

# Used Fuel Disposition R&D Campaign

## Overview of Deep Borehole Disposal Concept

***David C. Sassani***

***Sandia National Laboratories***

***Used Fuel Disposition R&D Campaign***

***Workshop on the Fifth Worldwide Review***

***“Challenging Issues in Deep Geologic***

***Disposal of Nuclear Wastes”***

***May 26, 2016***

***Lawrence Berkeley National Laboratory,***

***Berkeley, California, USA***

■ **Deep Borehole Disposal Concept**

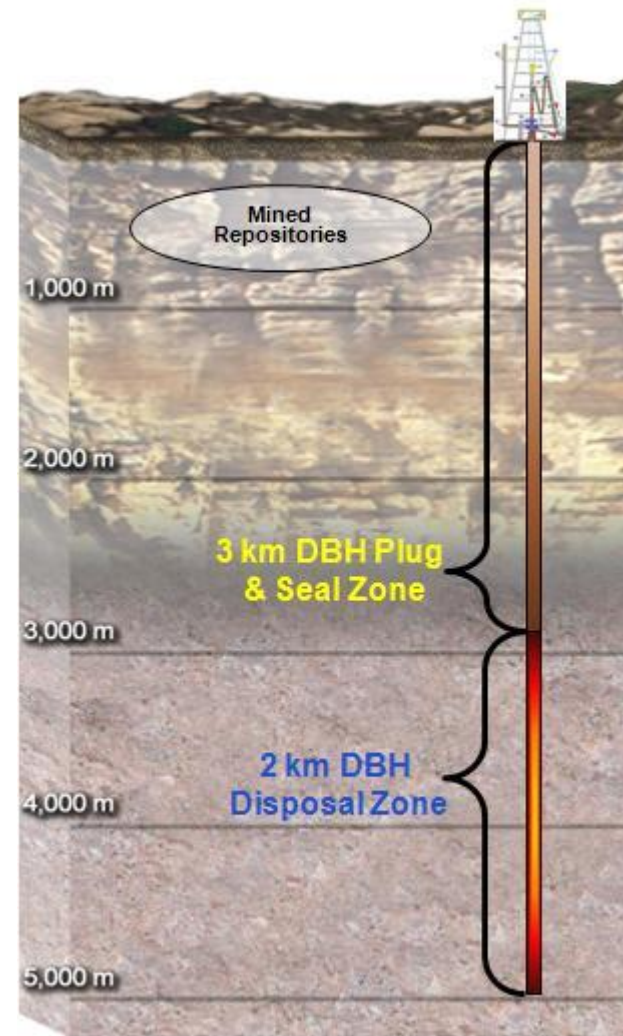
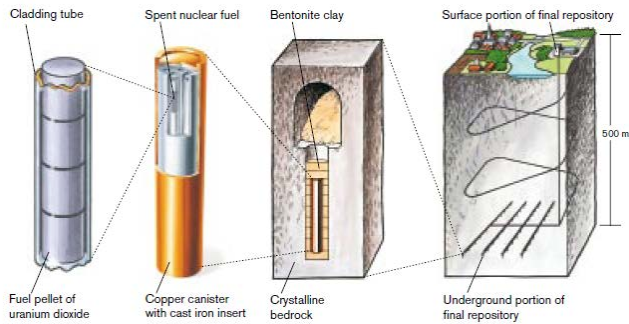
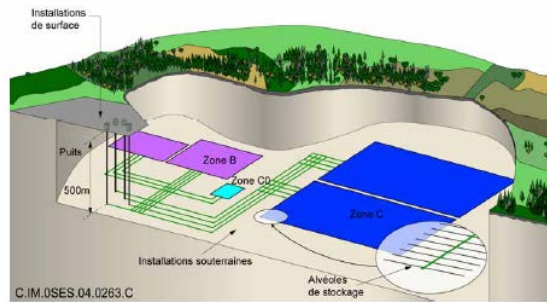
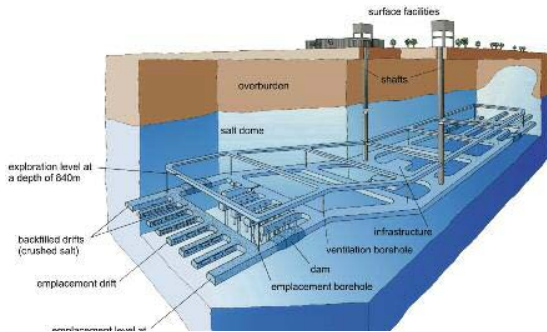
- Background
- Characteristics and Safety Considerations
- Feasibility

