SAND2015-4506C

Used Fuel Disposition Campaign

Experimental Studies of Sorption, Diffusion, and Swelling in Clay Minerals

Ed Matteo

Nuclear Waste Disposal Research and Analysis

enmatte@sandia.gov

UFD Working Group Meeting

Las Vegas, NV

June 2015

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.
SAND Number: 2014-4732C

Used Fuel Disposition Campaign

Sandia National Laboratories

Experimental Studies of Sorption, Diffusion, and Swelling in Clay Minerals

Our Team:

Jessica Kruichak[1], Melissa Mills[1], Clay Payne[1], and Yifeng Wang[1]

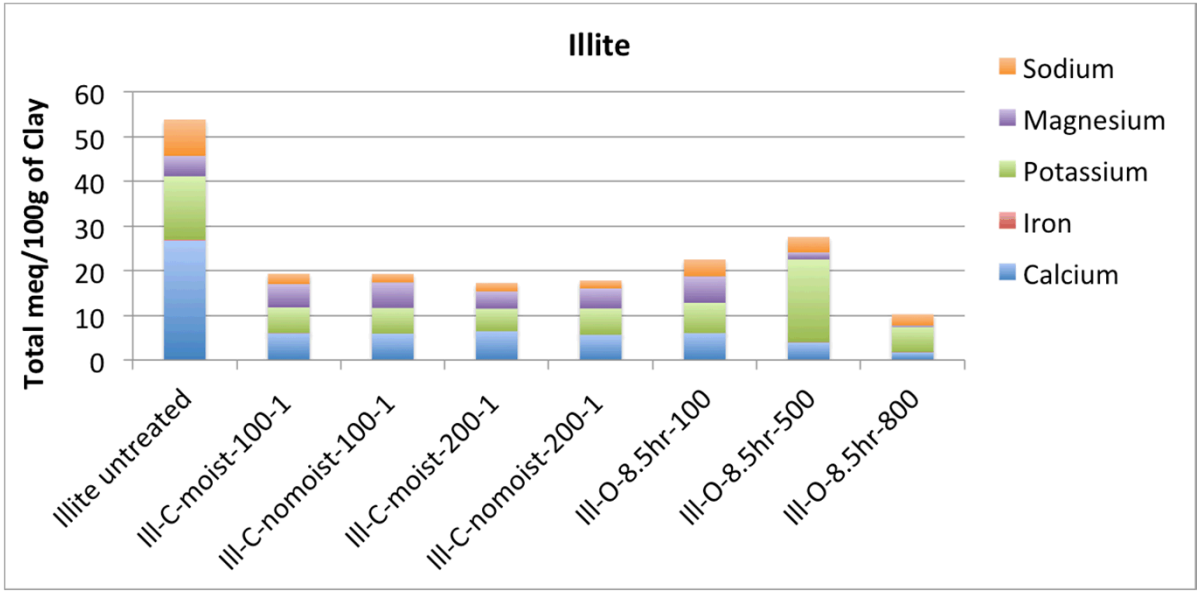
[1] Sandia National Laboratories, Nuclear Waste Disposal Research and Analysis, P.O. Box 5800, Albuquerque, NM 87185-0779, USA

