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Salt Reconsolidation Principles and Application

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Verantwortung für Generationen / Responsibility for Generations DBETEC DBE TECHNOLOGY GmbH

PTKA Project Management Agency Karlsruhe Karlsruhe Institute of Technology

U.S. DEPARTMENT OF ENERGY NNSA National Nuclear Security Administration

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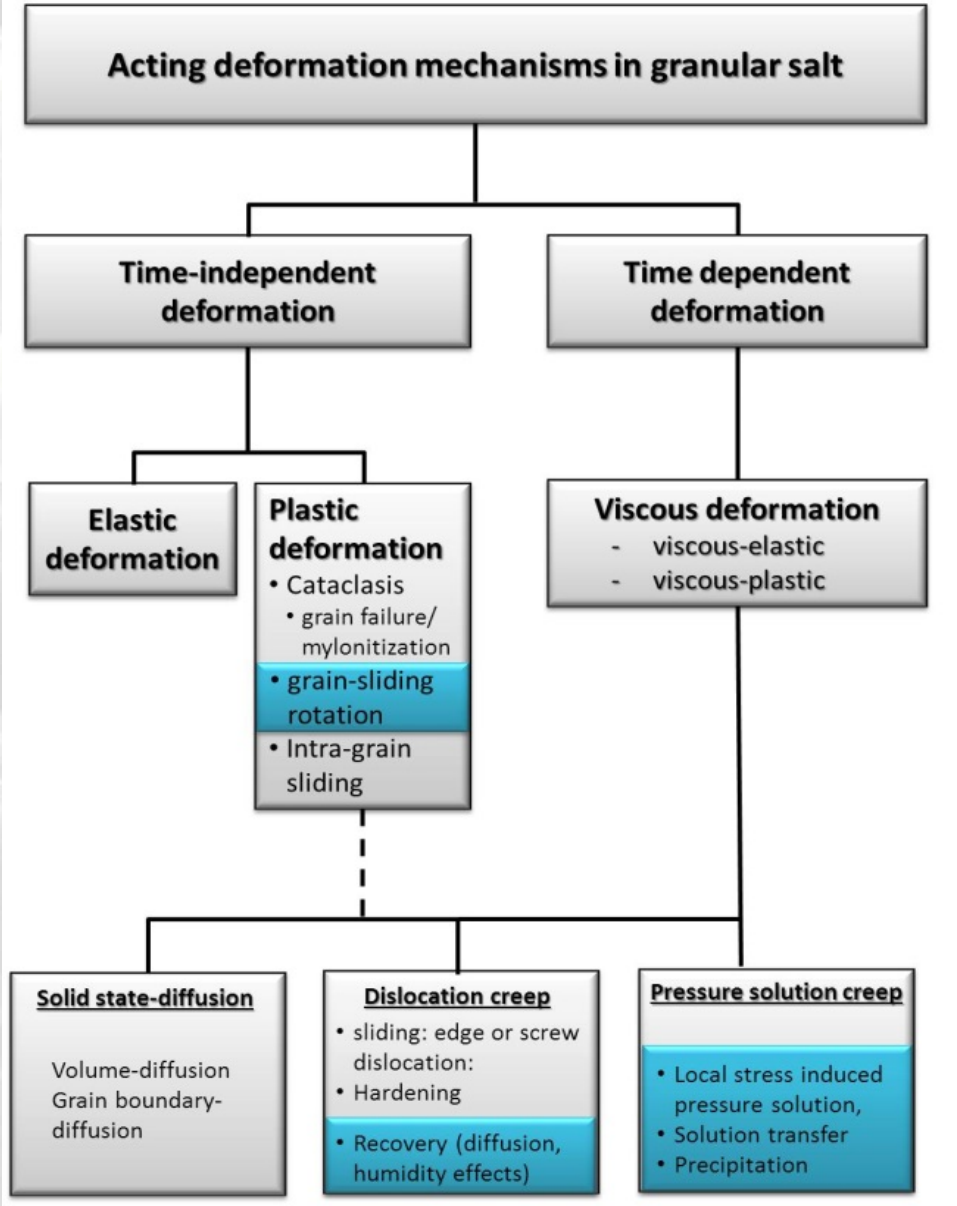
Presentation Content

- Background
- Micromechanics--hydro-mechanical interactions
- Experimental salt reconsolidation mechanics
- Transport properties of compacted crushed salt
- Natural analogues--Field-scale observations--Applications
- Perceptions--Future work

