SAND2011-6398C

Bundesministerium für Wirtschaft und Technologie BMWi
Visit to Sandia Albuquerque
September 12-13, 2011

US/German Collaboration on Salt Repository Science and Engineering

Frank D. Hansen PhD PE
Sandia National Laboratories
Albuquerque, New Mexico

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

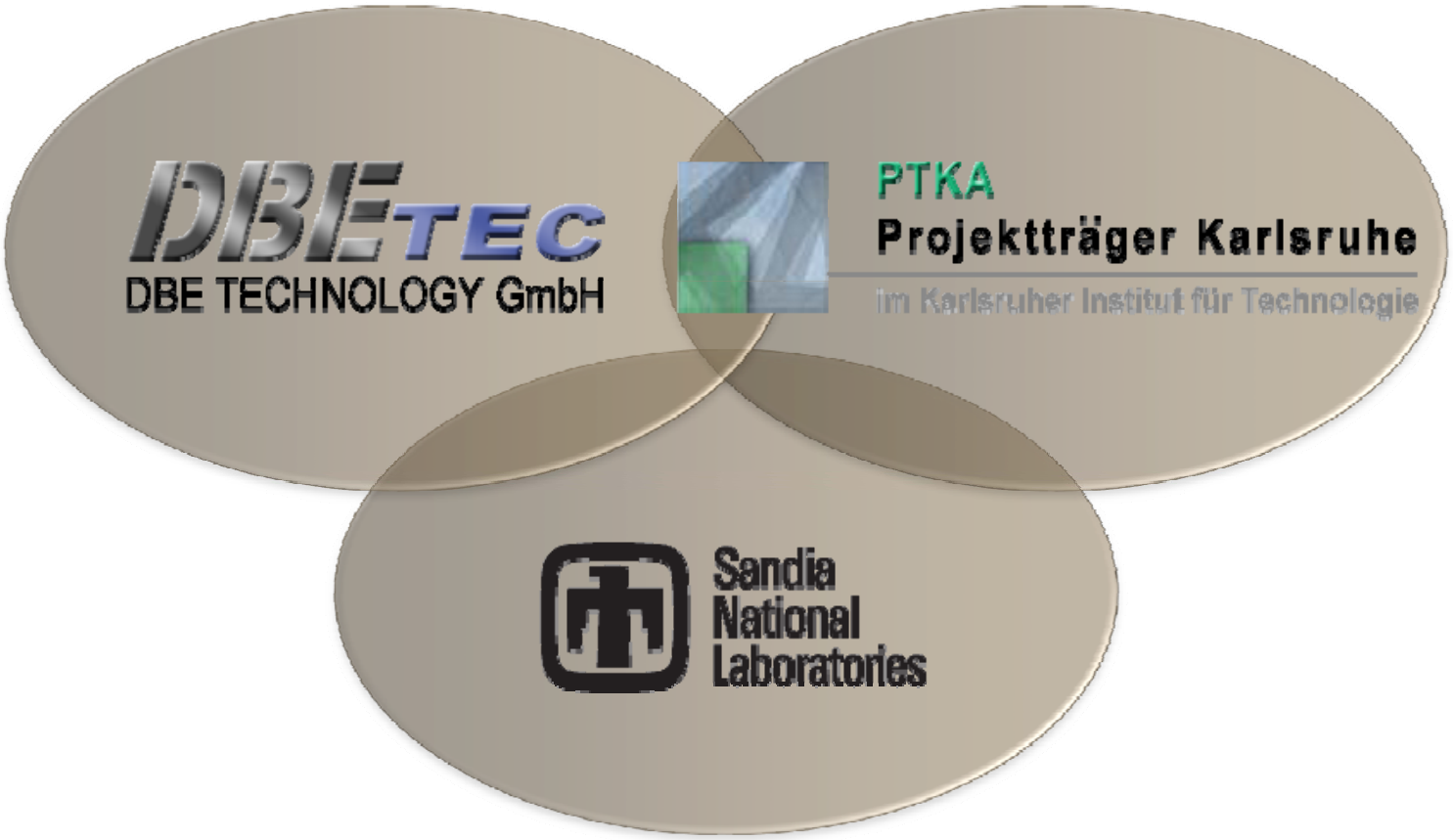
Restart of Salt Repository Collaborations

- Background
  Recent developments in Germany and the United States have renewed efforts in salt repository investigations.

- Purpose and Objectives
  - Renew collaborations and cooperation on overall salt repository science,
  - To coordinate a potential research agenda of mutual interest, and
  - To leverage collective efforts for the benefit of their respective programs.