U.S. DEPARTMENT OF ENERGY | Nuclear Energy

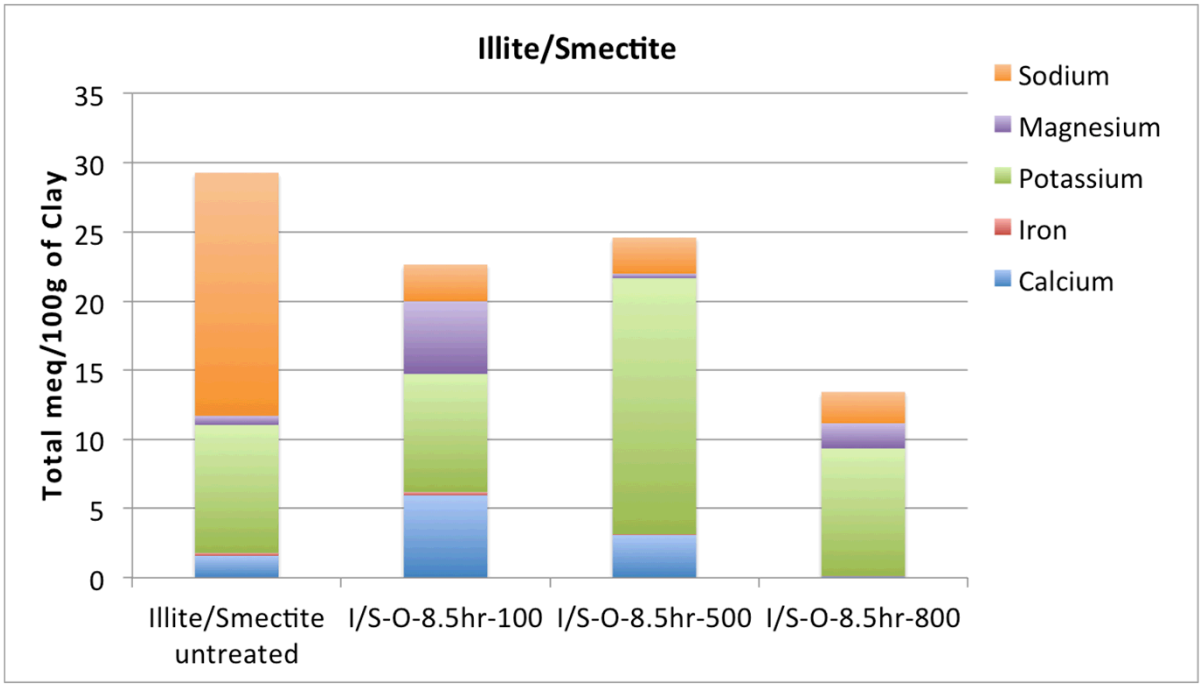
Sandia National Laboratories is a multi program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND #: .

NNSA National Nuclear Security Administration

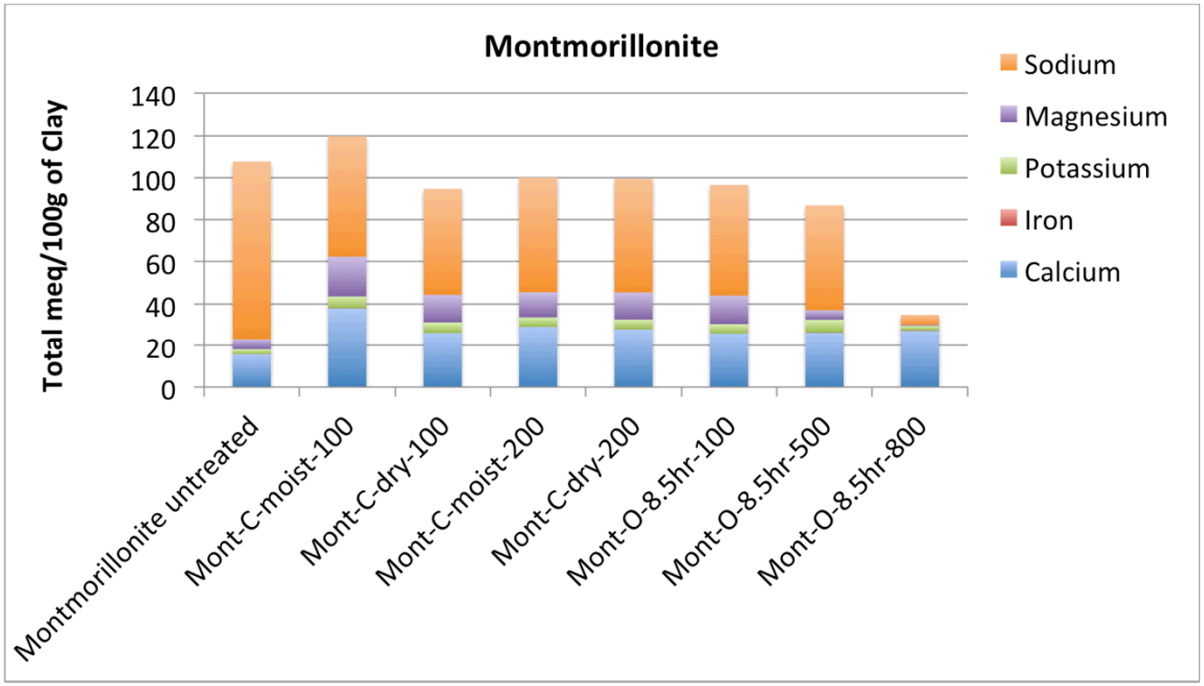
PART 1: Sorption (CEC) Measurements on thermally treated clays