■ **Deep Borehole Field Test**

- Objectives
- Characterization
- Status

# Used Fuel Disposition

## Deep Borehole Disposal Concept



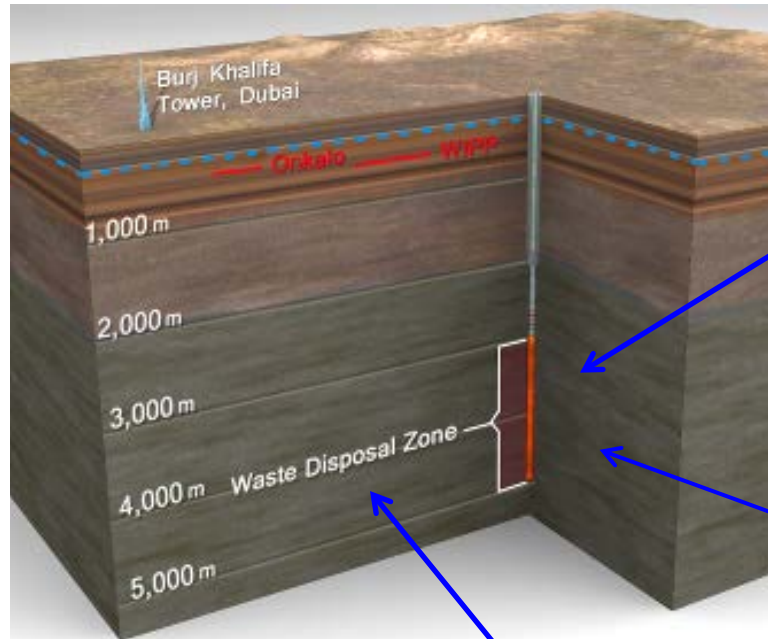
# **Deep Borehole Disposal Concept: Why Deep Borehole Disposal?**

---

- **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 – 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:

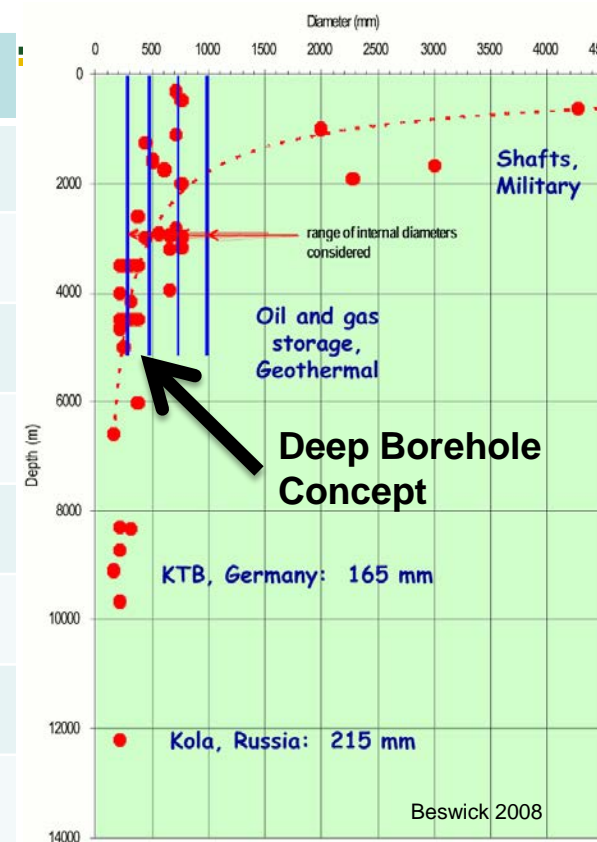
- Can have very long residence times – isolated from shallow groundwater
- Can be highly saline and geochemically reducing – enhances the sorption and limits solubility of many radionuclides
- Can have density stratification (saline groundwater underlying fresh groundwater) – opposes thermally-induced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