Sandia National Laboratories

Restart of Salt Repository Collaborations

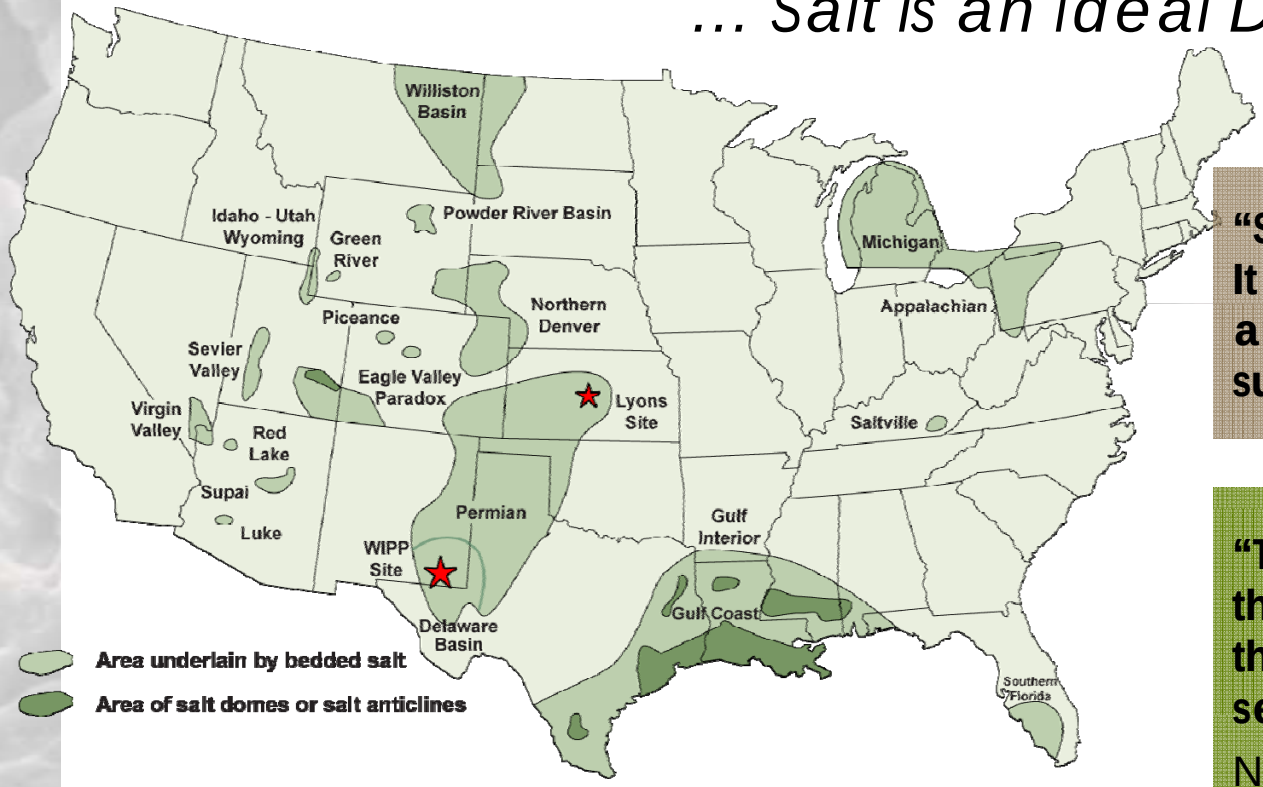


http://www.sandia.gov/SALT/SALT_Home.html

Sandia National Laboratories

Salt Disposal Investigations

… Salt is an Ideal Disposal Medium



"Salt at great depth 'flows.' It will encapsulate waste and isolate it from the surface for eons."

"The great advantage is that no water can pass through salt. Fractures are self healing…."

National Academy of Sciences, 1957

"No engineered barriers are needed – the natural barrier alone makes disposal in salt permanent"