PART 1: Sorption Measurements on thermally treated clays

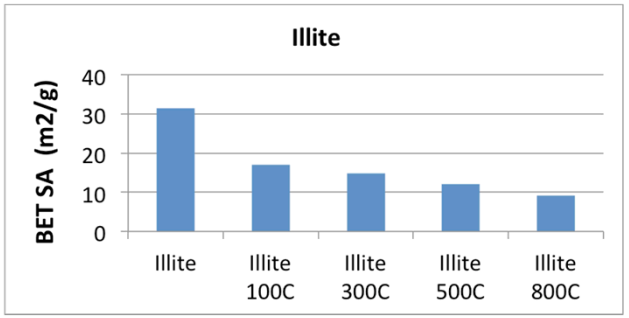


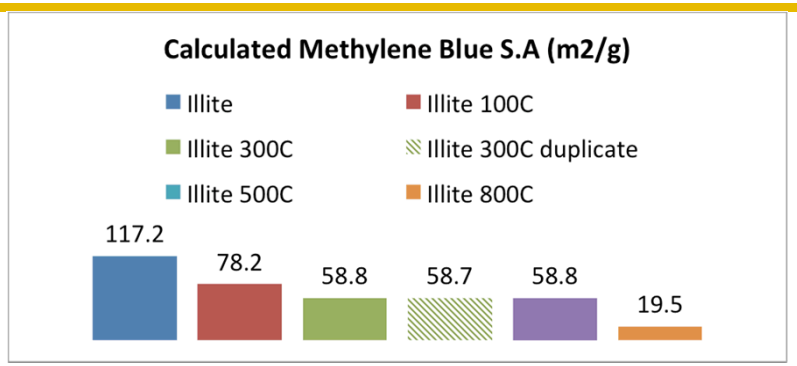
PART 1: Sorption Measurements on thermally treated clays

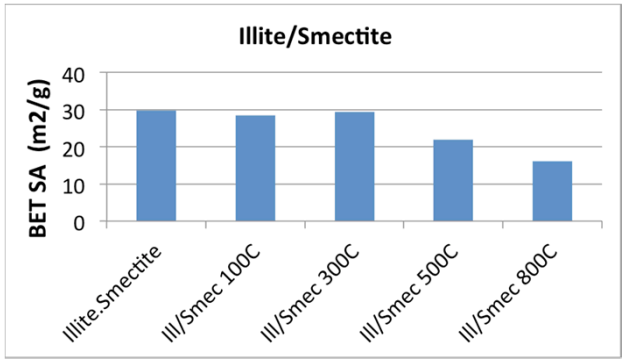


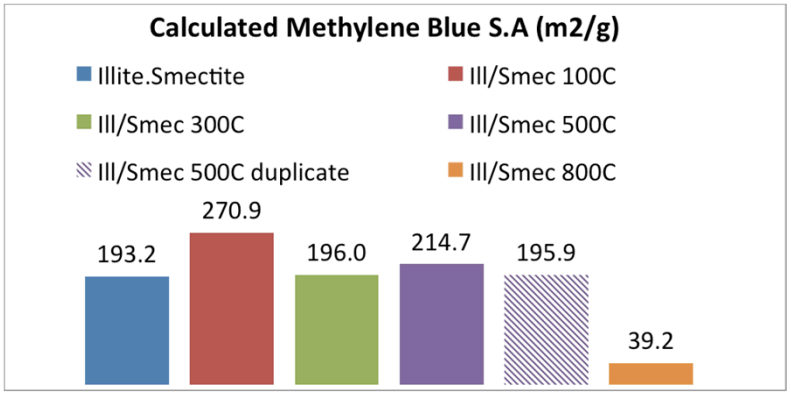
Used Fuel Disposition

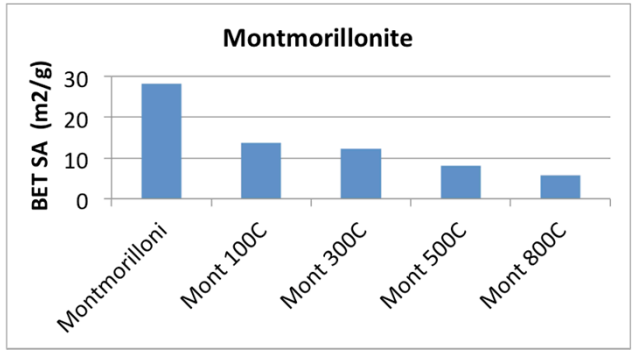
PART 1: Sorption Measurements on thermally treated clays

