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Deformation in layered Zechstein-III K-Mg salts with high mechanical contrasts. Core analysis revealing strain concentrations and the development of fracturing and folding into a tectonic mélange.

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In fully developed evaporite cycles, effective viscosity contrasts of up to five orders of magnitude are possible between different layers, but the structures and mechanics in evaporites with such extreme mechanical stratification are not well understood. During the late stage of an evaporation cycle potassium and magnesium (K-Mg) salts are precipitated. These K-Mg salts are of economic interest but also a known drilling hazard due to their very low viscosity. A better understanding of salt tectonics with extreme mechanical stratification is needed for better exploration and production of potassium-magnesium salts and to predict the internal structure of potential nuclear waste repositories in salt
We analyzed a unique carnallite (KMgCl3*6H20) - and bischofite (MgCl2*6H20) - rich drill core from the Zechstein III-1b subunit in the Veendam Pillow in the Netherlands, which has a complex tectonic history with multiple phases of extension and compression as shown by seismic reflection data. Salt withdrawal followed by convergent flow into the salt pillow produced ruptures and folds in the underlying ZIII- Anhydrite-Carbonate Stringer and formed the outer shape of the soft ZIII-1b layer.
The slabbed core was analyzed by macroscale photography, bulk chemical methods, XRD and optical microscopy. Results show high strain in the weaker bischofite- and carnallite- rich layers, with associated dynamic recrystallization at very low differential stress, completely overprinting the original texture. Stronger layers formed by alternating beds of halite and carnallite show complex recumbent folding on different scales commonly interrupted by sub-horizontal shear zones with brittle deformation, veins and boudinage. We attribute this tectonic fragmentation to be associated with a softening of the complete ZIII-1b subunit during its deformation. The result is a tectonic mélange with cm - to 10m size blocks with internal folds and boudinage. We infer that these structures and processes are common in deformed, rheologically strongly stratified evaporites.