Background—Role of Reconsolidated Salt

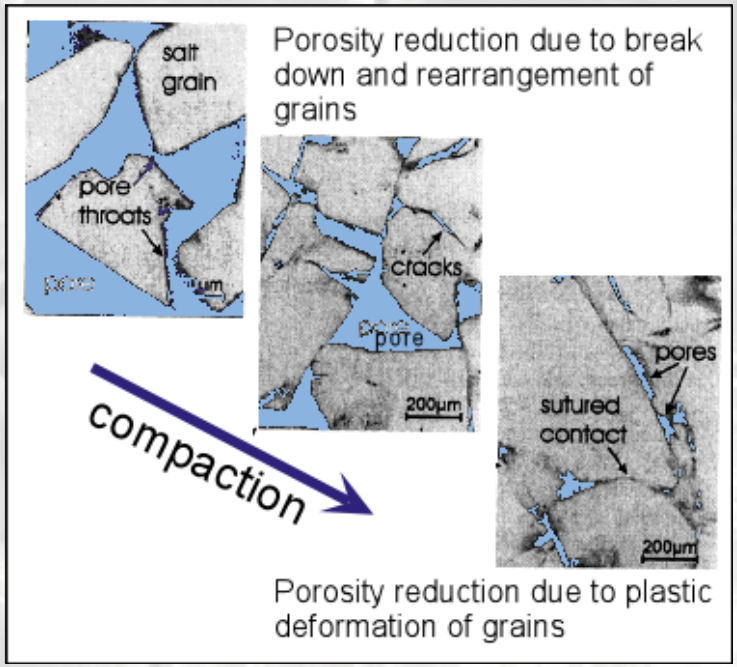
- Act as a long-term barrier against inflowing brine or water and eliminate release pathways via drifts and shafts
- Conduct heat generated by radioactive decay from the waste to the host rock
- Stabilize repository excavations
- Provide low permeability and/or diffusivity and/or long-term retardation
- Key questions involve how, when, and to what degree properties of reconsolidating granular salt approach or attain those of the native salt formation

Micromechanics

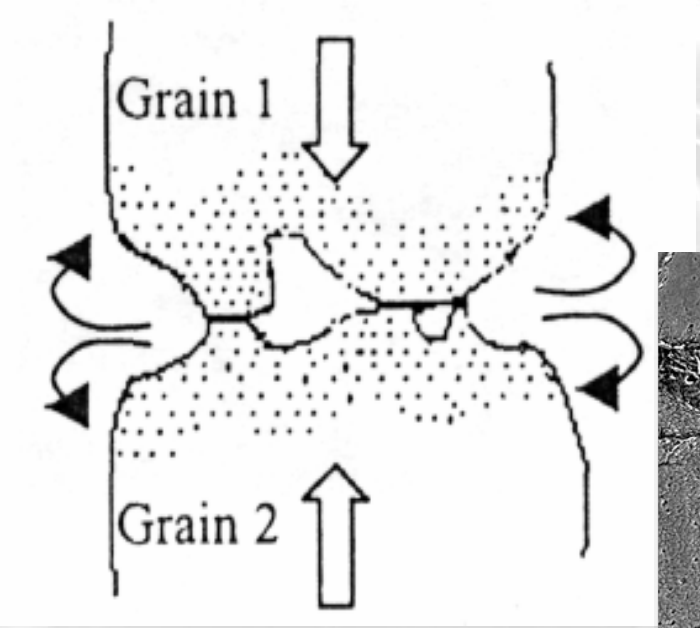


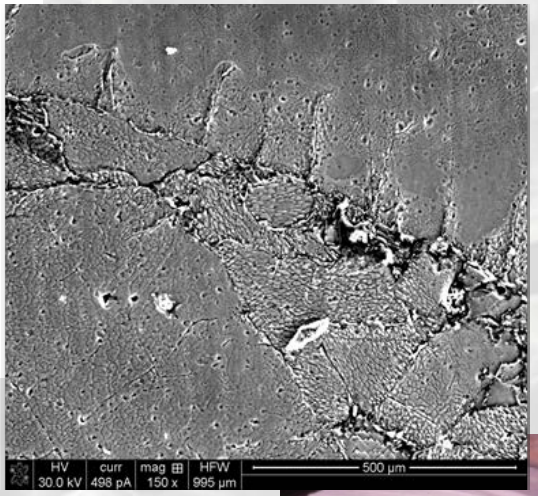
Note/Source: (modified after Elliger, 2004)