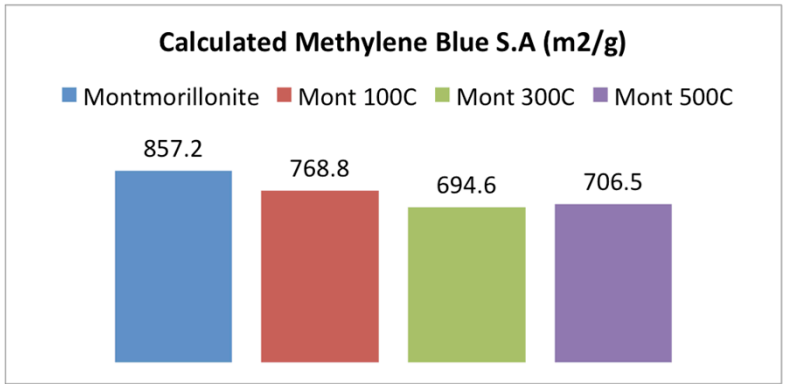








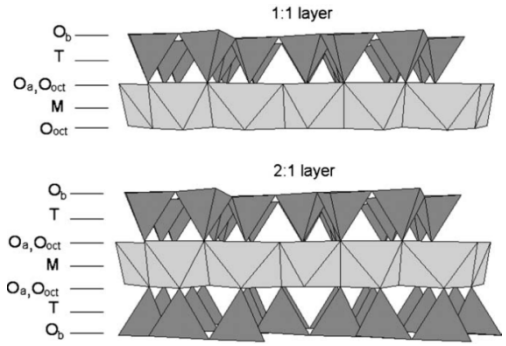




Used Fuel Disposition

PART 2: Iodide diffusion behavior

Clay mineralogy

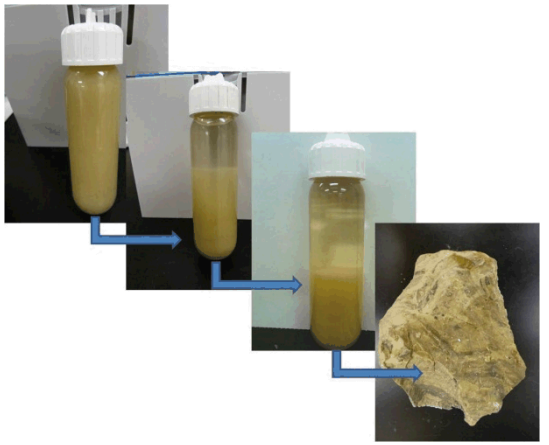


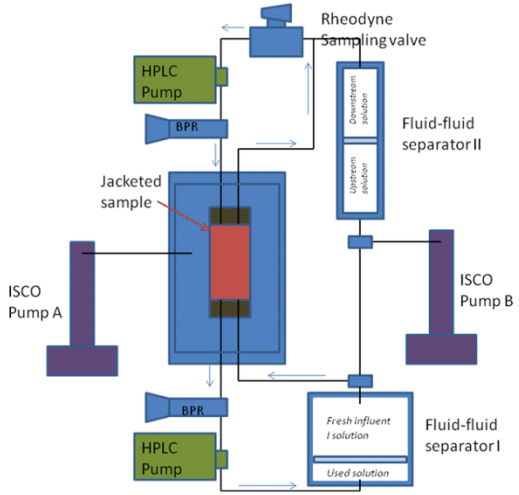
***Handbook of Clay Science**, Eds.: Bergaya, F., Theng, B.K.G., Lagaly, G.; Elsevier, 2006.*

Potential reasons for anion interactions

1. *Interactions?… what interaction?*
2. *Iodine redox -> oxyanions*
3. *Clays impurities*
4. *Nano-environments*

