Artificially induced clay mineral authigenesis in an underground gas storage field, North Alpine Foreland Basin, Austria

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Secondary processes within reservoir sandstones during and after hydrocarbon production are poorly understood. This study focusses on the effect of secondary water fill on a sandstone reservoir within a time span of eight years. The reservoir rocks consist of medium grained litharenites with large clasts of shales and carbonates. They originate from a depleted gas reservoir which has been converted into an underground storage field for natural gas. Gas production caused a rise of the gas-water-contact of about 30 m. Based on their initial and final gas and water saturations, four zones can be identified.

Observed diagenetic changes in all four zones include carbonate cementation, K-feldspar overgrowths, authigenic quartz overgrowths, pyrite formation, and poorly crystallized authigenic clay minerals. However, the authigenic clay mineral fraction differs significantly within the zones. Total clay mineral content and crystallinities of smectite, chlorite, kaolinite and illite increase from the gas-bearing to the initial water zone. Additionally, expandable clay minerals and kaolinite were not identified in the gas-bearing zone. This is different in the secondary watered zones, where smectites and kaolinite are developing. The study shows that within a maximum of eight years from the initial flux of water into the gas zone new clay minerals are forming.

The reduction of porosity and permeability caused by this anthropogenically induced process might continue and can also be of relevance within other producing reservoirs, where water saturation increases during production.

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