Granular Salt Forensics



Plasticity-Coupled Pressure Mechanism



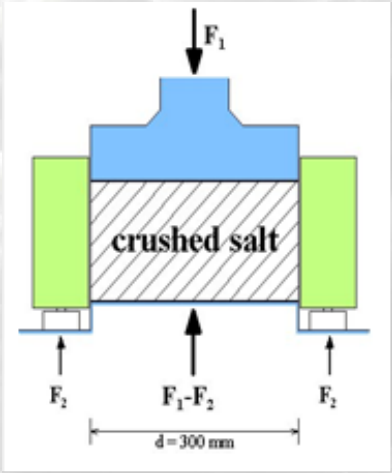
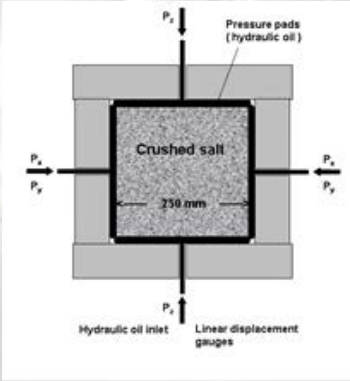
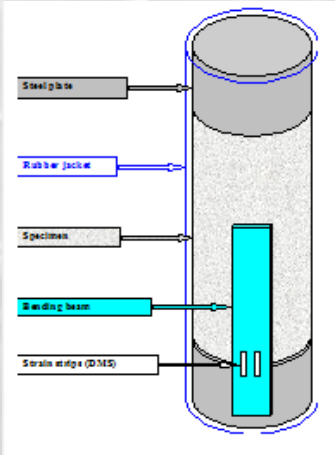
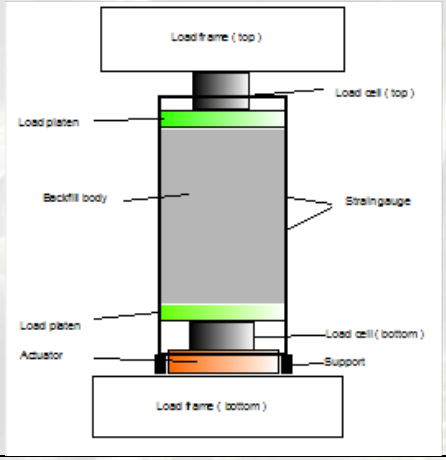


SEM Micrograph

Consolidation Around Test Heater

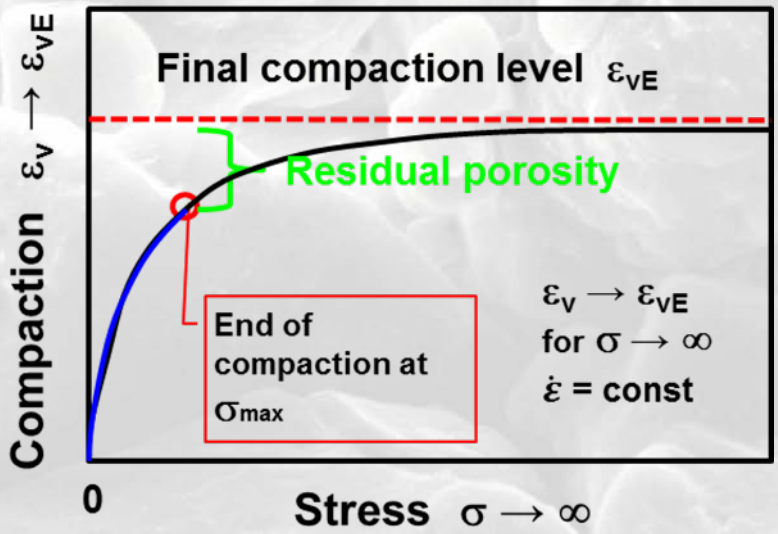
After Spiers and Brzesowsky 1993

Experimental Reconsolidation Set-Ups

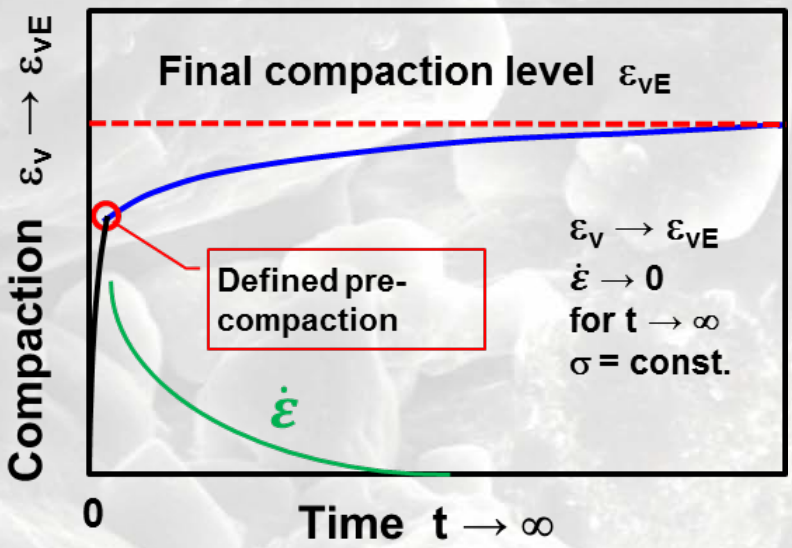
			
Oedometer cell (BGR) $\sigma_1 = (F_1 – F_2)/A$	True triaxial testing device (FZK-INE)	Triaxial cell (GRS)	Backfill compaction cell (IfG)

After Bechthold et al. 2004)