ARMA Conference

Sandia National Laboratories

Waste Isolation Pilot Plant Chronology

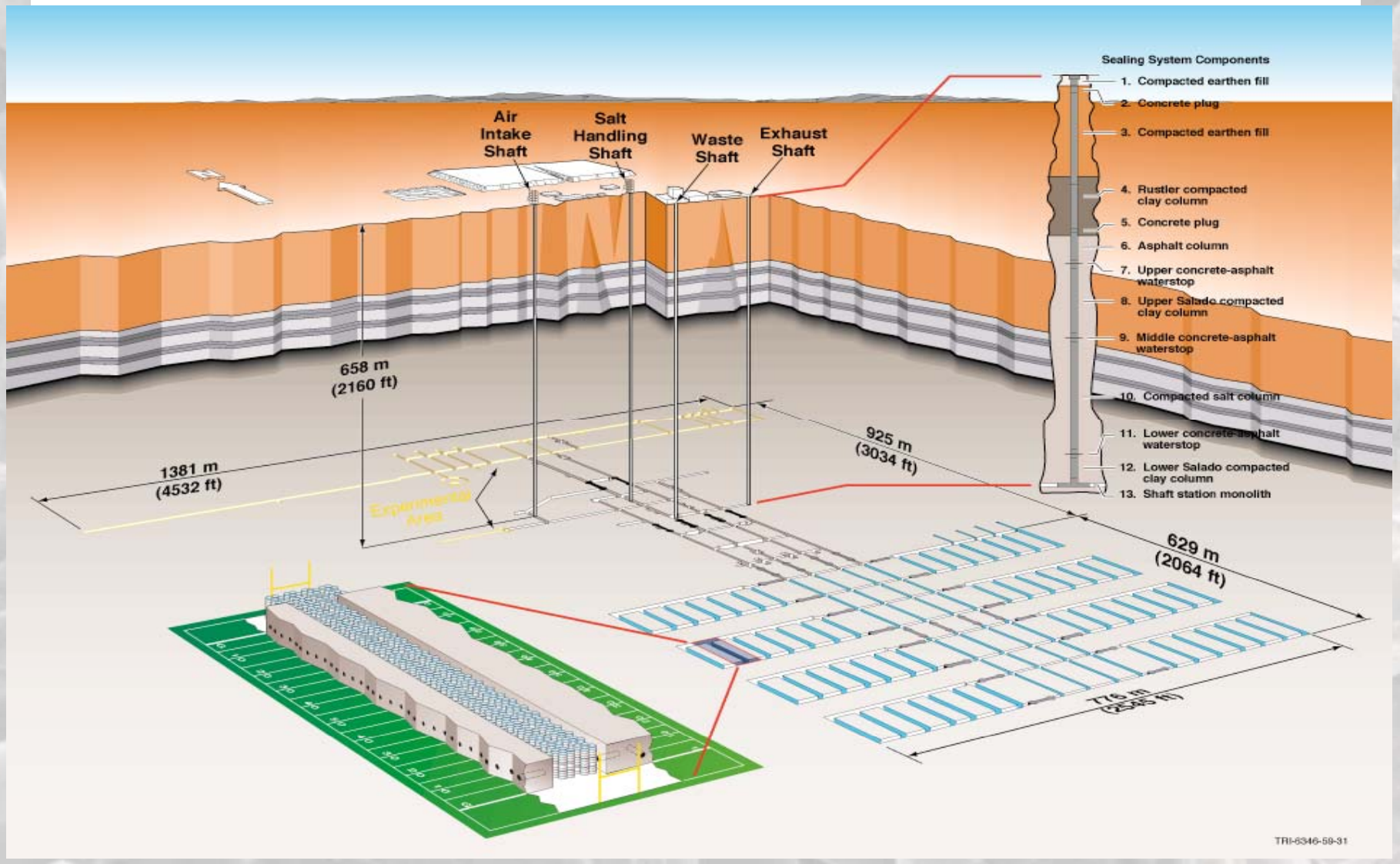
1975

1979

2000

Sandia National Laboratories

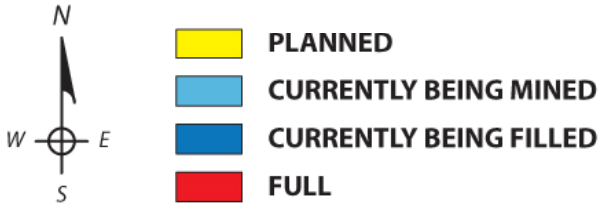
WIPP Underground Layout



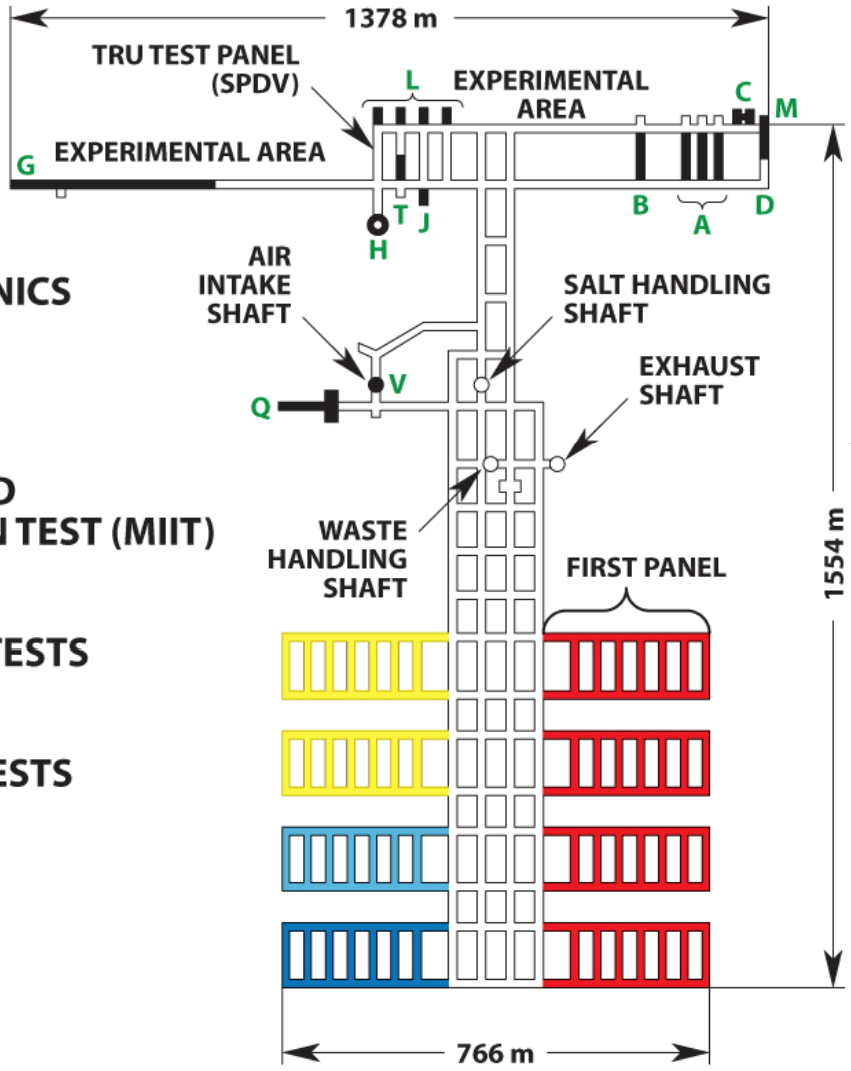
WIPP Major Tests

FIELD TESTS:

- **A.** 18 W/m² MOCKUP
- **B.** DHLW OVERTEST
- **C.** INTERMEDIATE SCALE ROCK MECHANICS AND PERMEABILITY TESTS
- **D.** MINING DEVELOPMENT
- **G.** GEOMECHANICAL EVALUATION
- **H.** HEATED PILLAR
- **J.** SIMULATED CH TRU TESTS (WET) AND MATERIALS INTERFACE INTERACTION TEST (MIIT)
- **L.** PLUGGING AND SEALING, WASTE DRUM/BACKFILL TESTS
- **M.** SMALL SCALE SEAL PERFORMANCE TESTS
- **T.** SIMULATED CH AND RH TESTS
- **Q.** CIRCULAR BRINE ROOM TESTS
- **V.** AIR INTAKE SHAFT PERFORMANCE TESTS



SALT AND INTERBED PERMEABILITY AND BRINE SEEPAGE TESTS AT NUMEROUS LOCATIONS



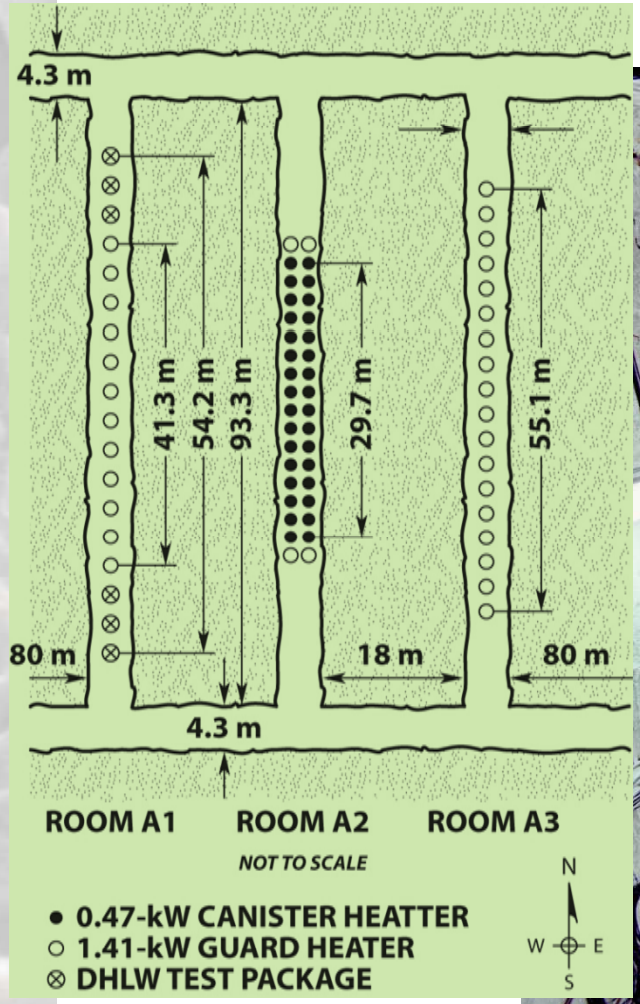
[NOT TO SCALE]