# Used Fuel Disposition

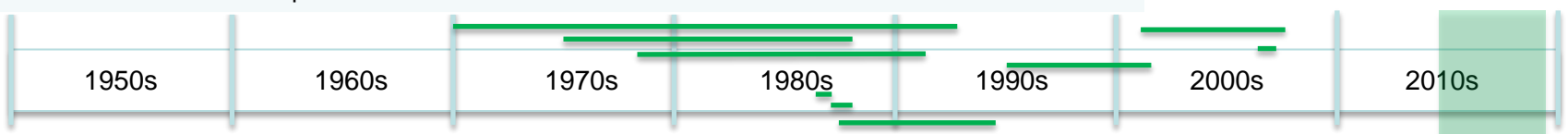
# Deep Crystalline Drilling

Site	Bores	Location	Years	Depth [km]	Diam* [in]	Purpose
Kola SG-3	1	NW USSR	1970-1992	12.2	8½	Geologic Exploration + Technology Development
Fenton Hill	3	New Mexico	1975-1987	3, 4.2, 4.6	8¾, 9⅝	Enhanced Geothermal
Urach-3	1	SW Germany	1978-1992	4.4	5½	Enhanced Geothermal
Gravberg	1	Central Sweden	1986-1987	6.6	6½	Gas Wildcat in Siljan Impact Structure
Cajon Pass	1	California	1987-1988	3.5	6¼	San Andreas Fault Exploration
KTB	2	SE Germany	1987-1994	4, 9.1	6, 6½	Geologic Exploration + Technology Development
Soultz-sous-Forêts GPK	3	NE France	1995-2003	5.1, 5.1, 5.3	9⅝	Enhanced Geothermal
SAFOD	2	Central California	2002-2007	2.2, 4	8½, 8¾	San Andreas Fault Exploration
Basel-1	1	Switzerland	2006	5	8½	Enhanced Geothermal