Compaction – Experimental Procedures

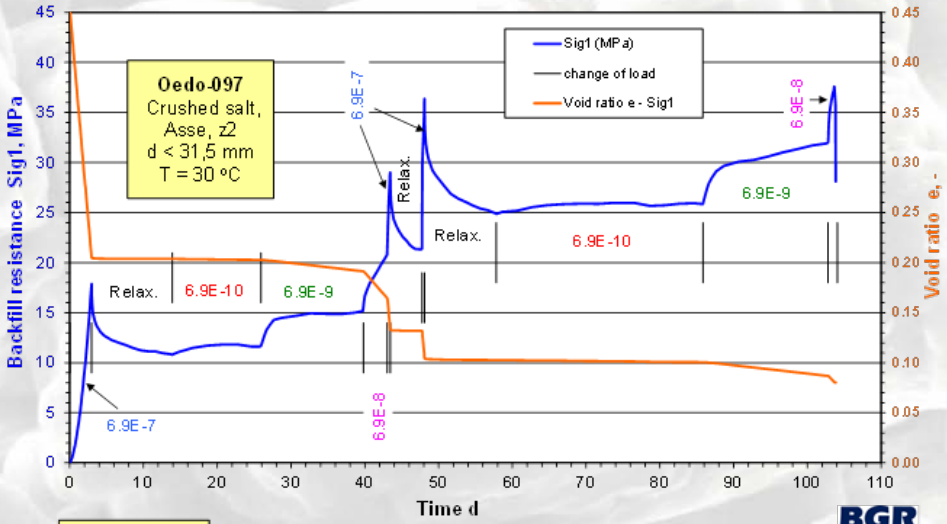


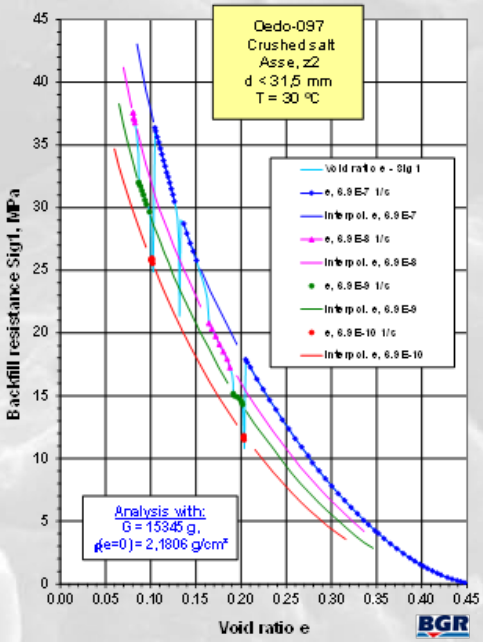
Type I Constant strain rate

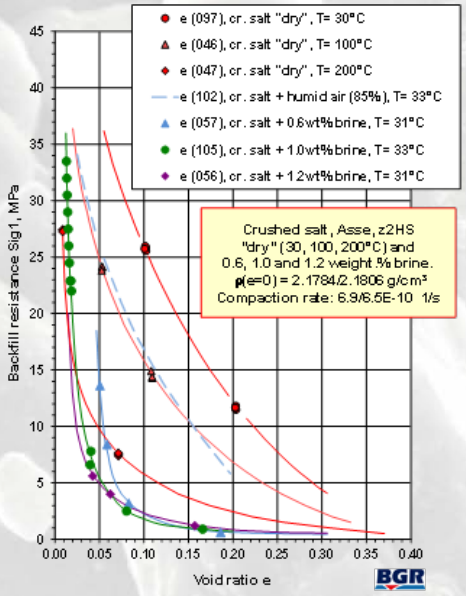


Type II Constant load creep

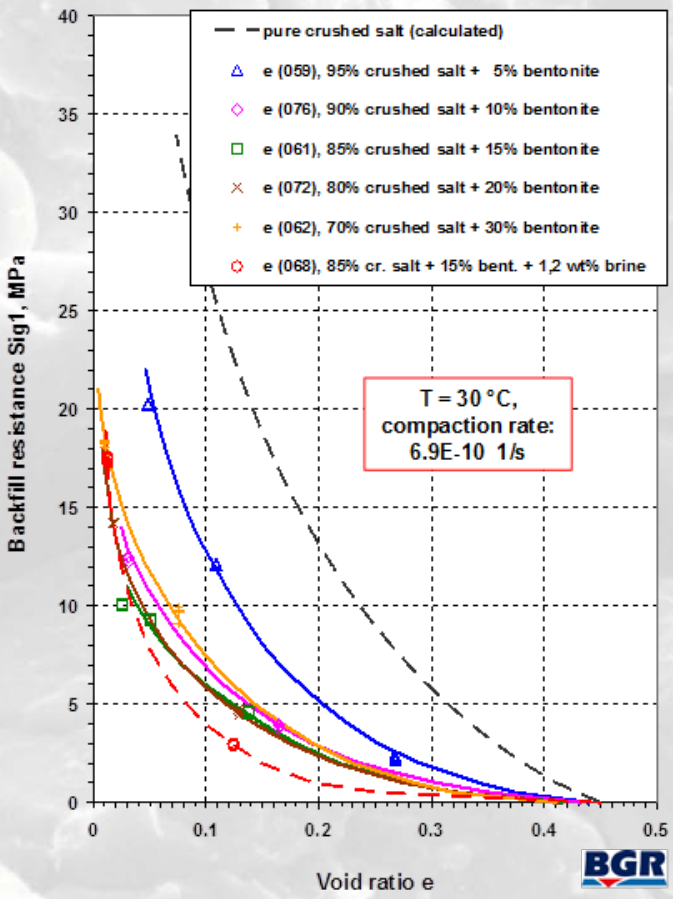
Consolidation under Oedometer Test Conditions

