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I-S precipitation in pore space as the cause of geopressuring in Mesozoic mudstones, Egersund Basin, Norwegian continental shelf

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ABSTRACT

The role of clay diagenesis in pressure-ramp (overpressure) development is evaluated from Mesozoic mudstone well cuttings in the Egersund Basin, Norwegian Continental Shelf. Major changes in the mineral assemblage over the range of increasing geopressure include ~50% decrease in detrital kaolinite in bulk material, and increases in the proportions of illite, I-S, and percent of nonexpandable illite-like layers in I-S. SEM and TEM observations confirm that pore space is defined primarily by intersecting clay-mineral packets at the scale of tens or hundreds of nanometers (0.01–0.1 μm). TEM data document the reactions of kaolinite and detrital mica to form I-S. The principal reaction that occurred over the geopressure ramp was dissolution of kaolinite and precipitation of neoformed I-S in pore space of these mudstones. These changes also correspond to changes in <0.1 μm particle populations, as determined by Pt/C shadowed TEM measurements, as well as high-resolution TEM lattice-fringe observations. The neoformed I-S has dimensions similar to those of the pore space in the mudstones. The results support a mineralogical model of precipitation of diagenetic clay, resulting in severe permeability reduction, which can be related to the observed pressure ramp. These observations and results provide an integrated petrologic framework for modeling pressure-ramp development, which had been difficult to achieve using conventional basin models of porosity and permeability evolution based on mechanical compaction.