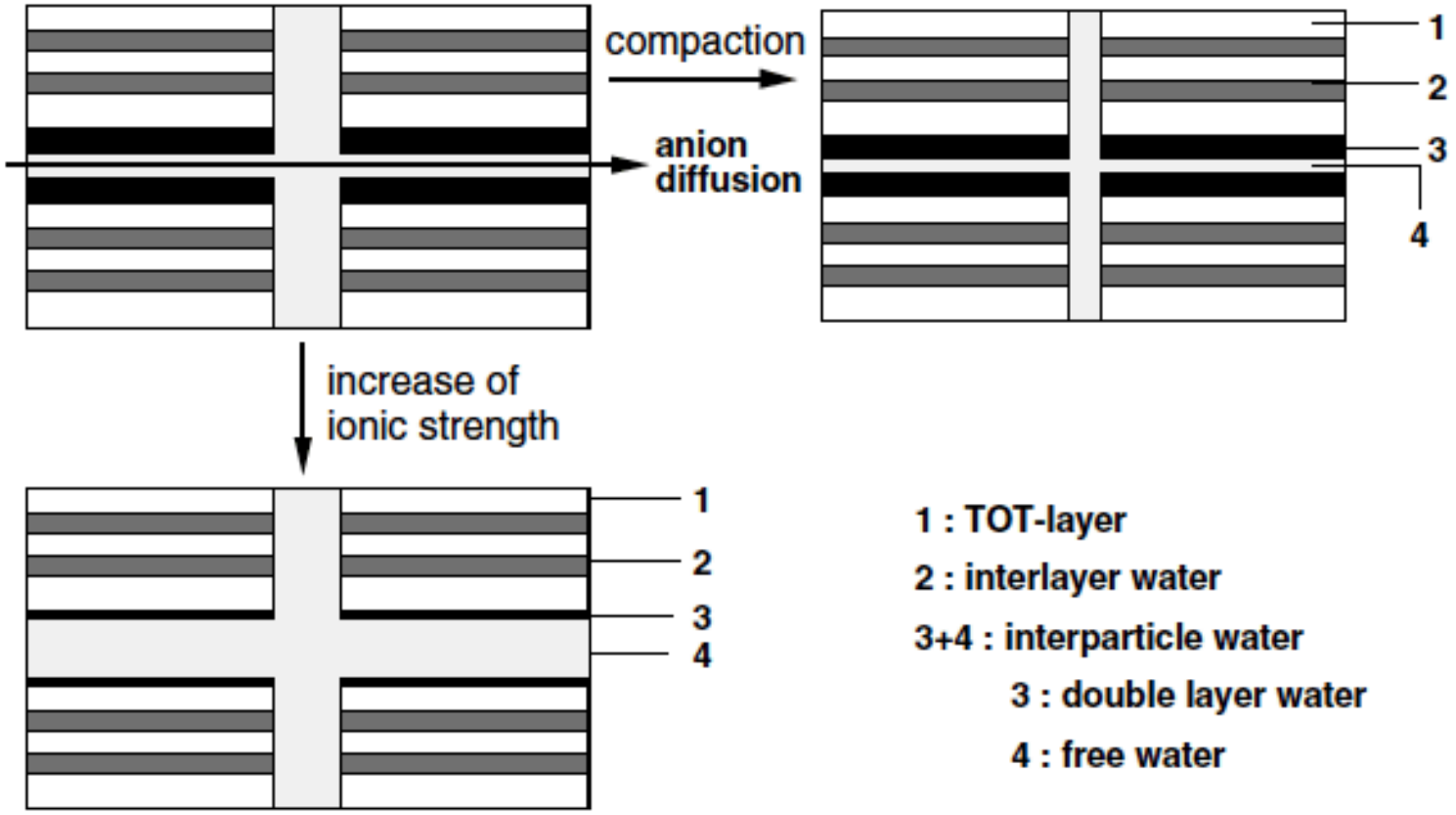
Experimental conditions/results





Sandia National Laboratories

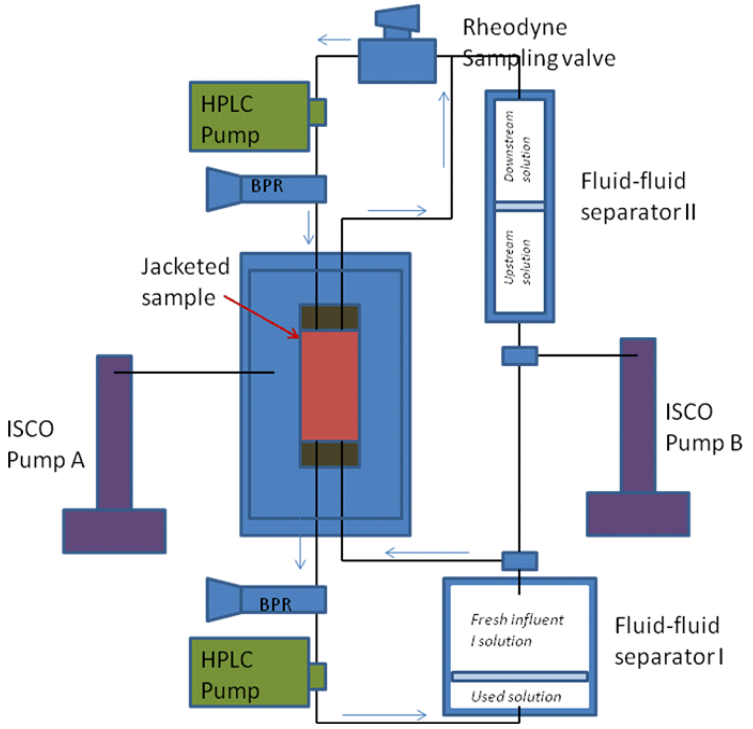
Anion Exclusion in Clays



L.R. Van Loon et al. / Applied Geochemistry 22 (2007) 2536–2552

Drawbacks of the HP, flow through diffusion setup

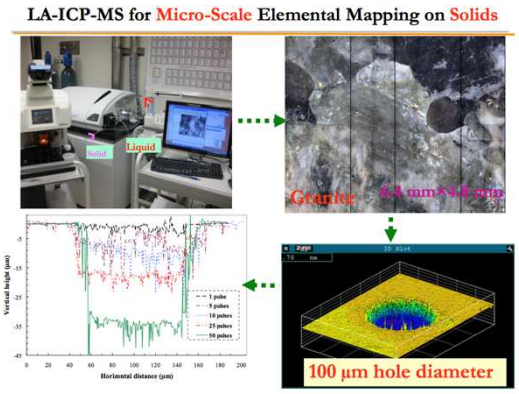
- Long setup and experiment times due to:
  - Saturation
  - Measuring of break-through
- Sampling resolution
- Sensitivity of diffusion process to sampling interval
