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A compaction front in North Sea chalk

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North Sea chalk from 18 wells shows a pronounced porosity drop, from ∼20% to less than 10% over a compaction front of less than 300 m. The position of the compaction frontis independent of stratigraphic position, temperature, and actual depth, but closely tied to an effective stress of ∼17 MPa. These observations require a strongly nonlinear rheology with a marked increase in compaction rate at a specific effective stress. Grain [U+2010] scale observations demonstrate that the compaction front coincides with marked grain coarsening and recrystallization of fossils and fossil fragments. We propose that this nonlinear rheology is caused by stress [U+2010] driven failure of the larger pores and the associated generation of reactive surface area by subcritical crack propagation away from these pores. Before the onset of this instability, compaction by pressure solution is slowed down by the inhibitory effect of organic compounds associated with the fossils. Although the compaction mechanism is mainly by pressure solution, the rheological response to burial may still be dominantly plastic and controlled by the (fracturing controlled) rate of exposure of reactive surface area. The nonlinear compaction of chalk has significant implications for the evolution of petroleum systems in the central North Sea, both with respect to sea [U+2010] floor subsidence above hydrocarbon–producing chalk reservoirs and for the formation of low [U+2010] porosity pressure seals within the chalk.