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Creep of Posidonia and Bowland shale at elevated pressures and temperatures

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The fracture-healing rate of artificial cracks generated by hydraulic fracturing is of major interest in the E&P industry since it is important for the long-time productivity of a well. To estimate the stress-induced healing rate of unconventional reservoir rocks, we performed deformation tests on Bowland shale rocks (UK) and on Posidonia shales (Germany). Samples of 1cm diameter and 2cm length were drilled perpendicular to the bedding and deformed in a high pressure, high temperature deformation apparatus. Constant strain rate tests at $5*10^{-4}*s^{-1}$, 50 MPa confining pressure and 100˚C temperature reveal a mainly brittle behaviour with predominantly elastic deformation before failure and high strength of low porosity (∼2%), quartz-rich (∼42 vol%) Bowland shale. In contrast, the low porosity (∼3%), carbonate- (∼43 vol%) and clay-rich (∼33 vol%) Posidonia shale deforms semi-brittle with pronounced inelastic deformation and low peak strength. These results suggest a good fracability of the Bowland formation compared to the Posidonia shale. Constant load (creep) experiments performed on Bowland shale at 100˚C temperature and 75 MPa pressure show mainly transient (primary) deformation with increasing strain rate at increasing axial stress. The strain rate increases also with increasing temperature, measured in the range of 75 – 150˚C at fixed stress and confinement. In contrast, increasing confining pressure (from 30 to 115 MPa) at given temperature and stress results in decreasing strain rate. In contrast, Posidonia shale rocks are much more sensitive to changes in stress, temperature and pressure than Bowland shale. Empirical relations between strain and stress that account for the influence of pressure and temperature on creep properties of Posidonia and Bowland shale rocks can be used to estimate the fracture healing rate of these shales under reservoir conditions.