed faults and fractures both mechanically and hydraulically before the next sets were formed. Cementation produced mechanically strong veins so that new fractures were localized along the vein/rock interface or within the matrix itself. The rapidly changing mechanical anisotropy in combination with a chemically reactive system form a complex feedback system in which the mechanical strength, strain and the permeability undergo major changes in this coupled thermal, hydraulic, and mechanical (THM) system. Simple conceptual models relating the mechanical strength of the vein and the morphology of the resulting vein network were tested in a series of experiments where pressed blocks of Al₂O₃ powder were fired to strengths equivalent to soft to very strong rocks. The blocks were broken in three-point bending, healed with a brittle cement of intermediate strength, broken again and healed with a cement of the same mechanical properties but different colour. Results show systematic changes and the development of syntaxial or antitaxial vein sets with different degrees of localization, dependig on the relative strengths of the host rock, vein cement and adhesive contact. They compare well with numerical simulations using Discrete Element Techniques (see contribution by Virgo et al., this conference).

Reference:

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