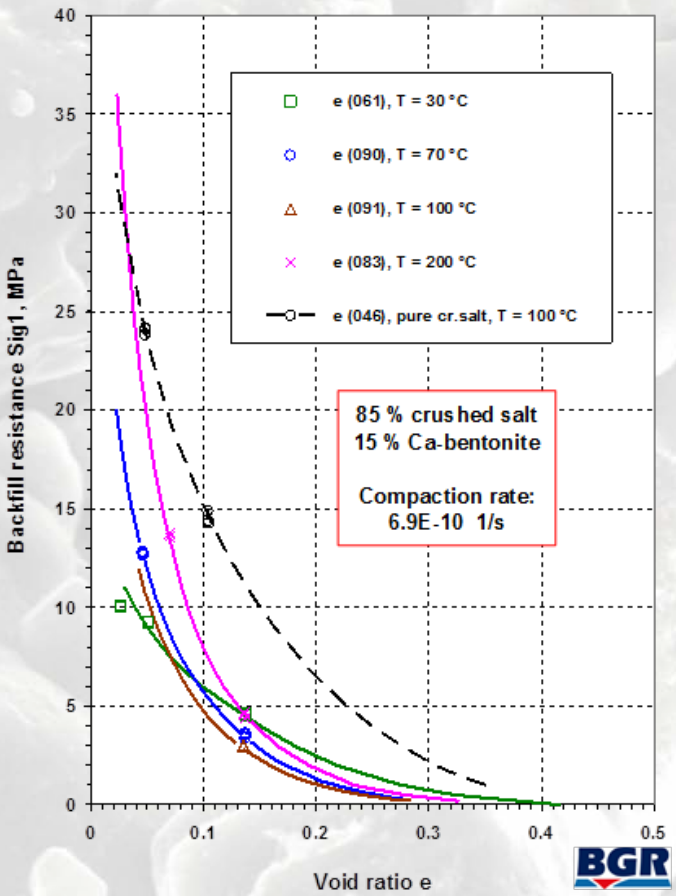




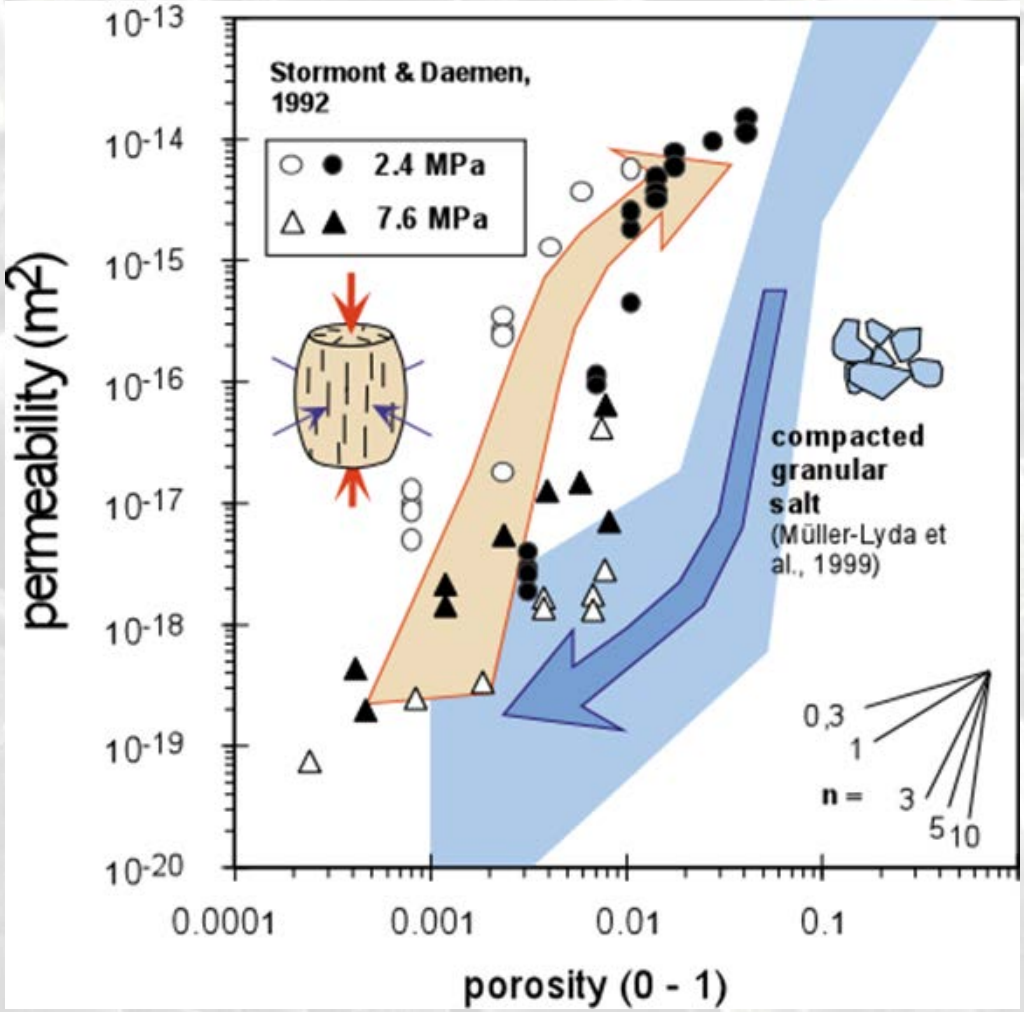


Impact of Additives on the Compaction Behavior

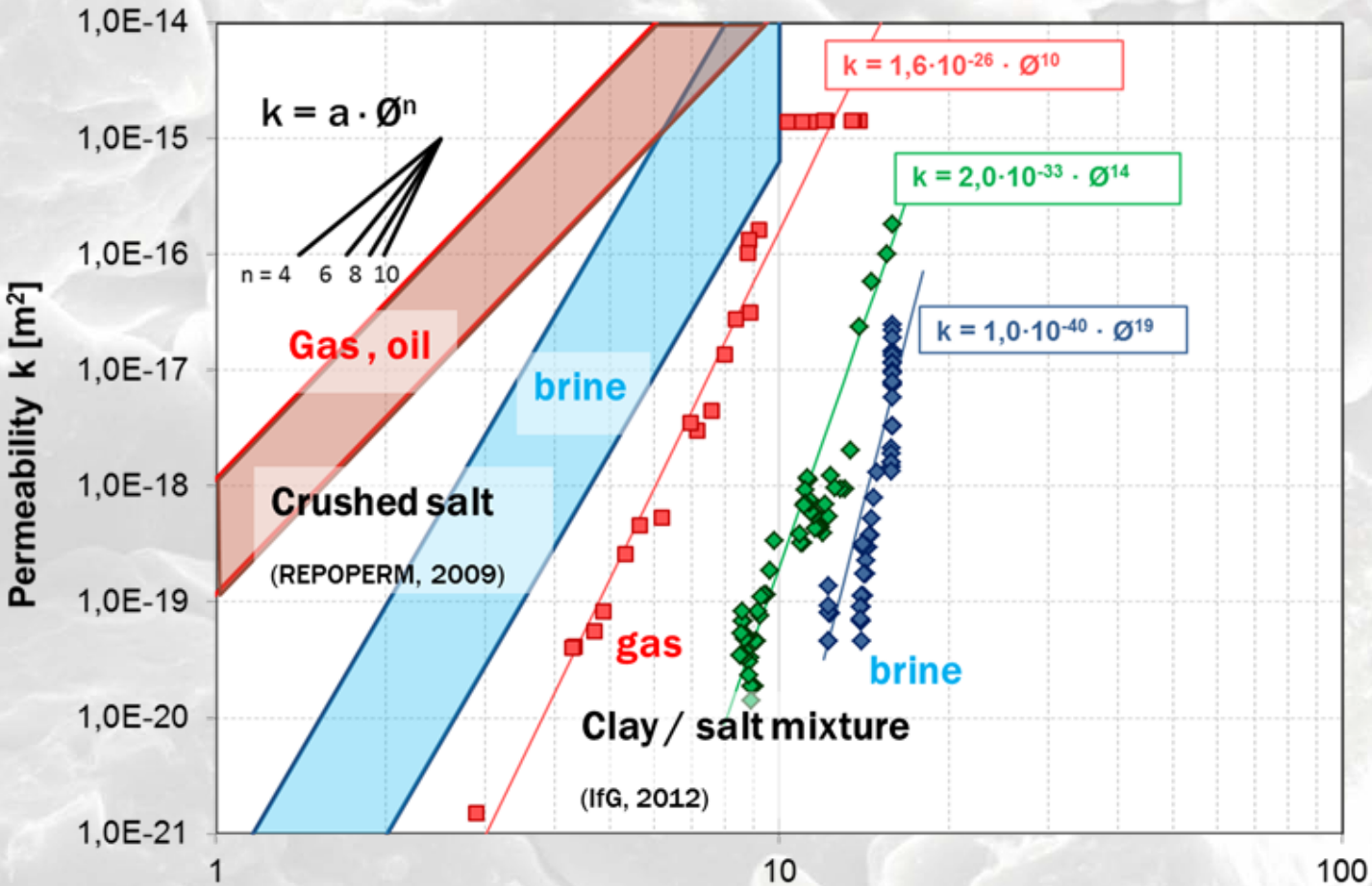




