



U.S. DEPARTMENT OF
ENERGY

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Nuclear Energy

Deep Borehole Field Test Overview

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Fuel Cycle Technologies Annual Meeting

Idaho National Laboratory

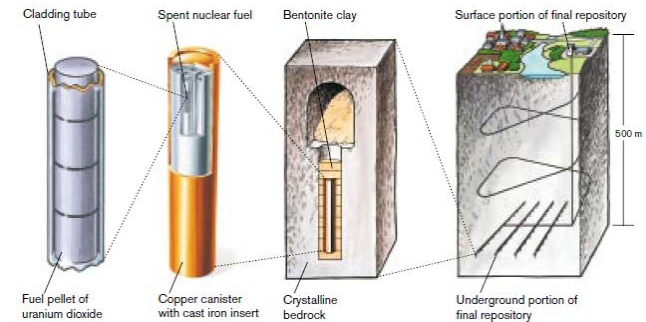
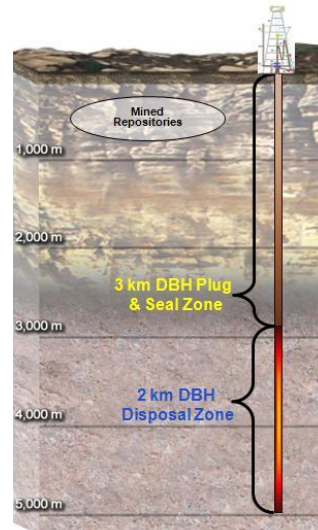
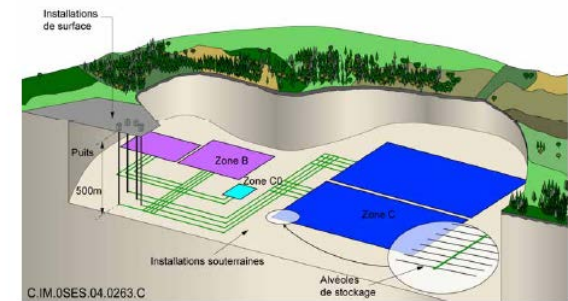
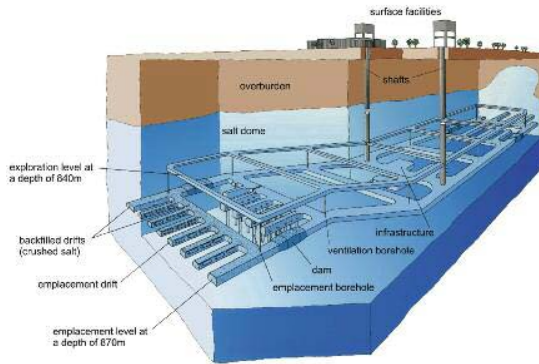
Idaho Falls, ID, November 3-5, 2015

Presentation Outline

- **UFD Campaign Disposal Focus**
- **Deep Borehole Disposal (DBD) Concept**
 - Background
 - Geologic Conditions
- **Deep Borehole Field Test (DBFT)**
 - Team
 - Schedule
 - Objectives
 - Characterization Borehole (CB)
 - Field Test Borehole (FTB)

UFD Focus for Used Nuclear Fuel and High-Level Radioactive Waste Disposal

- Provide a sound technical basis for multiple viable disposal options in the US
- Increase confidence in the robustness of generic disposal concepts
- Develop the science and engineering tools needed to support disposal concept implementation



Deep Borehole Disposal Concept

- **Deep borehole disposal of high-level radioactive waste has been considered in the U.S. and elsewhere since the 1950s and has been periodically studied since the 1970s**
- **Disposal concept consists of drilling a borehole or array of boreholes into crystalline basement rock to about 5,000 m depth**
- **Waste canisters/packages would be emplaced in the lower 2,000 meters of the borehole**
- **Upper borehole would be sealed with compacted bentonite clay, cement plugs, and cemented backfill**

Deep Borehole Disposal Concept

Why Deep Borehole Disposal?

