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Experimental mechanical compaction and elastic properties of smectite, kaolinite and their mixtures - relevance to seismic interpretation and basin modelling

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The properties of clays and mudstones in sedimentary basins vary greatly as a function of clay mineral composition and grain size distribution. Experimental compaction in the laboratory provides a basis for predicting the changes in porosity (density) and velocity due to mechanical compaction. These are critical parameters for basin modelling and seismic interpretation. Mixtures of smectite and kaolinite were compacted by applying vertical effective stresses up to 50 MPa under proper drained conditions. At 20 MPa effective stress pure wet kaolinite compacted to 20% porosity while smectitic clays maintained 40% porosity at the same stress level. This corresponds to about 2 Km burial at normal pore pressure. Dry mixtures of clay minerals were much less compressible than wet samples showing the effect of fluid mineral interaction. The increments of acoustic velocities are much higher for dry specimen than the wet specimens over the studied pressure range. The acoustic velocity increases nonlinearly with increasing stress whereas the elastic moduli increase almost linearly with increasing effective stress. The bulk moduli of the smectite aggregates are appreciably higher than those of kaolinite. The shear modulus is relatively small for all clay mixtures at low stresses, but at high stresses kaolinite rich clays has significantly higher shear strength than smectitic clays, probably as a result of the large and angular kaolinite grains. The different clays also showed a significant difference in Poisson's ratio, particularly at lower stresses. The results of this study have impact on the well log interpretation of shales, and the determination of shale properties from seismic data at relatively shallow depth ($<$2 Km, 80°C) prior to significant chemical compaction. If the compositions of mudstones in sedimentary basins are known the velocity can be used to infer fluid pressure (overpressure). The experimental data on mudstone com-

paction showed that the porosity (density) varies greatly with depth depending on the clay mineral composition and this should be taken into account in basin modelling.