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Deformation mechanisms and their microstructural indicators in the compaction of crushed salt as a geotechnical barrier

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Deformation mechanisms in the compaction of crushed salt as geotechnical barrier

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Introduction

Crushed salt is considered as the most suitable backfill material in the disposal of radioactive waste within salt formations [1]. Its rheology is controlled by the allocation of different deformation mechanisms, which, in turn, are controlled foremost by moisture, temperature and deformation state as well as deformation rate [2, 3, 4].

Therefore, we investigated the microstructure of three crushed salt samples that differ in moisture content (0.1 – 0.3 Wt.-%), increasing degree of compaction (loose material, 16 and 6 % remaining porosity), and compaction rate (ranging from 10^{-7} to 10^{-10}).

Indicators for deformation mechanisms

Cataclasis

Loose crushed salt | *Compacted to ~16 % porosity* | *Compacted to ~6 % porosity*

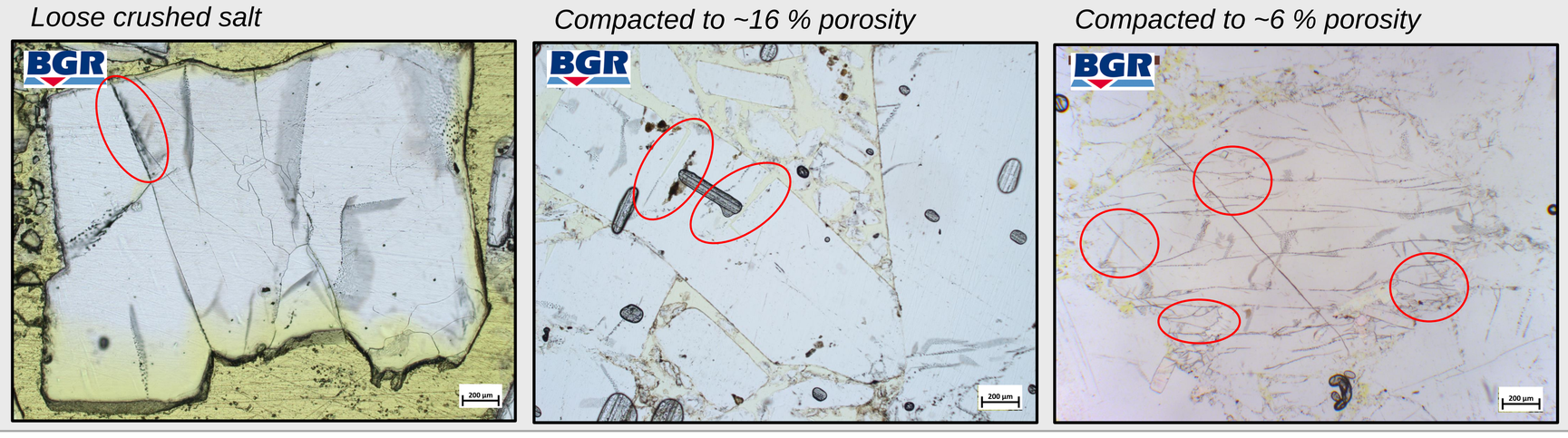

Fig. 1: Lesser abundance of microcracks in loose crushed salt than in compacted crushed salt.

Dislocation creep

Loose crushed salt | *Compacted to ~16 % porosity* | *Compacted to ~6 % porosity*