\*borehole diameter at total depth



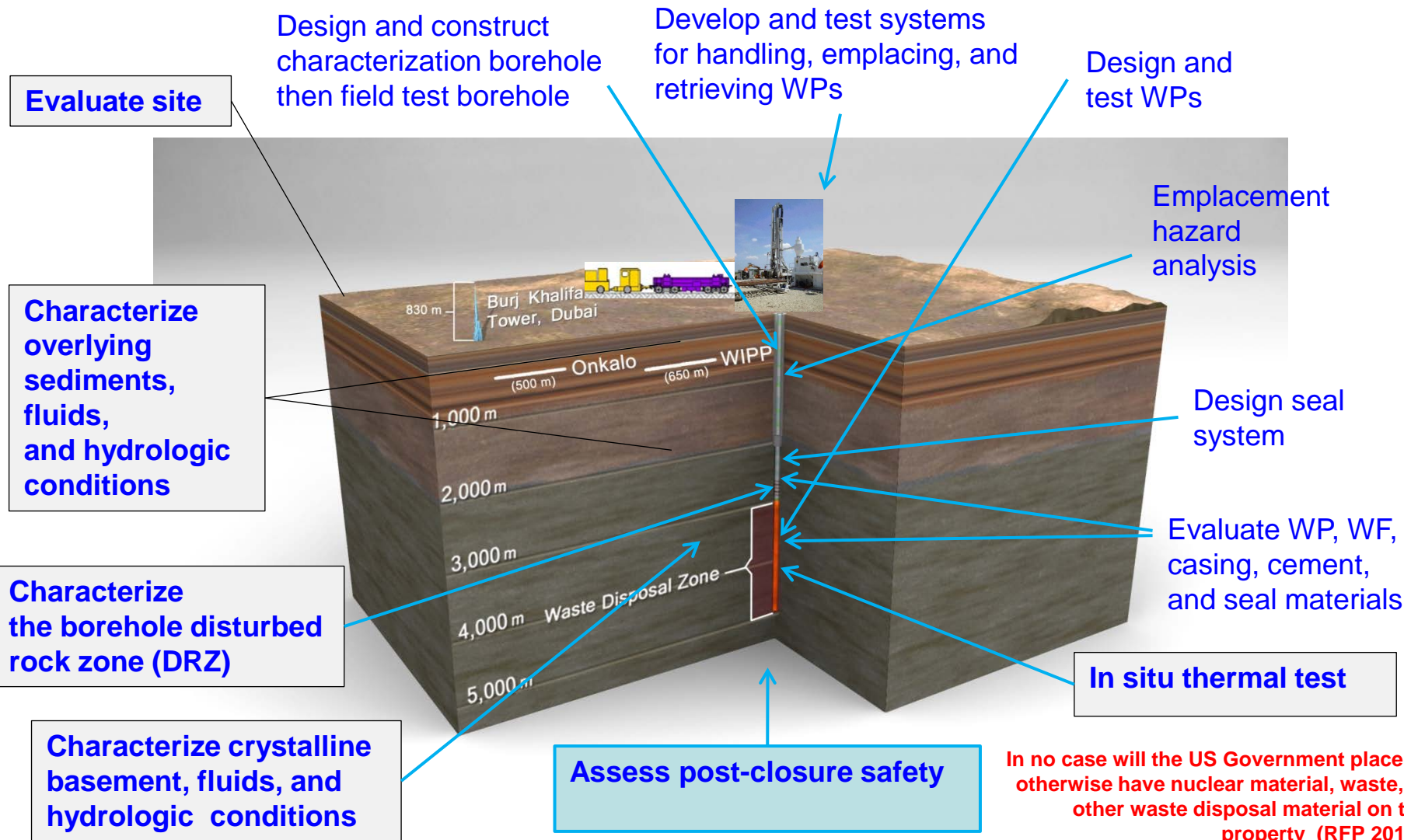
Deep Borehole Field Test DBFT



# Used Fuel Disposition

# Objectives of the Deep Borehole Field Test

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

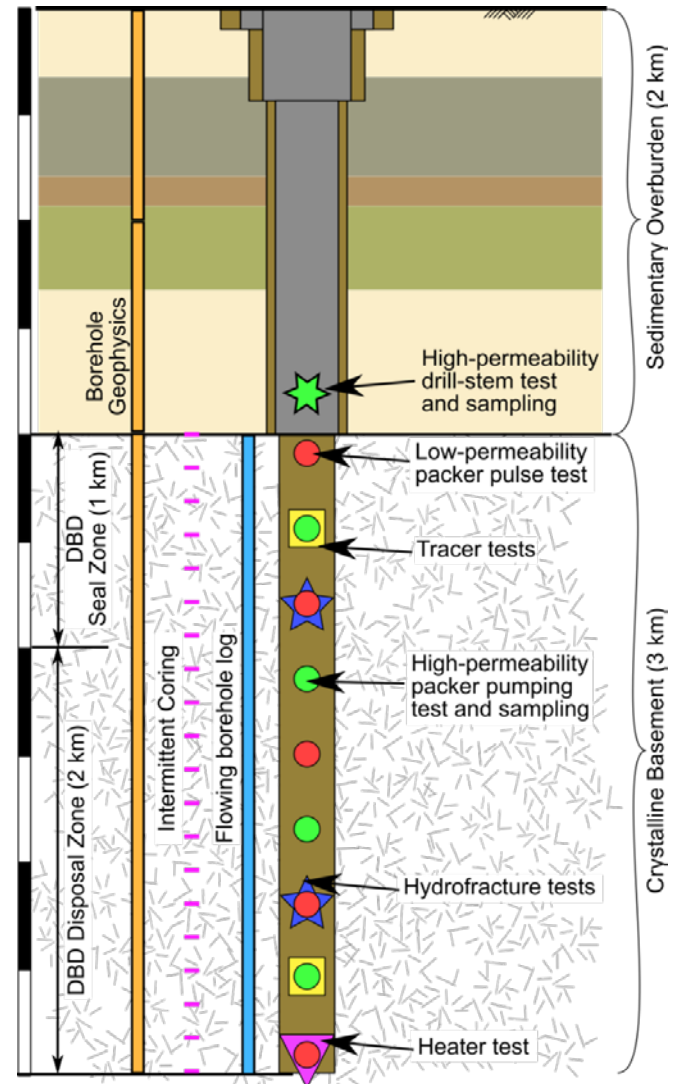


# Characterization Borehole (CB)

- Focus is on Crystalline Basement
  - Not all Char. Methods Included, e.g.,
    - *Surface geophysics*
    - *Testing sedimentary sequence*
  - No need to demonstrate in DBFT
- 8.5” diameter at 5 km
  - ~geothermal experience
- Core ~150 m of Crystalline Basement
- Testing/Sampling After Completion
  - Packer tool via work-over rig
  - At limits of current technology