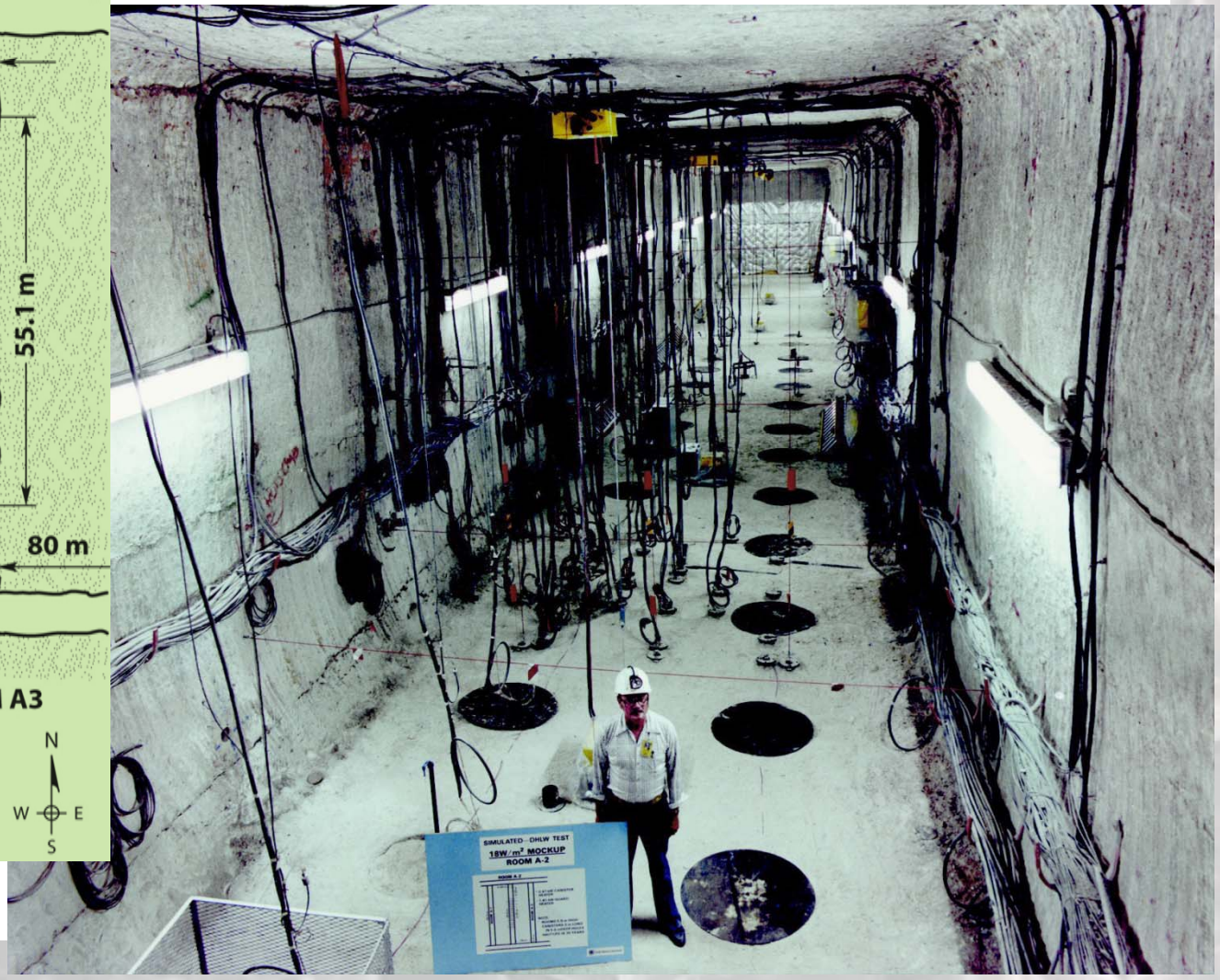
Axisymmetric Test with Insulation

Room H

18 W/m^2 Thermomechanical Test

A Rooms



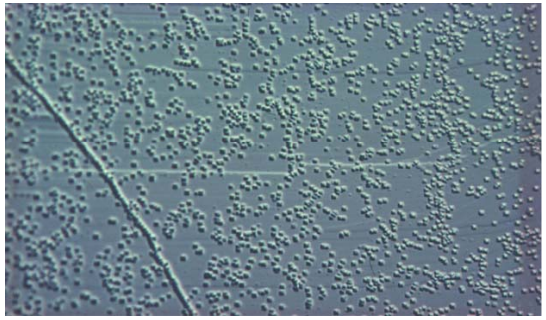


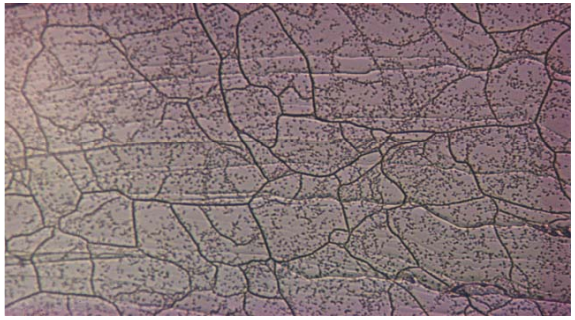
Thermomechanical Response of Salt

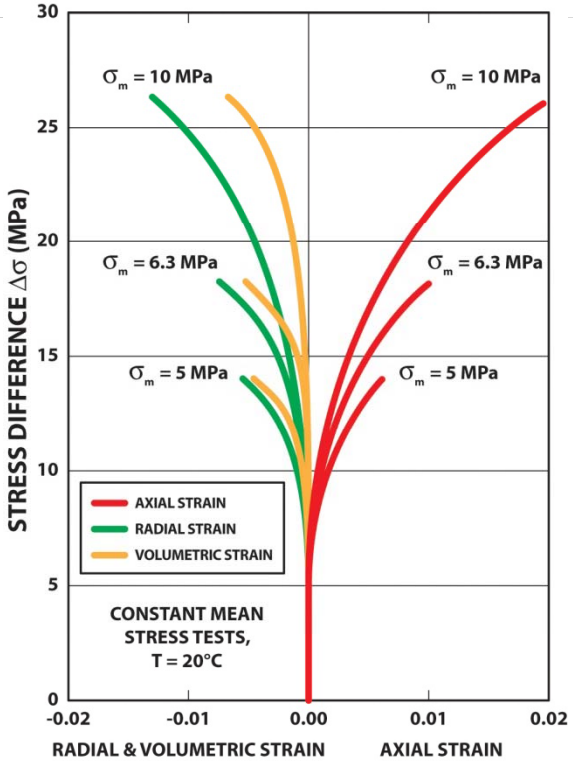
- Thermal activation will increase creep of the salt
- Plastic creep deformation would enhance room closure and encapsulation
- WIPP's original mission included defense HLW and spent fuel
- Thus, there is a considerable amount of information on heat-generating waste in a salt repository

