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Creep behavior of Bowland and Posidonia shale at In Situ pc, T - conditions

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We conducted constant stress deformation experiments at elevated confining pressures, pc = 50 – 115 MPa, and temperatures, T = 75 – 150 °C, on Posidonia (GER) and Bowland (UK) shale to unravel their long – term creep properties at simulated reservoir conditions, also with respect to petrophysical and mechanical properties. Depending on applied pc – T conditions and sample composition, recorded creep curves exhibit either only a primary (decelerating) or additionally a secondary (quasi steady state) and subsequently a tertiary (accelerating) creep phase during deformation. Creep strain is enhanced and a transition from primary towards secondary and tertiary creep behavior is observable at high temperature and axial differential stress and low confining pressure. Posidonia shale, which is rich in weak constituents (clay, mica, organic content), creeps faster when compared to either carbonate – or quartz – rich Bowland shale. Electron microscopy performed on polished thin sections was conducted to observe microstructural features, revealing that the primary creep strain is mainly accommodated by deformation of weak minerals and local pore space reduction. In addition, micro crack growth occurred during secondary creep. We used an empirical correlation between creep strain and time based on a power law to describe the decelerating creep phase, also accounting for the influence of confining pressure, temperature and axial differential stress. The results suggest that the primary creep strain can be correlated with mechanical properties determined from short – term constant strain rate experiments such as static Young's modulus, triaxial compressive strength or brittleness.