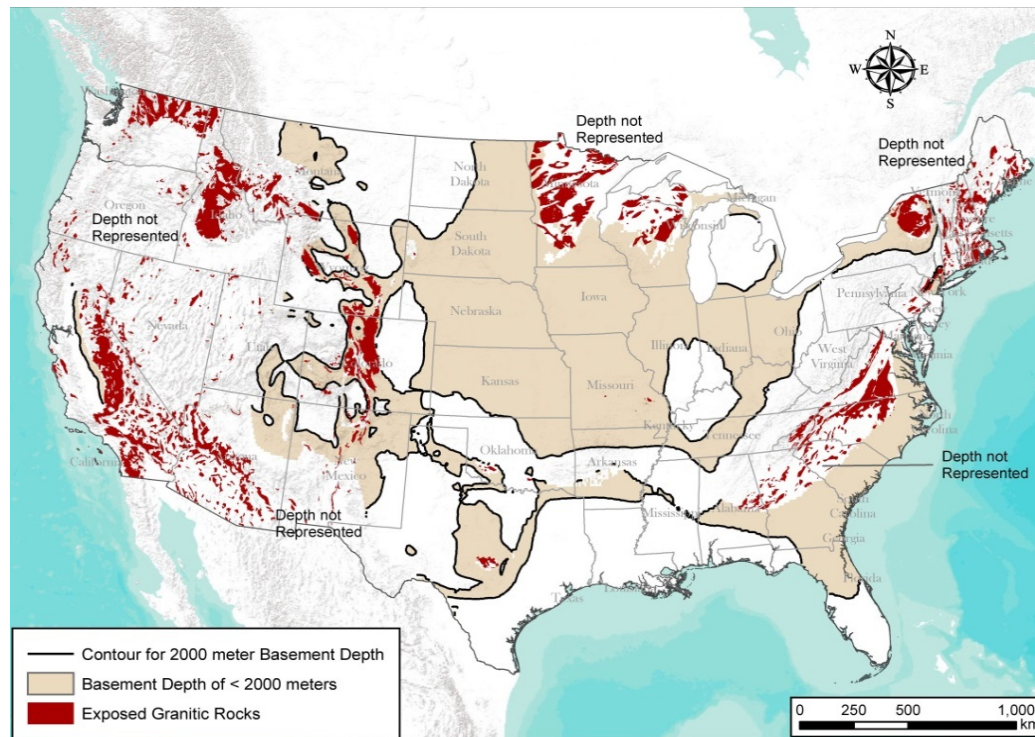
- **Potential for robust isolation**
- **Gives DOE the flexibility to consider options for disposal of smaller waste forms in deep boreholes**
 - **Potentially earlier disposal of some wastes than might be possible in a mined repository**
 - **Possible reduced costs associated with projected treatments of some wastes**
- **Several DOE-managed small waste forms are potential candidates for deep borehole disposal (SNL 2014)**
 - Cesium and strontium capsules. 1,936 cesium and strontium capsules stored at the Hanford Site
 - Untreated calcine HLW currently stored at INL in sets of stainless steel bins within concrete vaults
 - Salt wastes from electrometallurgical treatment of sodium-bonded fuels could be packaged in small canisters as they are produced
 - Some DOE-managed SNF currently stored in pools at INL and SRS

Deep Borehole Disposal Concept

Aspects of Deep Borehole Siting

Site selection guidelines indicate that large areas with favorable geological characteristics exist in the U.S.

