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Microstructures in naturally deformed Upper Rotliegend salt rocks from Northern Germany

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Permian and Meso-/Cenozoic salt formations are represented in wide parts of the German geologic underground (Reinhold & Hammer 2016). They are of interest for cavern storage of oil and gas as well as of renewable energies (in form of compressed air or hydrogen). For industrial exploration purposes, more detailed data about the composition, barrier properties, as well as the genesis and deformation of the rocks is needed.

In central Northern Germany, salt rocks from the Upper Rotliegend are implemented in diapir structures together with salt formations from the Zechstein. Rotliegend salt rocks are characterized by halite that contains patches of detrital material which account for 5 to 60 vol.% of the rock. They show a characteristic red to purple color. Drill cores containing Rotliegend halite rocks from different locations were investigated in this study by using petrographical and microstructural methods.

The halite shows different fabric types: (i) euhedral to hypidiomorphic grains with grain sizes up to several millimeters, (ii) polygonal grains with smaller grain sizes between 0.1 and 3 mm, and (iii) fibrous halite. Halite grain boundaries are decorated with fluid inclusions, especially around the contact to detrital material. Subgrains in halite are abundant in all investigated samples and show average sizes between 140 μm and 217 μm. These correspond to average differential stresses of 1 MPa to 1.45 MPa (Carter et al. 1993, Schléder & Urai 2005).

The detrital material consists of clasts of quartz, feldspar, mica, carbonates and metal oxides with grain sizes of clay to silt fraction. In some samples, the detrital components show internal deformation by folding and fracturing. Depending on the location, different quantities of authigenic evaporite minerals, like carbonate and anhydrite, formed. Fractures are filled with halite, anhydrite and celestine.

The different types of halite fabric are an indication of locally different deformational behavior of the rocks, which depends mainly on the amount and type of detrital material. The observed subgrain formation points to intracrystalline dislocation creep as a deformation mechanism, which has occurred in different types of halite fabric. However, the high amount of fluid inclusions around material boundaries also point to an interaction of the different material components, which locally might have enhanced fluid based grain boundary migration during deformation. It is still to be investigated, how the overall rheological behavior of Rotliegend halite is influenced by the detrital components.

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