What controls the mechanical properties of shale rocks? – Part I: Strength and Young's modulus

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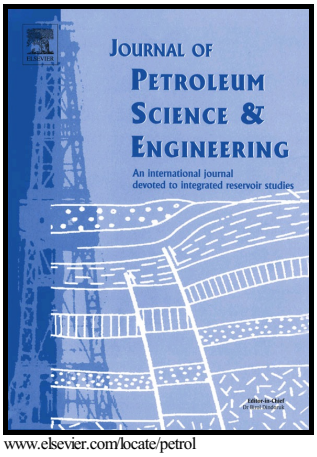

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Abstract

We performed mechanical tests on several, mainly European black shales with different mineralogical composition, porosity and maturity. The uniaxial and triaxial compressive strength, tensile strength and static Young's modulus were measured at varying confining pressures, temperatures and strain rates. Mechanical properties such as compressive strength and elastic moduli strongly depend on shale composition, porosity and water content, as well as pressure (P) and temperature (T) conditions, but less on strain rate. The shales are orthotropic as strength and elastic properties vary with bedding orientation to the loading direction. We found a transition from brittle to semibrittle deformation at high P-T conditions, in particular for high porosity shales. In the predominantly brittle regime up to about 100 MPa pressure, the compressive strength increases non-linearly with increasing pressure and correlates almost linearly with Young's modulus. The internal friction coefficients vary substantially between $\approx$0.2 and 1.1 for the investigated shales. The effect of strain rate and