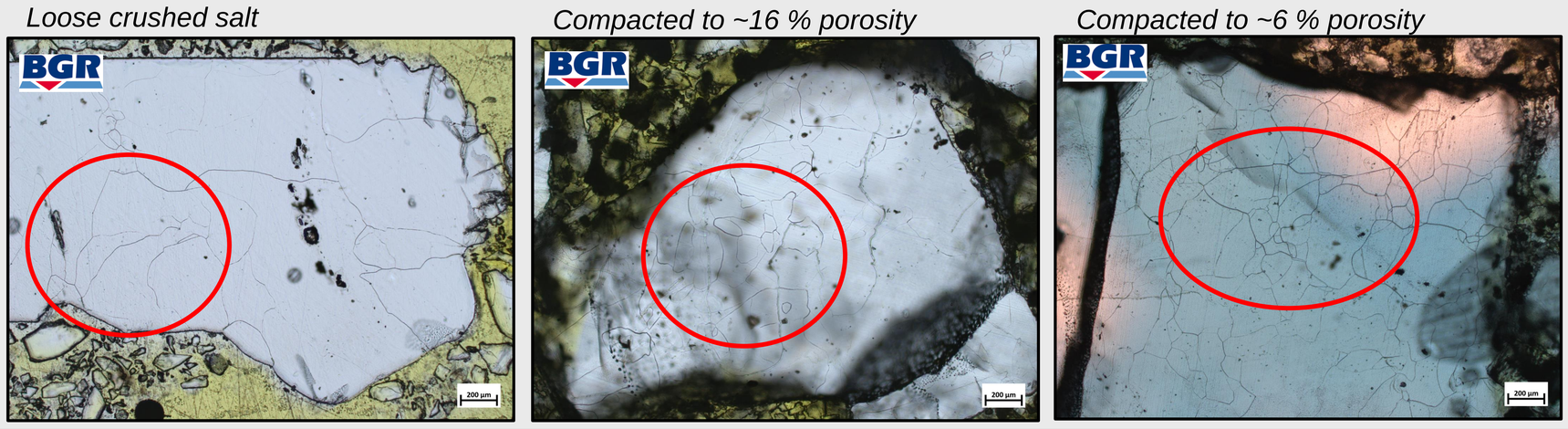

Fig. 2: Number of subgrains (visible as fine lined substructures within solid salt grains) increased, while size decreased with higher compaction.

Solution-precipitation creep

Loose crushed salt | *Compacted to ~16 % porosity* | *Compacted to ~6 % porosity*

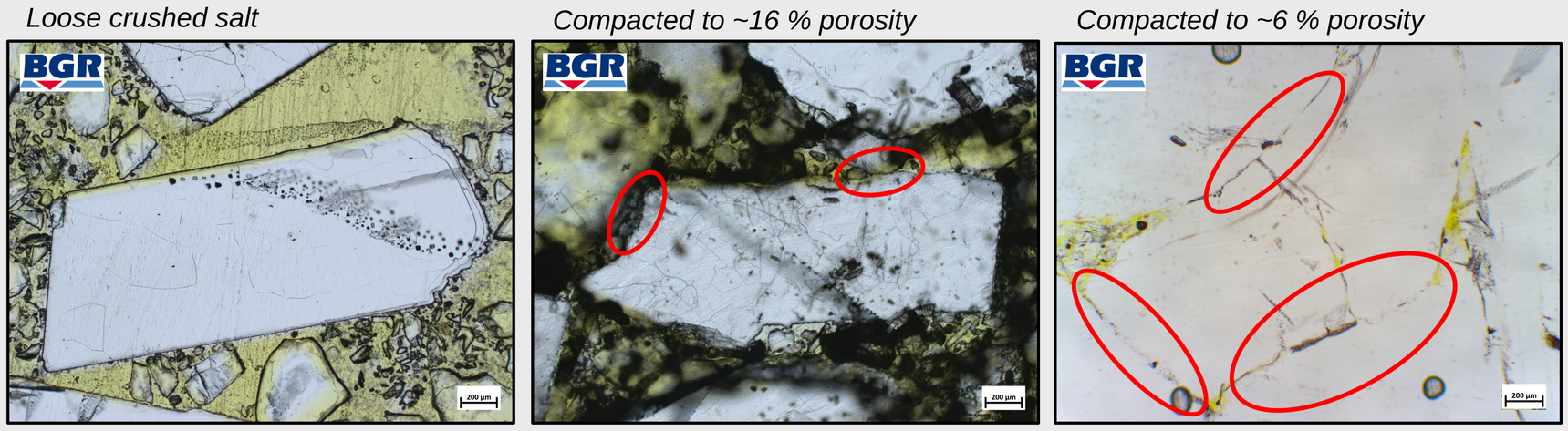

Fig. 3: With increasing degree of compaction, the contact area of grains and the number of rounded grain boundaries increases. This increase is an indicator for pressure solution-precipitation creep.

Preliminary results

We rank the microstructural deformation indicators (Fig. 1 – 3) subjectively for their quantity and preliminary conclude:

- All known deformation mechanisms are active at laboratory scale.
- For highly compacted samples, we report more rounded grain boundaries and more subgrains. This indicates visco-plastic deformation by pressure solution-precipitation creep and dislocation creep.
- From looking at the microstructures alone, it was not possible to distinguish the samples original moisture state (0.1 and 0.3 wt.%).

Outlook:

- Quantitative determination of deformation mechanisms with regard to different environmental settings.
- Comparison of laboratory and in-situ compacted crushed salt.

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