- Limited range of compaction densities worked with the system



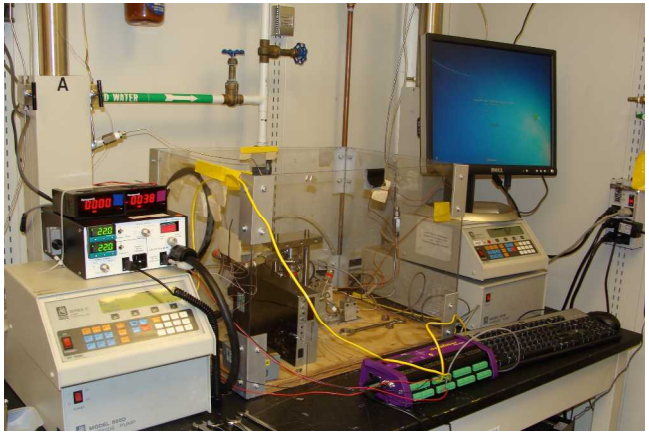
New Method of Pellet Preparation

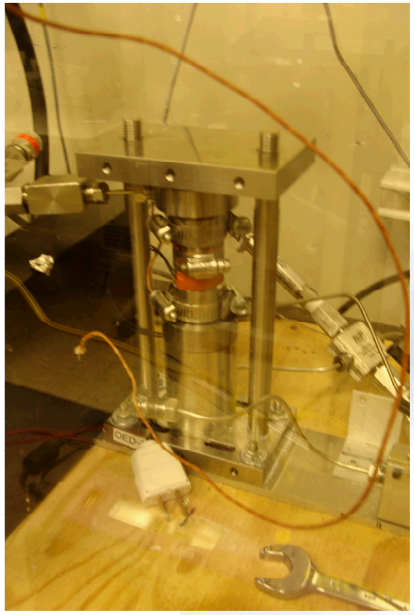
- Press pellet to desired compaction density
- Encase pellet in teflon sleeve with micro-porous hastelloy frits
- Load pellet-frit assembly into centrifuge tube to saturate pellet
  - Old setup = 30 days
  - New setup < 30 hours
- Flow-through diffusion set-up
- Freeze dry pellet
- Laser Ablation ICP-MS (LA-ICP-MS) for 2D distribution of elements

