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Temperature cycling and its effect on stress-strain relationships in a high porosity chalk

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Calcite has a highly anisotropic thermal expansion coefficient, and repeated heating and cooling due to water injection during oil production may destabilise and potentially cause a permanent deformation to a chalk reservoir. In this project, we preform hydrostatic pressure cycles, and compare the amount of irreversible deformation accumulated for cores exposed to temperature cycling to those without. Mechanical testing is performed on two chalks of different burial history from Kansas (USA) and Mons (Belgium) so the role of induration and contact cement can be assessed. A series of samples of the two chalks that are tested were saturated by either equilibrium calcitic water or with Isopar-H oil to analyse how the different chalk types responds to the different pore fluid composition. Isopar-H and equilibrium water are used to minimize the chemical reactions that could occur in these systems, and to focus on rock-fluid interactions related to adsorption on mineral surfaces instead.

Results show that the temperature cycling between each stress cycle for Kansas chalk, which has a higher induration and degree of contact cement than Mons chalk, has significantly more irreversible strain accumulated for each stress cycle regardless of the pore fluid in comparison to Mons. In addition, the Kansas cores exposed to temperature cycling accumulated almost double the irreversible deformation than cores tested at the constant temperatures. The effect of temperature cycling was not as pronounced for Mons samples. Therefore, we interpret that the importance of the temperature cycles in between each stress cycle is more evident for chalk types in which the overall stiffness and strength is more dictated by contact cement rather than only electrostatics between calcite grains.