***Borehole designed to maximize likelihood of good samples***

- If Geology Acceptable, 17” diameter Field Test Borehole would be Drilled
  - Emplacement/withdrawal Demonstration of Mock-ups



## **Deep Borehole Field Test Status 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](http://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 received September 23, 2015
- **The DOE Awarded Contract to the team led by Battelle Memorial Institute**
  - Early January 2016
    - *Local North Dakota community opposed the DBFT being sited there*
  - DOE and Battelle team are in process of finding a new site
    - *Public meetings have been held in Spink County, South Dakota*

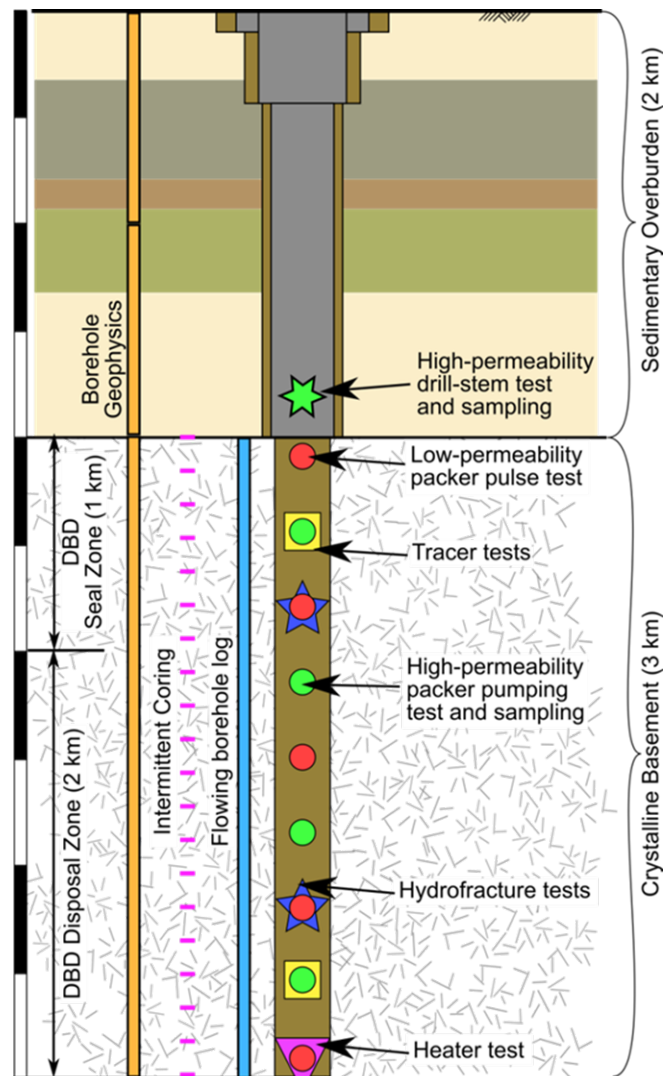
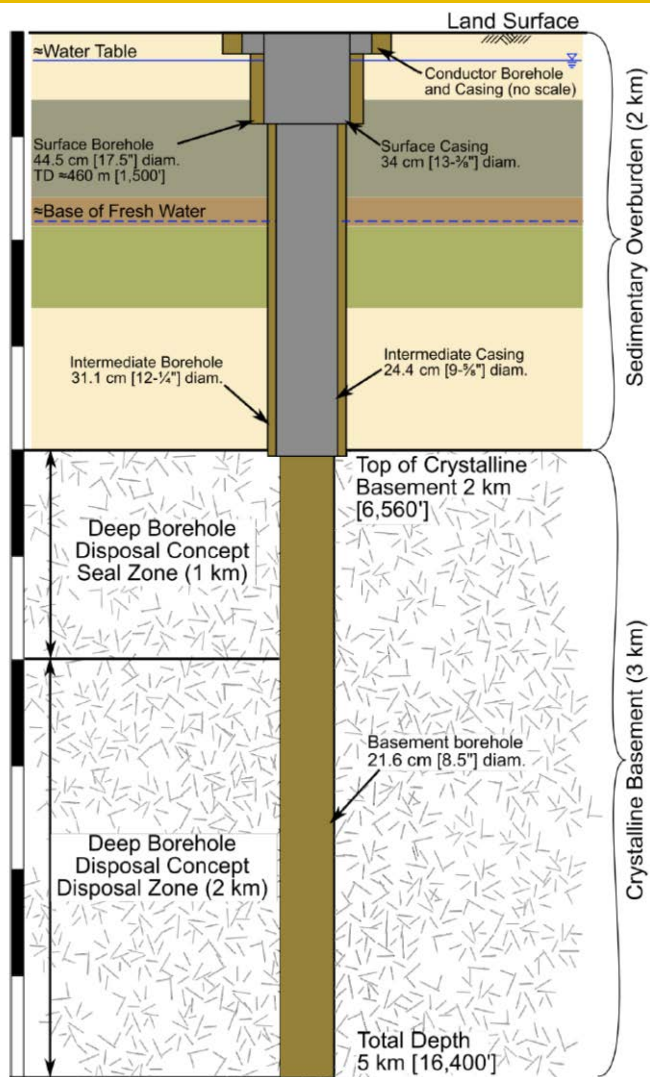
**Used  
Fuel  
Disposition**