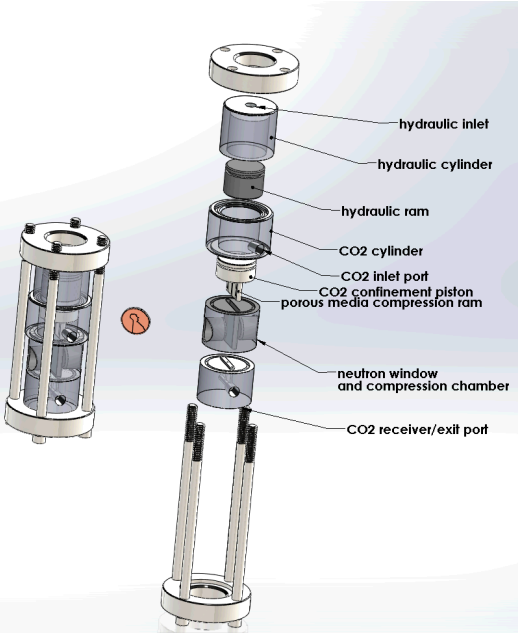
- ***Advantages over HP system***
  - No clogging, sampling issues
  - Multiple pellets in parallel
  - Faster end-to-end experiment cycle



PART 3: Swelling Measurements on thermally treated clays





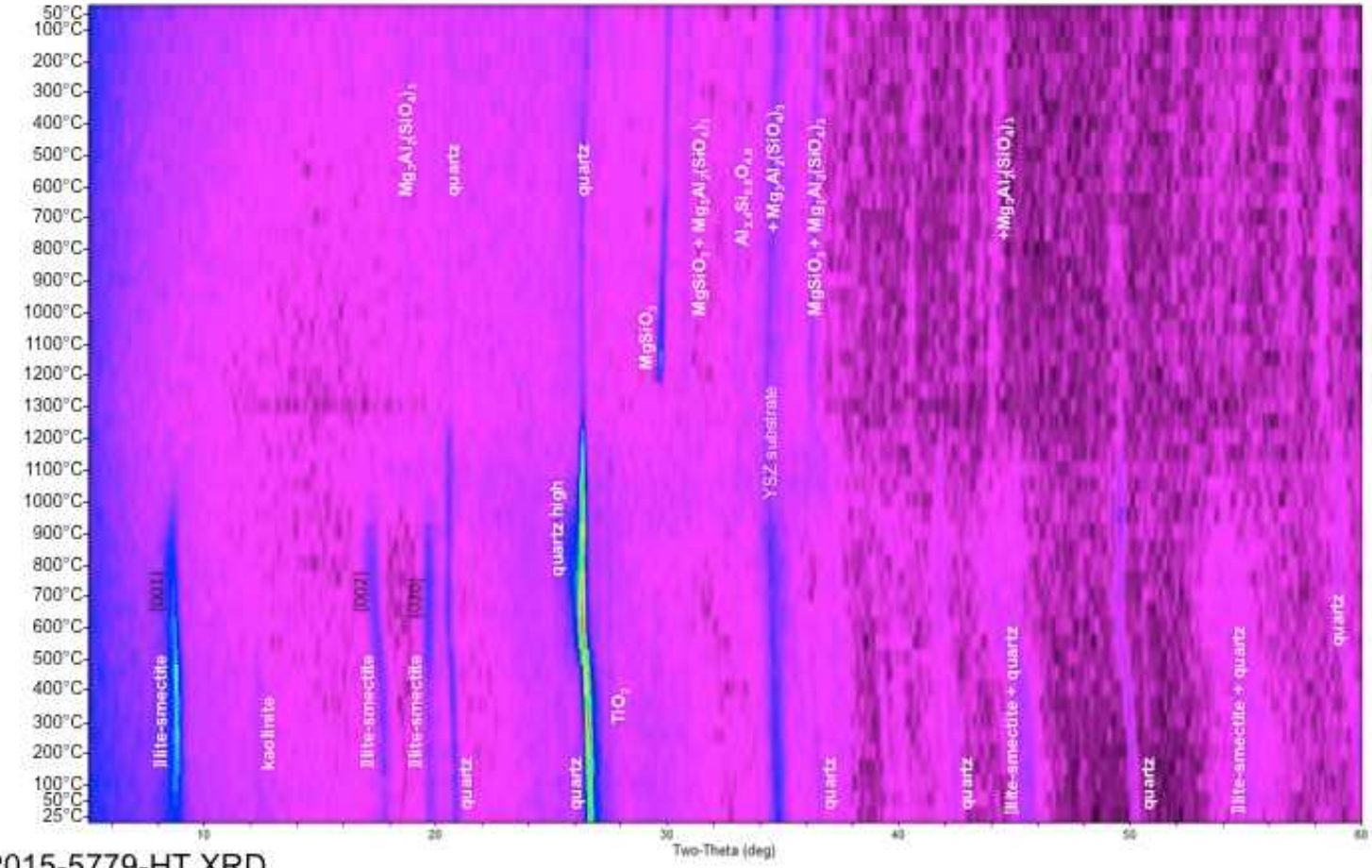


- ***Oedometer swelling system***
  - Allows for Const. P **or** Const V swelling measurement
  - Measures Pore Pressure, and displacement (via LVDT)

Back-Up Slides

XRD of thermally treated Illite

HT XRD results for: **Illite <75um** (Heating profile room temp → 1300°C → room temp, 50°C increments in static air.)