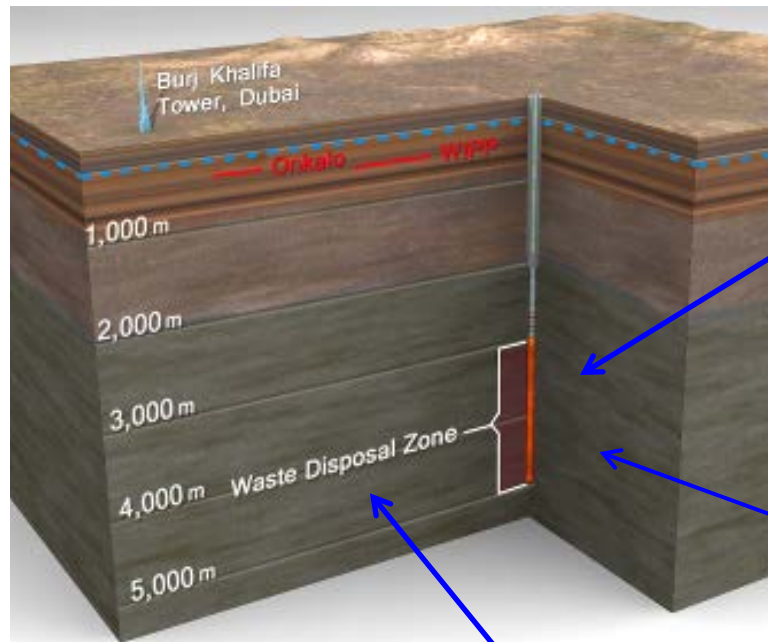
Depth to Crystalline Basement



from Perry et al. (2014) Regional Geology: A GIS Database for Alternative Host Rocks and Potential Siting Guidelines, FCRD-UFD-2014-000068

Deep Borehole Disposal Concept – Safety and Feasibility Considerations

Long-Term Waste Isolation (hydrogeochemical characteristics)



Waste emplacement is deep in crystalline basement

- At least 1,000 m of crystalline rock (seal zone) overlying the waste disposal zone
- Crystalline basement within 2,000 m of the surface is common in many stable continental regions

Crystalline basement can have very low permeability – limits flow and transport

Deep groundwater in the crystalline basement:

- Can have very long residence times – isolated from shallow groundwater
- Can be highly saline and geochemically reducing – enhances the sorption and limits solubility of many radionuclides
- Can have density stratification (saline groundwater underlying fresh groundwater) – opposes thermally-induced upward groundwater convection

Deep Borehole Field Test

■ Conducting a Deep Borehole Field Test

- Allows further evaluation of the feasibility of the deep borehole disposal concept
- Is consistent with the UFD Mission
- Implements a recommended near-term action of the *Blue Ribbon Commission on America's Nuclear Future* (BRC 2012)
- Is consistent with the Administration's *Strategy for the Management and Disposal of used Nuclear Fuel and High-Level Radioactive Waste* (DOE 2013)
- Economic and scientific benefits of a deep borehole field test are of interest and could be valuable to local, state, and regional stakeholders

Site Evaluation, Characterization, and Data Integration Team Members

■ DOE NE-53

- Tim Gunter, Federal Program Manager
- Lam Xuan, Program Lead

■ SNL – DBFT Project Technical Lead

- Bob MacKinnon, Manager
- Geoff Freeze, Project Lead and Safety Assessment
- David Sassani, Site Evaluation and Data Integration Lead
- Kris Kuhlman, Site Characterization Lead
- Ernie Hardin, Test Package/Emplacement Engineering Lead

■ DBFT Laboratory Participants

- LANL – Regional geology, geoscience, site characterization
- LBNL – Geoscience, site characterization
- ORNL – Surface site characteristics, GIS (OR-SAGE)
- INL – Web visualization/interface for geoscience data
- PNNL – Engineering design support

Deep Borehole Field Test Schedule

	FY15	FY16	FY17	FY18	FY19
Site & Characterization Borehole – Issue Draft RFP	◆ 04/07/15				
Field Test – Award Engineering Services Task Order	◆ 06/22/15				
Site & Characterization Borehole – Issue Final RFP	◆ 07/09/15				
Documentation – Borehole and Field Test Design	◆ 09/15/15				
Site & Characterization Borehole – Proposals Due	◆ 09/23/15				
Site & Characterization Borehole – Award Site, Management, and Drilling Services Contract		◆ 01/29/16			
Characterization Borehole – Start Drilling		◆ 09/01/16			
Field Test Borehole – Award Management and Drilling Services Contract			◆ 01/13/17		
Characterization Borehole – Complete			◆ 02/27/17		
Field Test Borehole – Start Drilling			◆ 07/07/17		
Field Test Borehole – Complete				◆ 01/07/18	
Field Test – Start Emplacement Demonstration				◆ 01/17/18	
Field Test – Complete Emplacement Demonstration				01/17/19	◆
Documentation – Field Test Analyses and Evaluation				09/30/19	◆