Sandia National Laboratories

Salt Behavior is well Understood

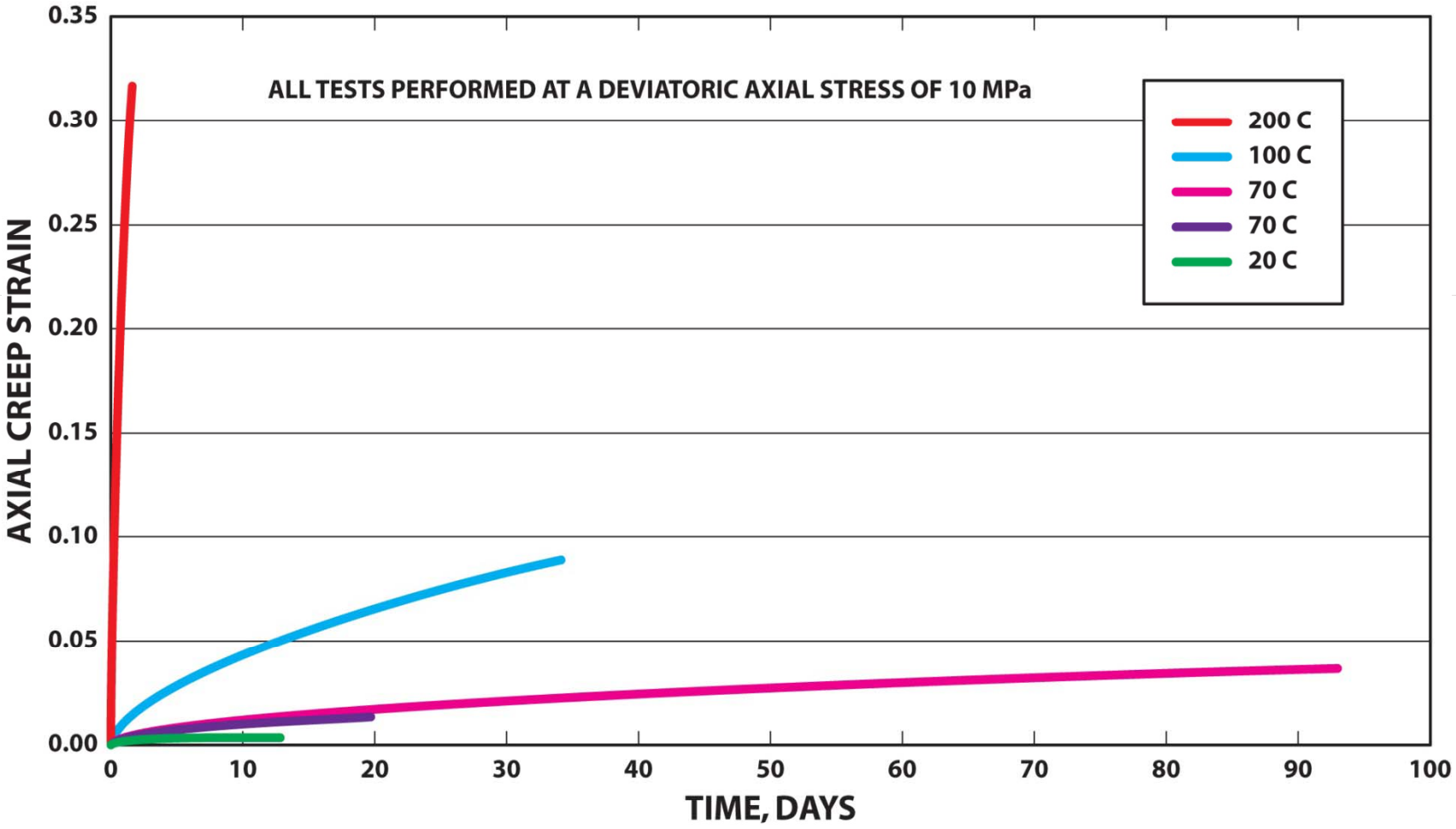






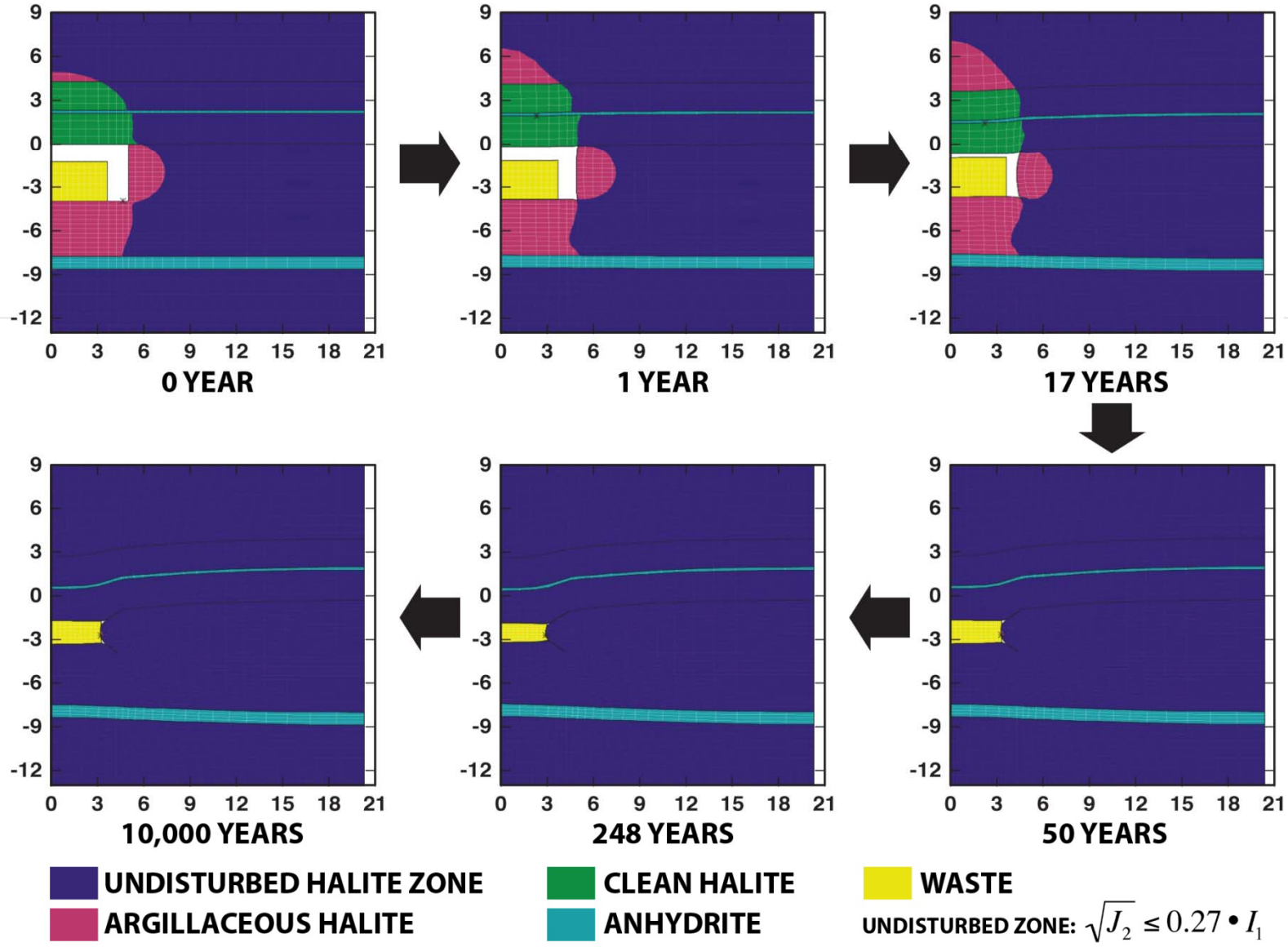
Sandia National Laboratories

Temperature Effect on Salt Deformation

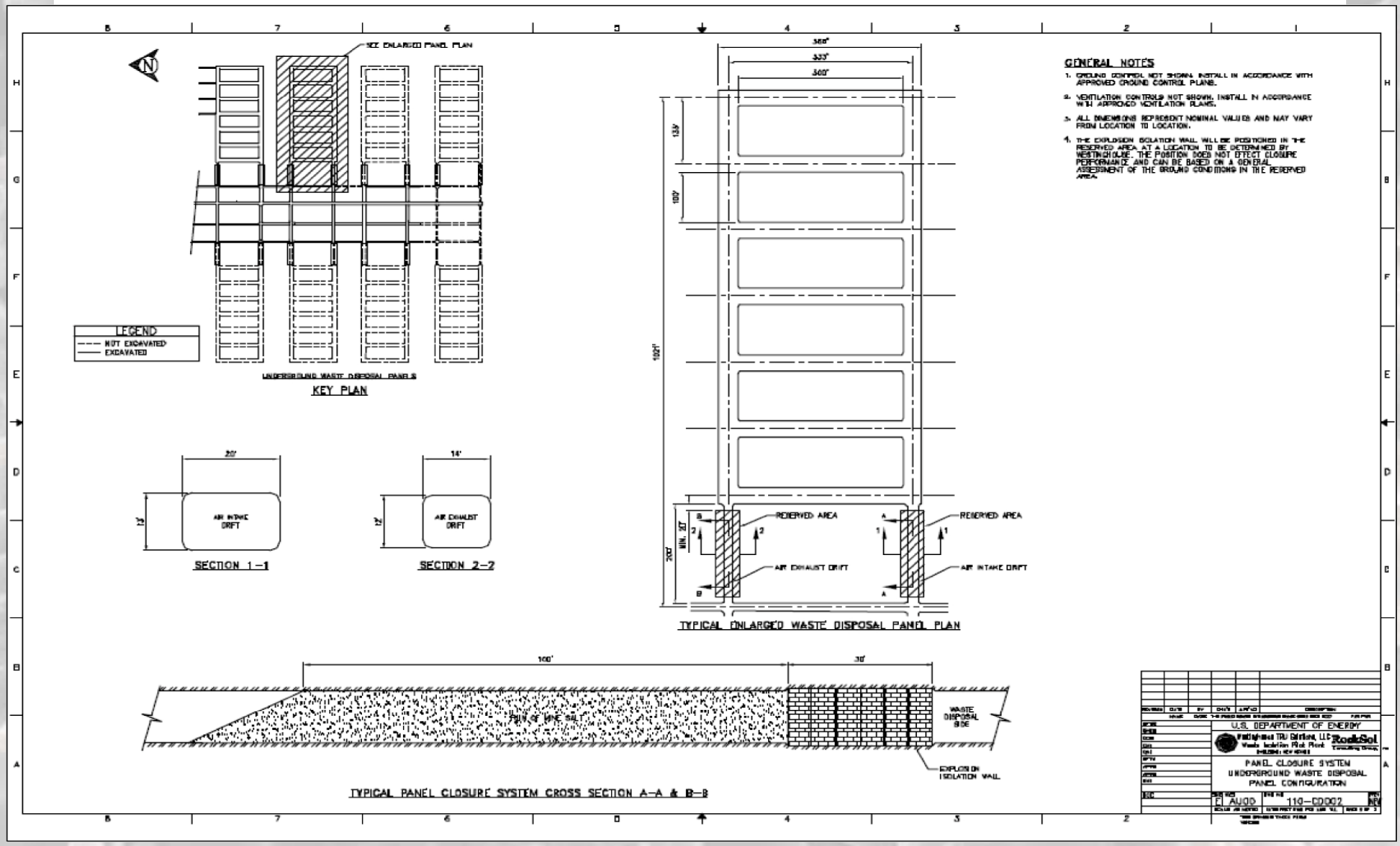


Sandia National Laboratories

Disturbed Rock Zone around a Disposal Room



