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Microstructural and crystallographic features and deformation characteristics of the halite fabric type 'Kristallbrocken' from the German Zechstein Basin

Y. Küster (1), B. Leiss (2) and M. Schramm (1)

(1) Federal Institute for Geosciences and Natural Resources (BGR), Stilleweg 2, 30655 Hannover, Germany, (2) Geoscience Centre of the University of Göttingen, Goldschmidtstr. 3, 37077 Göttingen, Germany (y.kuester@bgr.de)

Profound knowledge about the rheological behaviour and the deformation mechanisms of halite during salt-migration is crucial for understanding the development of salt diapirs and predicting the evolution of rock salt deposits that are used as host rock for hydrocarbon storage caverns or intended as host rock for the disposal of radioactive waste. In Northern and Eastern Germany, the rock salt of the Stassfurt formation occurs both in flat-lying settings as well as in diapiric structures, and is thus well suited for investigating the various deformation mechanisms active during salt migration.

This study focuses on a certain halite fabric type in the Stassfurt formation rock salts, the so-called Kristallbrocken that are characterized by an internal lamination consisting of different amounts of sulphate inclusions [1]. This cm- to dm-sized, laminated halite is surrounded by a finer-grained (mm to cm), recrystallised halite matrix consisting of clear, inclusion-poor, partly elongated halite crystals with worm-like fluid or gaseous inclusions at their grain boundaries. The most distinguishing characteristic of the Kristallbrocken is that they show a set of unusual microstructural features suggesting the occurrence of processes during salt migration that are different from those generally expected in salt. For example, some Kristallbrocken are fractured, with the relics having been dragged apart, rotated away from each other, or stacked; others are weakly bent or even folded. Besides, all Kristallbrocken show no grain boundaries macroscopically. Therefore, the questions arise whether they are extremely fine-grained polycrystalline or monocrystalline aggregates, as well as which deformation mechanisms can explain the observed microstructures.

On samples taken from the Stassfurt formation rock salt of the Teutschenthal salt pillow, the local textures of the Kristallbrocken were investigated by electron backscatter diffraction (EBSD) and by conventional X-ray texture goniometry with recently developed new features like a beam size up to 7 mm and the measuring of large sample areas in scanning mode.

The texture analyses of the unbent Kristallbrocken reveal that they are single crystals. This monocrystallinity explains the generally brittle behaviour of the Kristallbrocken and the observed strong competence contrast between the Kristallbrocken and the finer-grained halite matrix. Probably, the rigidity of this halite fabric type is further enhanced by the sulphate inclusions of the internal lamination. The local texture analyses of the folded Kristallbrocken clearly display that their crystal lattice is bent. As the Kristallbrocken-related microstructures show evidence for both brittle and ductile behaviour next to each other, this may be explained by different strain rates, a dependency of the deformation mechanisms on the orientation of the Kristallbrocken in respect to the stress field or the inclusion density, or a combination thereof.

These results clearly show that the Kristallbrocken not only control the anisotropic physical properties but also the rheological properties of the Stassfurt formation rock salt.

Reference

[1] Küster, Y., Schramm, M., Leiss, B., 2007. Different types of solid inclusions as indicators for the formation of laminated halite beds of Late Permian rock salt sequences. Geophysical Research Abstracts, this conference volume, Vienna.