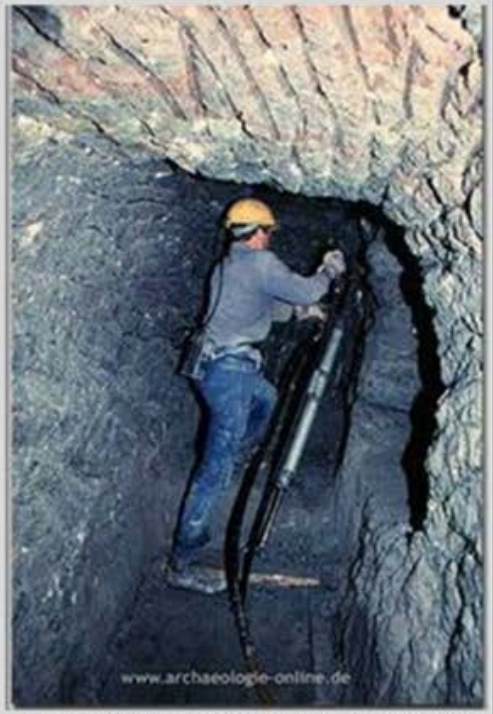
Permeability-Porosity Relations of Dilating Rock Salt and Reconsolidating Granular Salt



Permeability-Porosity Data Sets for Crushed Salt Aggregates