---

# **Backup Slides**

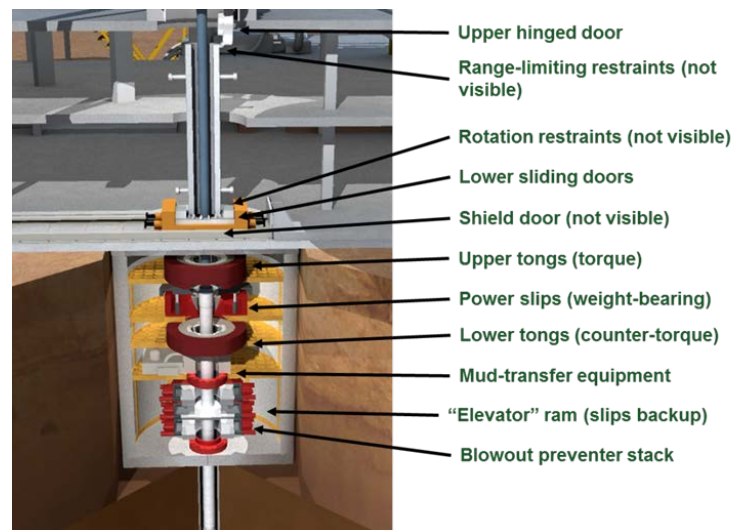
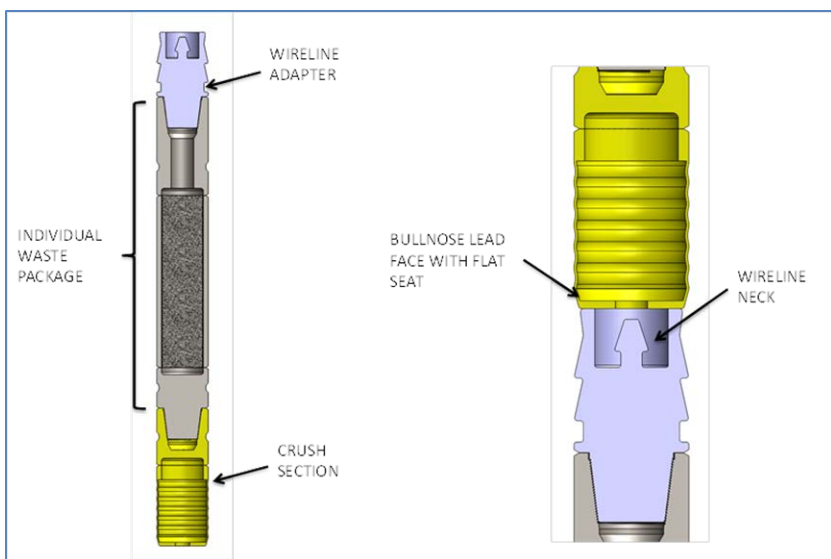
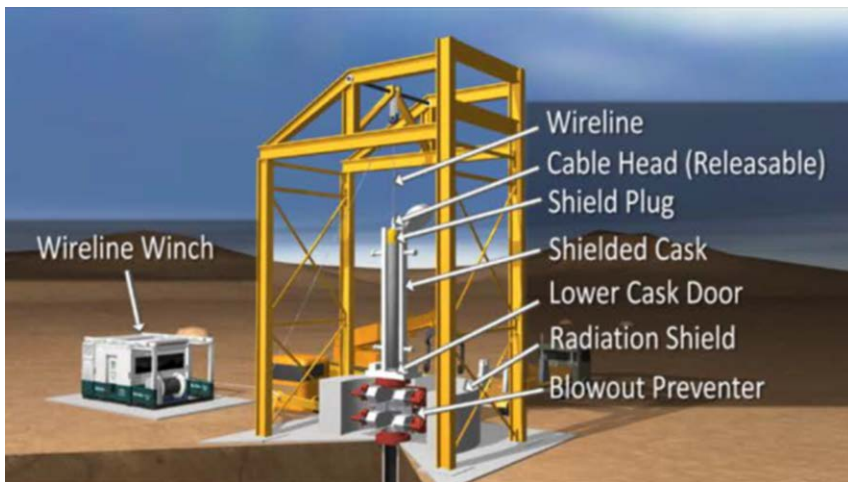
# Used Fuel Disposition