Proposed Panel Closure System

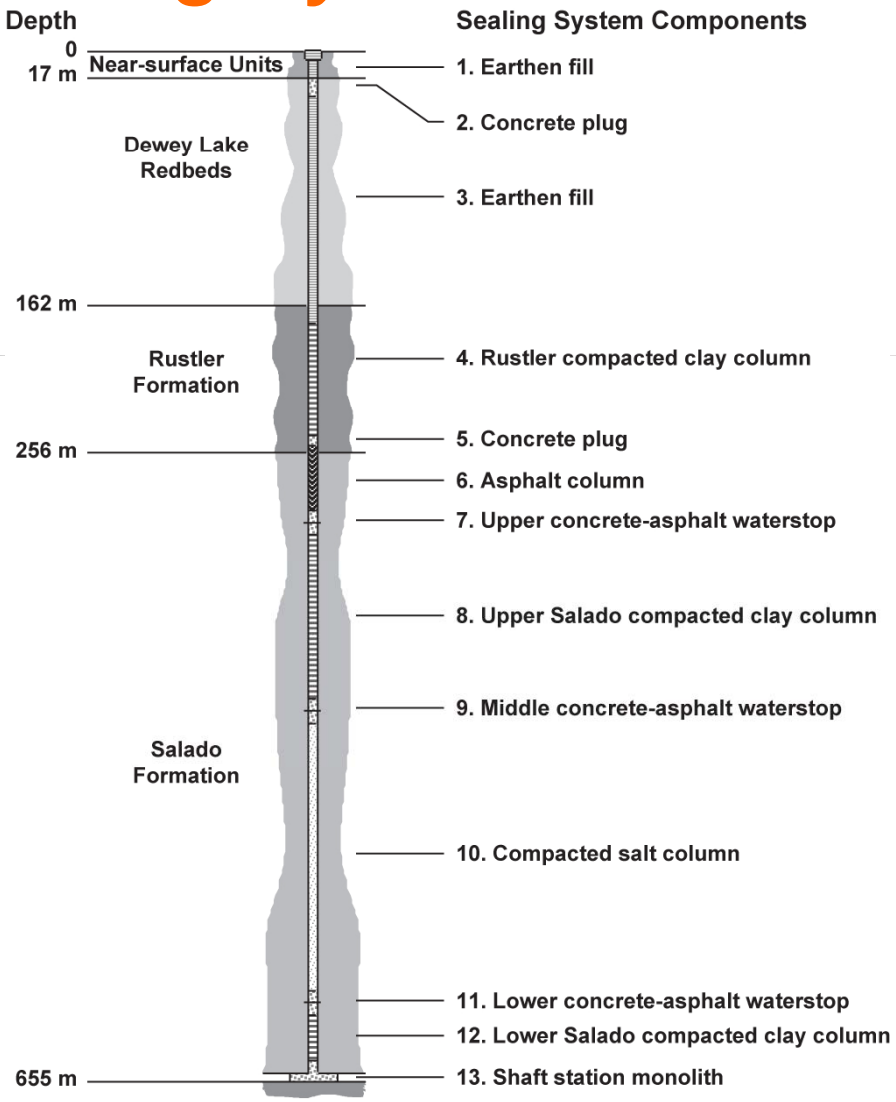


Shaft Seal System Design Guidance

- Limit hazardous constituents reaching regulatory boundaries
- Restrict groundwater flow through the sealing system
- Use materials possessing mechanical and chemical compatibility
- Protect against structural failure of system components