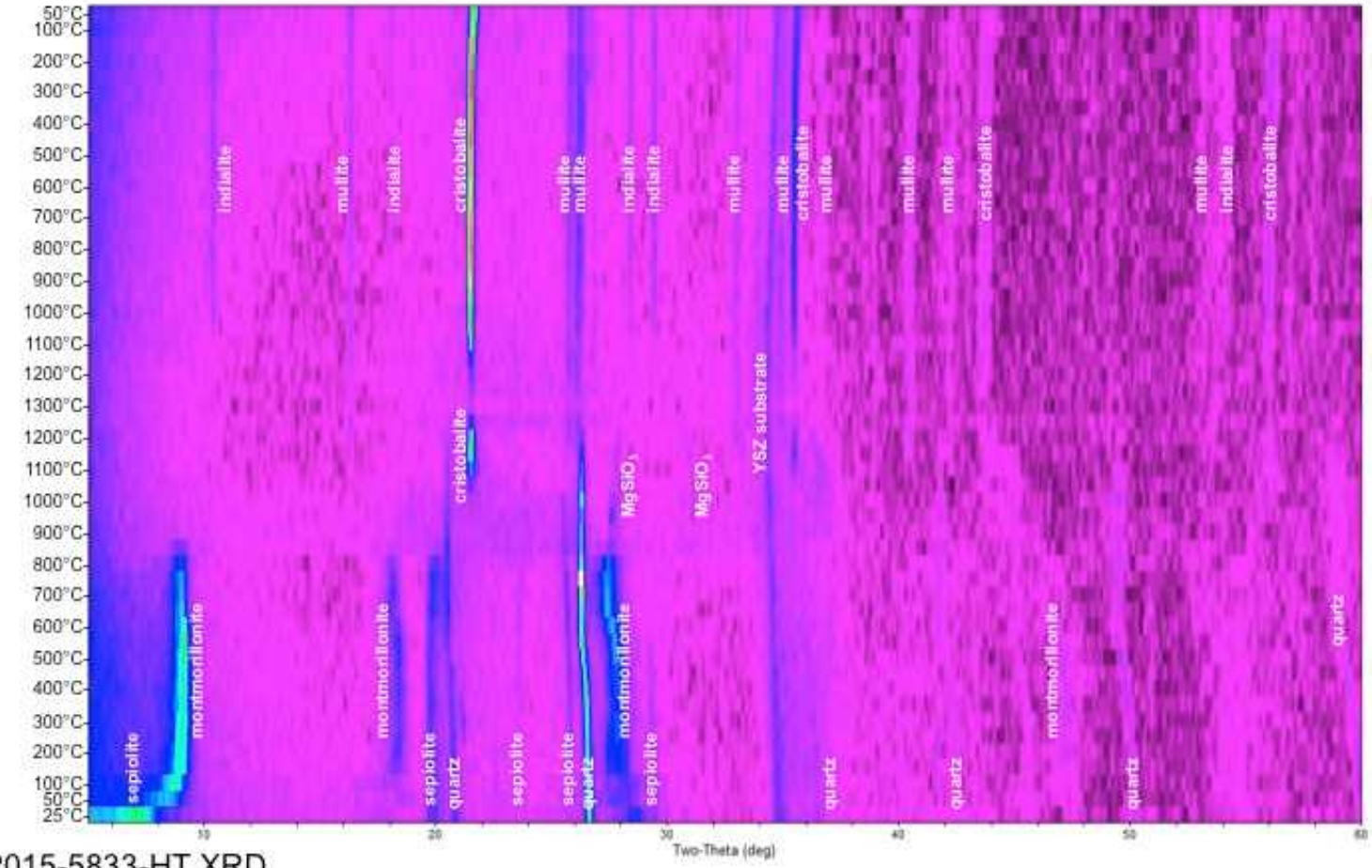


2015-5779-HT XRD

Used Fuel Disposition

XRD of thermally treated Smectite

HT XRD results for: **Smectite <75um** (Heating profile room temp → 1300°C → room temp, 20°C increments in static air.)



2015-5833-HT XRD

PART 3: Swelling Measurements on thermally treated clays