# Characterization Borehole Casing Plan and Testing Diagram



# Used Fuel Disposition

# Field Test Borehole – Conceptual Designs for Mock-Ups, Handling, Operations Demonstrations



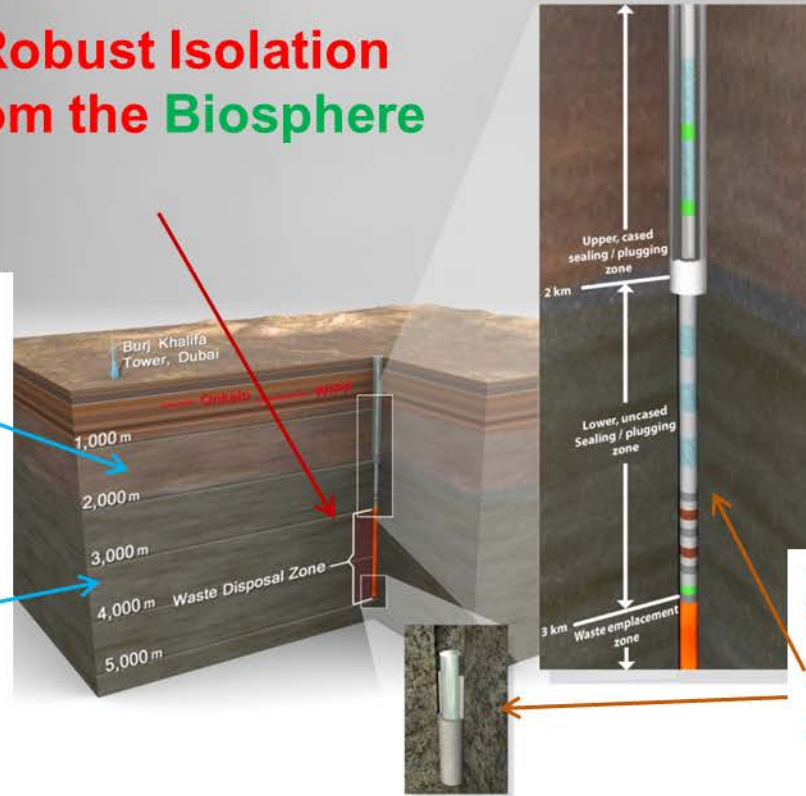
# Used Fuel Disposition

## DBD Post-Closure Conceptual Model – Components

### Robust Isolation from the Biosphere

#### Natural System

- Overlying Sediments
- Crystalline Basement
  - Isolated from shallow groundwater (low permeability and long residence time)
  - Density stratification (saline groundwater underlying fresh groundwater) opposes upward convection
  - Geochemically reducing conditions limit the solubility and enhance the sorption of many radionuclides



#### Engineered Barriers

- Waste forms
- Waste packages
- Borehole seals (and DRZ)