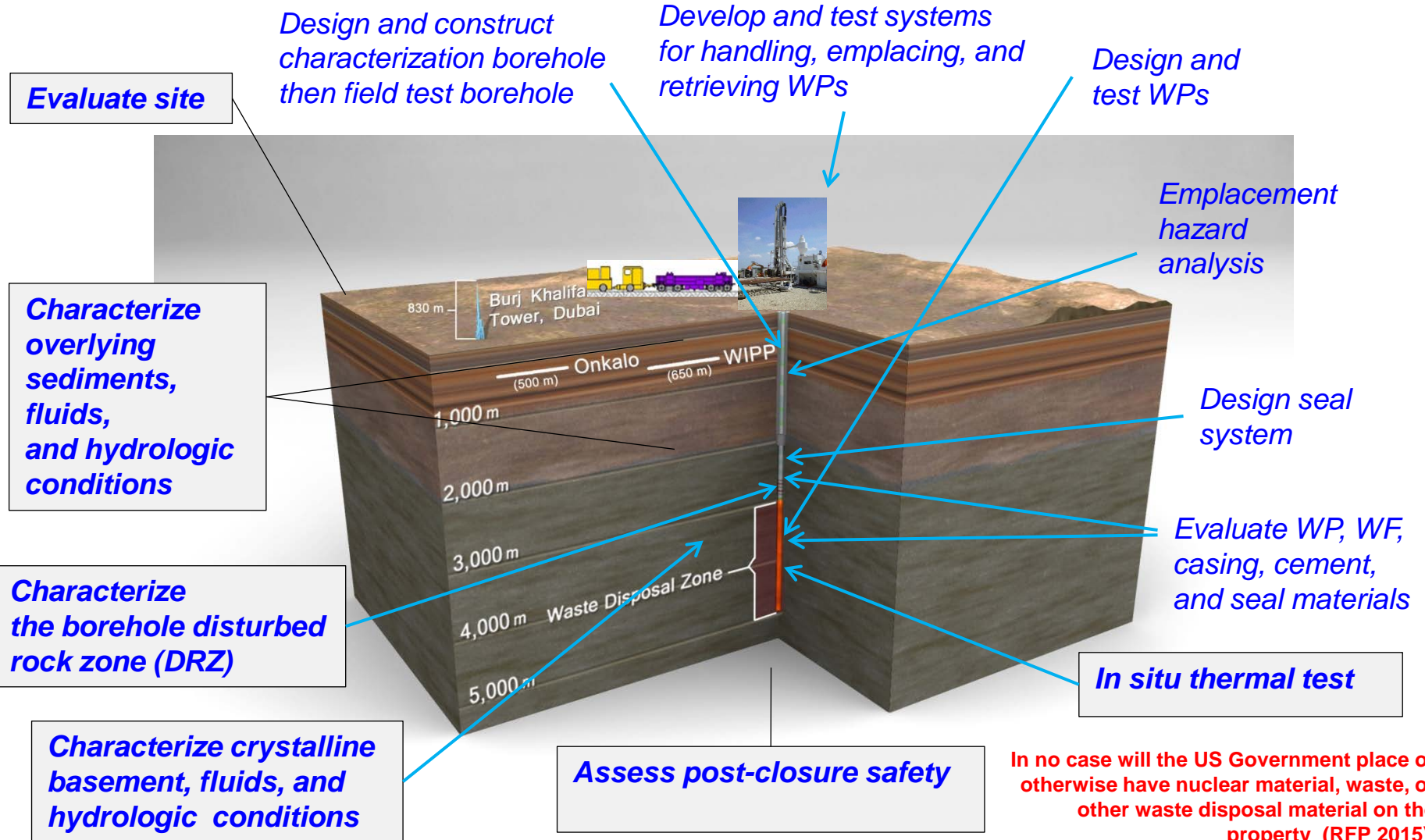
Deep Borehole Field Test

Acquisition of Site and Services

- **Request for Information solicited input and interest from States, local communities, individuals, private groups, academia, or any other stakeholders who were willing to host a DBH Field Test**
 - *Posted to via Federal Business Opportunities (FedBizOps, www.fbo.gov) on October 24, 2014*
 - *Responses received on December 8, 2014 (45 days)*
- **Sources Sought and Draft Request For Proposal (RFP)**
 - *Posted on FedBizOps on April 7, 2015*
 - *Feedback received on May 5, 2015*
- **Final RFP (Solicitation Number DE-SOL-0008071)**
 - *Pre-solicitation notice posted on June 22, 2015*
 - *Final RFP posted on FedBizOps on July 9, 2015*
 - *Proposals due and received September 23, 2015*
 - *Contract award anticipated by early 2016*