- Limit subsidence and prevent accidental entry
- Utilize available construction methods and materials

Sandia National Laboratories

Shaft Sealing System



Sandia National Laboratories

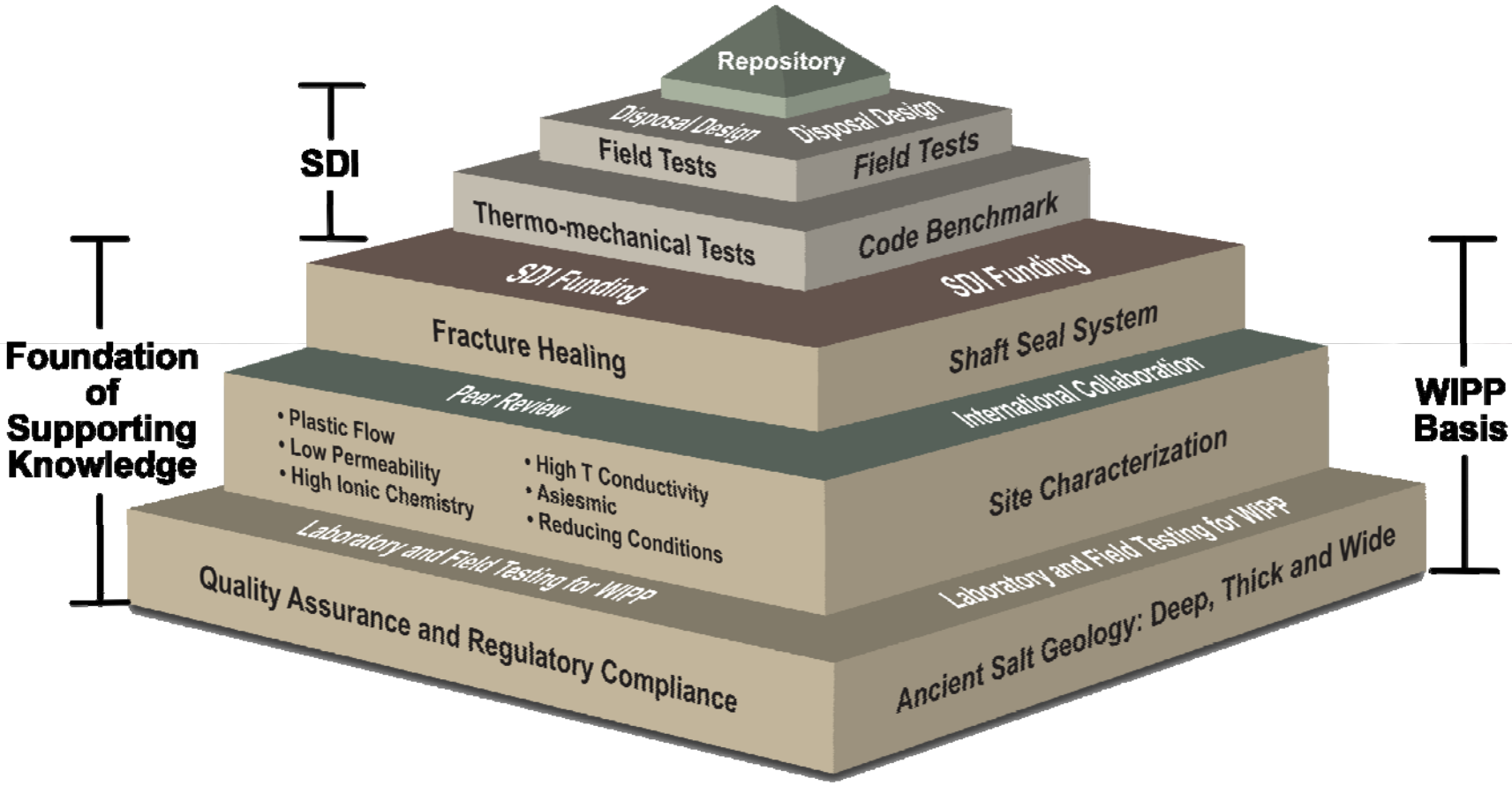
Shaft Seal System Conclusions

- The WIPP shaft seal system effectively limits fluid flow within the seal system.

