Spent Fuel and Waste Science and Technology

Laboratory Testing Approach for Intermediate Scale Borehole Heater Test

Melissa Mills

Sandia National Laboratories

SFWST Working Group Meeting

May 23, 2017

Overview

- **Pre-field test materials interaction experiments**

- **Laboratory investigations and experiments of samples before and after the test include:**

  - Core Analysis

  - Brine Evaporation

  - Gas Analysis

  - Brine Analysis

Core Analysis

- **Impurities**
  - Hydrous minerals that influence gas and brine samples

- **Microstructural**
  - Details of any apparent deformation mechanisms
  - Micro-mechanic processes are important for long-term performance of heat-generating repositories

- **Flow and Pore Properties**
  - Porosity (He porosimetry)
  - Pore size distribution (Hg-injection porosimetry)
  - Pore network and brine distribution (small-angle neutron scattering, Robo-Met 3D)

Gas and Brine Analysis: Composition

Gas

- **Gas Chromatograph**
  - Major and key noble gases (e.g. He and Ar)
- **Gas specific field detection equipment**
  - Anticipated HCl gas

Brine

- **Thermal-gravimetric analysis (TGA)**
  - Estimate inter- and intra-granular brine as well as moisture associated with different mineral and their phases (gas chromatograph could also be connected)
- **Ion Chromatography (IC)**
  - Cations (Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Li^+) and Anions (Cl^-, Br^-, F^-, NO_3^-, SO_4^-)
- **Ion Coupled Plasma (ICP)**
  - Other major and minor ions

Brine Analysis: Chemistry

- **Natural WIPP brine chemistry is difficult to accurately measure**

- **Deal et al. 1989 did extensive natural brine analysis but problems existed**

- **Current WIPP procedures use correction factors and simulated synthetic brines**
  - Synthetic brines do not include the level of complexity found in natural WIPP brines
- **Properties interested in are as follows:**
  - pH
  - Alkalinity
  - TDS
  - Density
  - Electrical Conductivity

Brine Analysis: Chemistry Measurements

■ pH

– pH meter with high ionic strength pH standards for calibration to correct for electrode junction potential errors
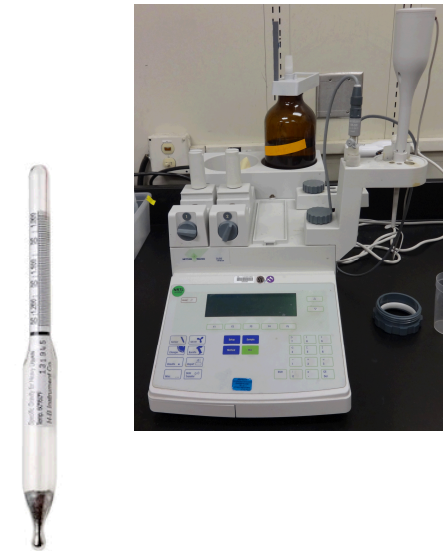
■ Alkalinity

– Titration by autotitrator

■ TDS

– Evaporation and mass measurements

■ Density or specific gravity

– Hydrometer

■ Electrical Conductivity

– Conductivity meter

Brine Analysis: Preliminary Results

■ **Three samples gathered from Feb. 2017 visit from previously drilled horizontal boreholes**

■ **Filtered and diluted 1:1000 (IC) and 1:10000 (ICP)**

■ **Na-Mg-Cl brine**

Sample	Concentration (g/L)										
	F	Cl	Br	NO$_3$	SO$_4$	Li	Na	NH$_4$	K	Mg	Ca
SNLCH114(yellow)	0.02	259	2.9	0.03	29.9	0.04	44.9	3.05	30.5	49.6	0.01
SNLCH111 #1	0.02	271	3.1	0.04	32.1	0.04	44.0	2.88	32.2	52.3	0.01
SNLCH111 #2	0.02	280	3.2	0.02	33.1	0.04	45.0	2.97	33.0	53.7	0.04

IC Analysis

Brine Analysis: Preliminary Results

■ **ICP-Mass Spectrometry Semi-Quant scan**