Objectives of the Deep Borehole Field Test

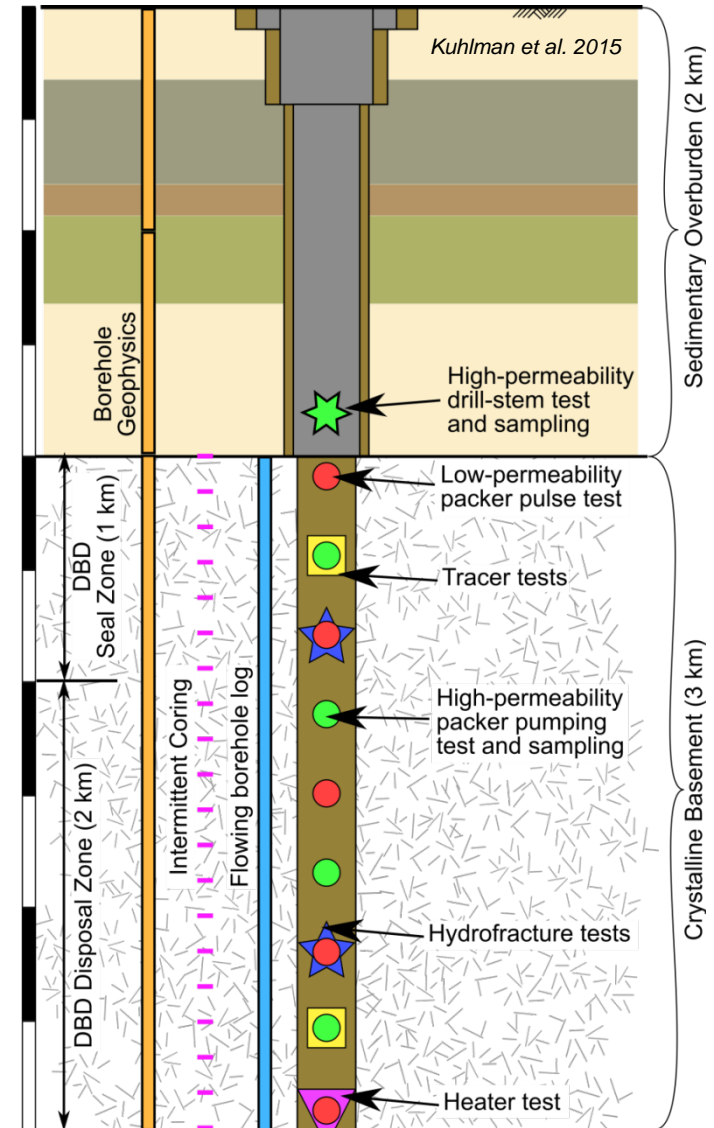
Synthesize field test activities, test results, and analyses into a comprehensive evaluation of concept feasibility



In no case will the US Government place or otherwise have nuclear material, waste, or other waste disposal material on the property (RFP 2015).