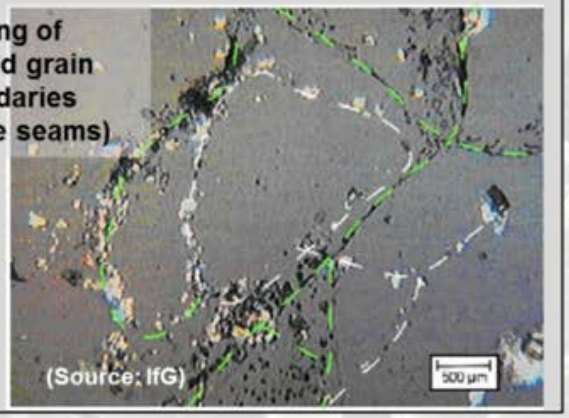
Summary of Analogues



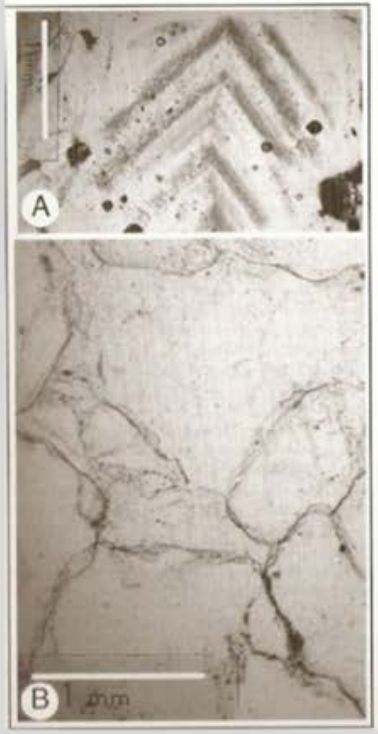
Headwork with jack-hammer in old-drifts in the salt mine Dürnberg (A)

a)

b)