- The salt column becomes an effective barrier to gas and brine migration by 100 years after closure.

- Long-term flow rates within the seal system are limited.

Sandia National Laboratories



Science Based Foundation for TRU and HLW Disposal in Salt

Sandia National Laboratories

Key geomechanics areas of interest

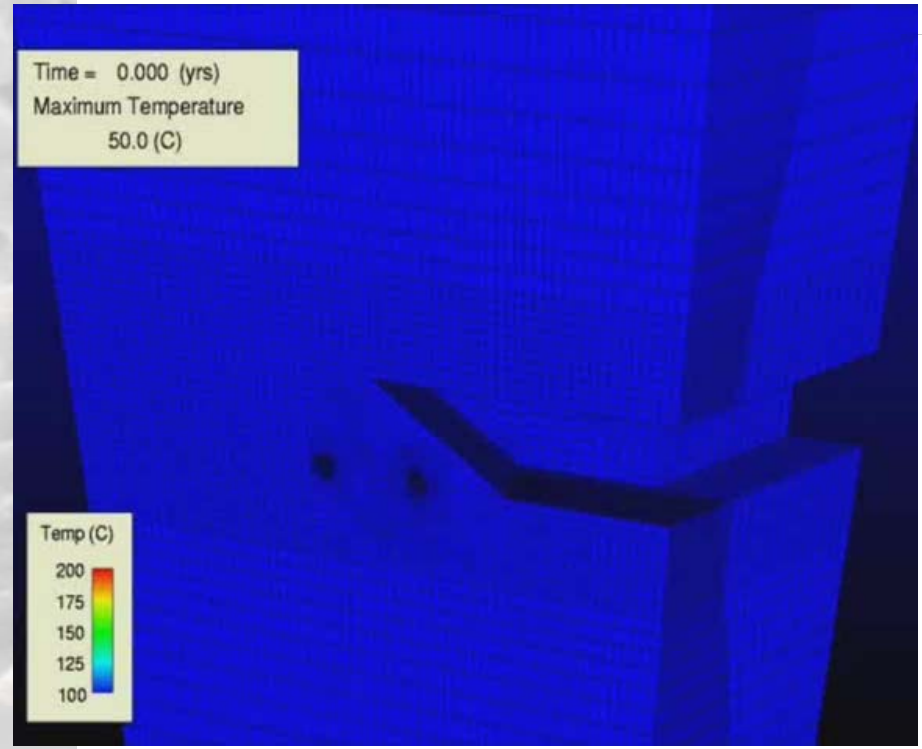
- DRZ Evolution and Healing
- Consolidation of Backfill Materials at Elevated Temperature
- Availability and Movement of Brine
- Vapor Phase Transport Mechanism

Sandia National Laboratories

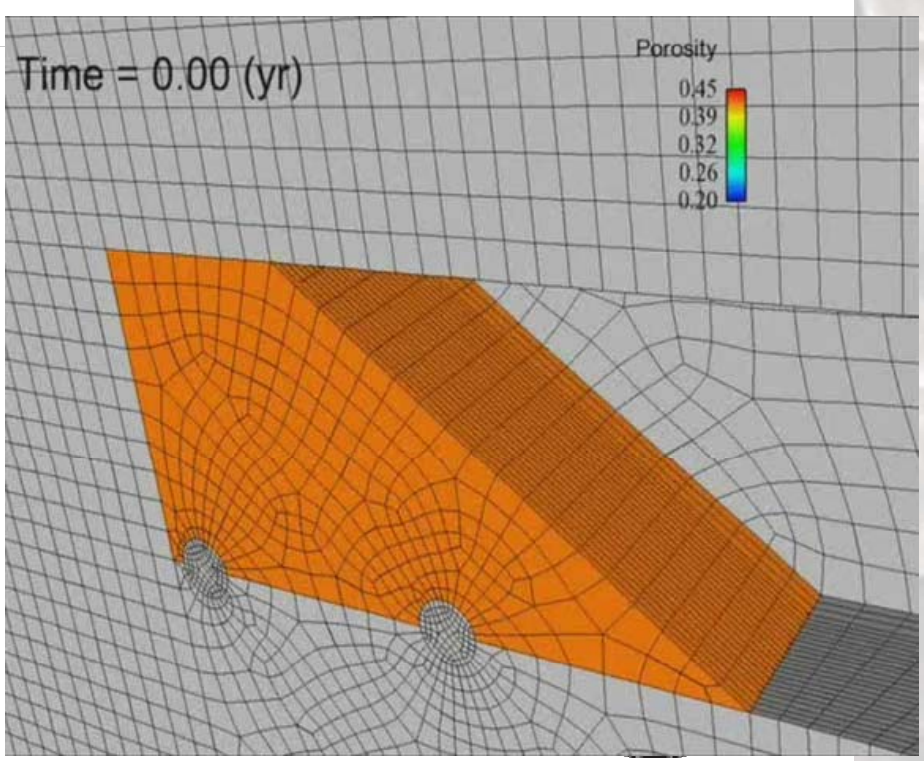
The Future

Advanced multi-physics modeling will aid salt analyses and performance assessment

Temperature Contour



Coupled Salt Consolidation



Salt disposal investigations

- Laboratory Testing — could begin immediately, as the state-of-the-art is known and incremental R&D identified.
- Modeling and Simulations — international collaboration in this effort can position salt repository sciences in a very favorable position for field testing, design and analysis.
- Workshops and International Collaborations — a workshop environment with subject matter experts can reconcile many of the issues.
- Field Testing — a proof-of-principle test could advance salt sciences sufficiently to lead to efficient and safe disposal.

Sandia National Laboratories