Characterization Borehole: Profile Data

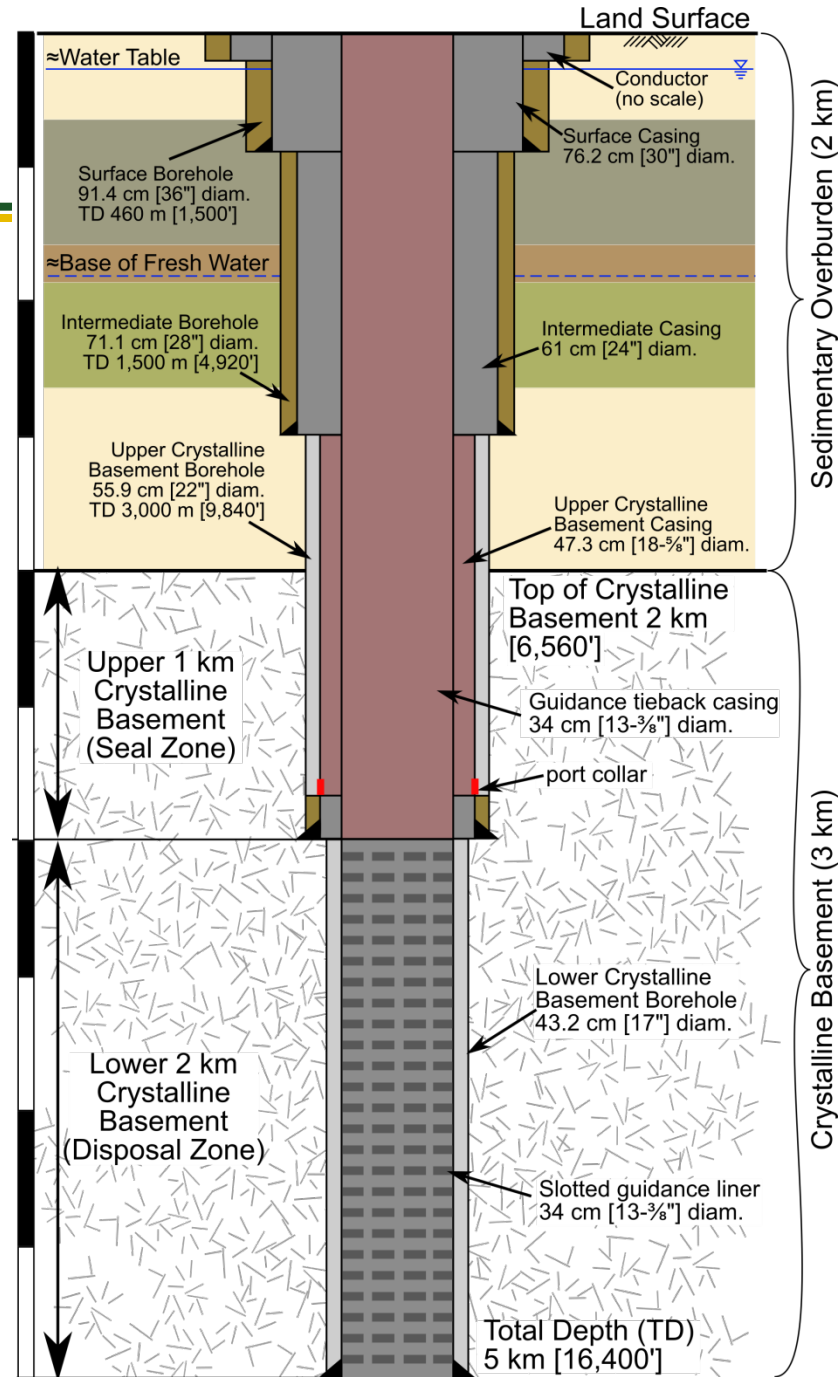
- **Borehole Geophysics**
- **Coring/Cuttings/Rock Flour**
 - **Mineralogy/petrology**
 - **Fluid samples from cores**
 - **Bulk composition (salinity; rock equilibration)**
- **Sample-based Profiles**
 - Fluid density/temperature/major ions
 - Pumped samples from high-*k* regions
 - Samples from cores in low-*k* regions
- **Drilling Parameters Logging**
 - Mud fluids/solids/dissolved gases
 - Torque, weight-on-bit, etc.
- **Testing-Based Profiles**
 - Static formation pressure
 - Formation hydraulic/transport properties
 - ***In situ* stress (hydrofrac + breakouts)**





Field Test Borehole

- Disposal borehole diameter/plan
- Demonstrate emplacement and test canisters
- Casing removal
- 17-inch diameter at a few km depth in hard rock is not uncommon for geothermal



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Nuclear Energy

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