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Rheological stratification in Zechstein rock salt caused by thermodynamically controlled reorganization of grain boundary fluids? A test using gravitationally induced sinking of anhydrite-dolomite stringers.

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The rheology of rock salt during slow deformation in nature is controlled by the dominant deformation mechanism. Newtonian viscous rheology is associated with solution precipitation processes, while power law rheology is associated with dislocation creep. In large strain deformation during salt tectonics these two processes both contribute equally to the total strain rate, and grain boundaries contain mobile brine films. It has been shown that after the end of active salt tectonics, these fluid films neck down into arrays of disconnected brine inclusions, rendering the grain boundaries immobile and thus stopping solution-precipitation creep. This results in very low gravitational sinking rates of isolated anhydrite-dolomite stringers in Zechstein salt in the Tertiary, consistent with power law creep, while in Newtonian salt the stringers would sink to the bottom in geologically short time. In a recent paper Ghanbarzadeh et al., (Science, Nov 2015) provided evidence that below approximately 2 km depth the thermodynamically controlled dihedral angle between solid-liquid and solid-solid grain boundaries decreases to below 60 degrees, so that a connected grain boundary triple junction network of fluid channels is formed and permeability of the salt increases. The same process can be argued to lead to permanently mobile grain boundaries below this critical depth, activating solution-precipitation creep even in the absence of active tectonics. We test this hypothesis by comparing estimated gravitationally induced sinking rates of isolated anhydrite-dolomite stringers in the Zechstein of NE-Netherlands, based on 3D sesmic data, at depths above and below this proposed transition. First results suggest that there is no significant change in stringer sinking rate with depth.