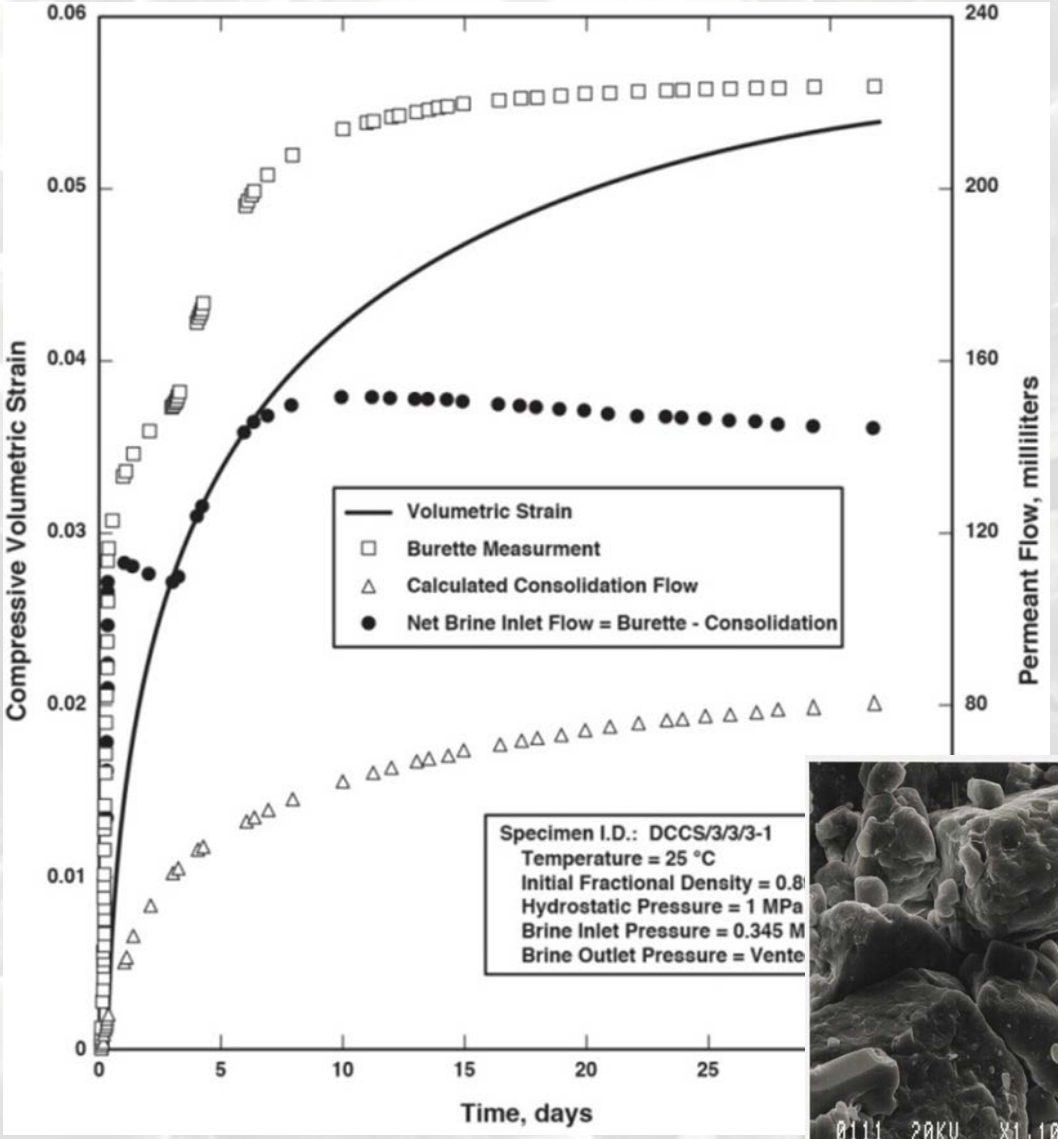
c)



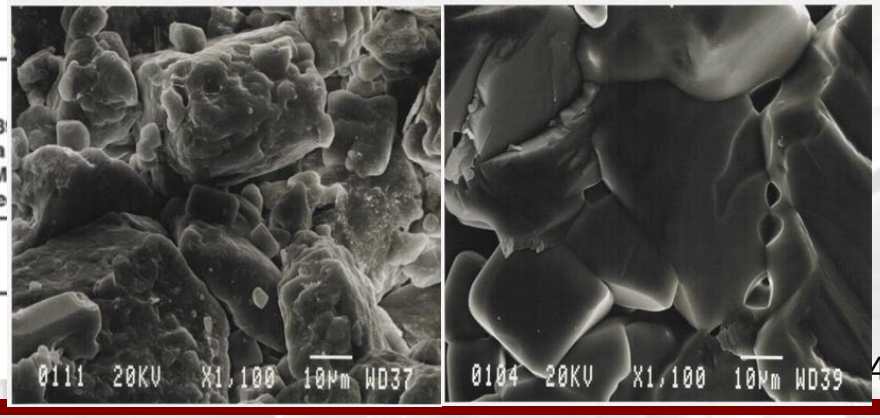
A) Chevron-structures due to grain grow by precipitation
B) B) 120° polygon-structures developed by recrystallisation

d)

Volumetric Strain and Brine Flow Measurements



Evolution of substructure



Perceptions--Future Work

- What final porosity of crushed salt is necessary to achieve an efficient seal and at which time can it be reached?
- Capability of additives such as moisture and clay can be optimized for construction and attainment of sealing properties
- The nature of testing fluids (brine or gas) and the resultant permeability/porosity relationships warrant further examination
- Numerical modeling provides capabilities but lacks low porosity verification
- Further analogue experience from underground sources is imperative

Used Fuel Report

Granular Salt Summary: Reconsolidation Principles and Applications

Fuel Cycle Research & Development

Prepared for

U.S. Department of Energy

Used Fuel Disposition

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