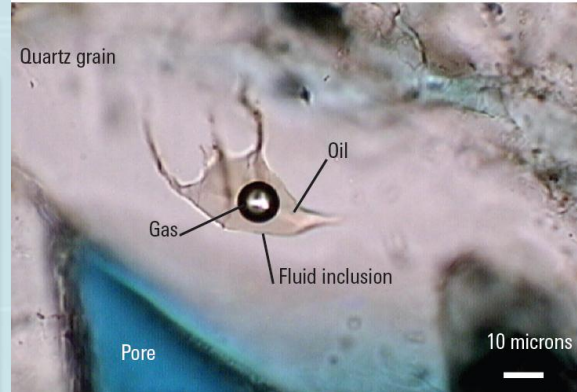
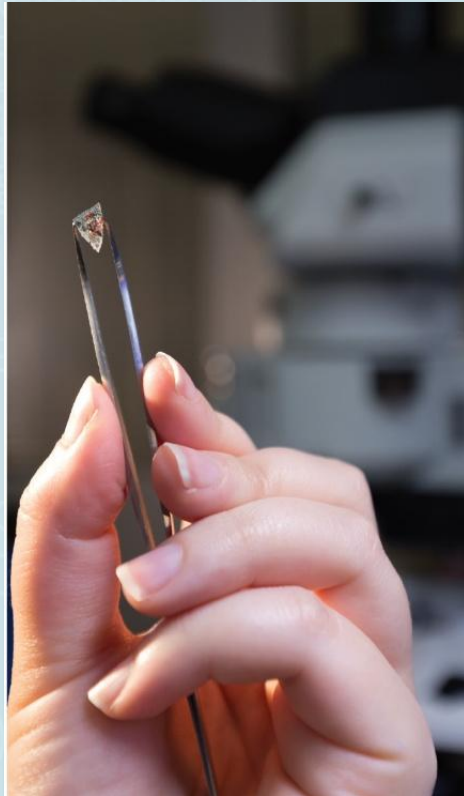


# **Evidence of Seal Integrity and Internal Baffling Using Fluid Inclusion Analysis on Legacy Cuttings from the Illinois Basin Decatur Project**

Seth Cowan, Barbara Hill, JC Chao, Wipawon Phiukhao, Donald Hall

# What are Fluid Inclusions?



## Definition: Fluid Inclusions (FI)

- Subsurface waters, oils and gases trapped in microscopic cavities
- Past or near-present-day pore fluids info

## Advantages

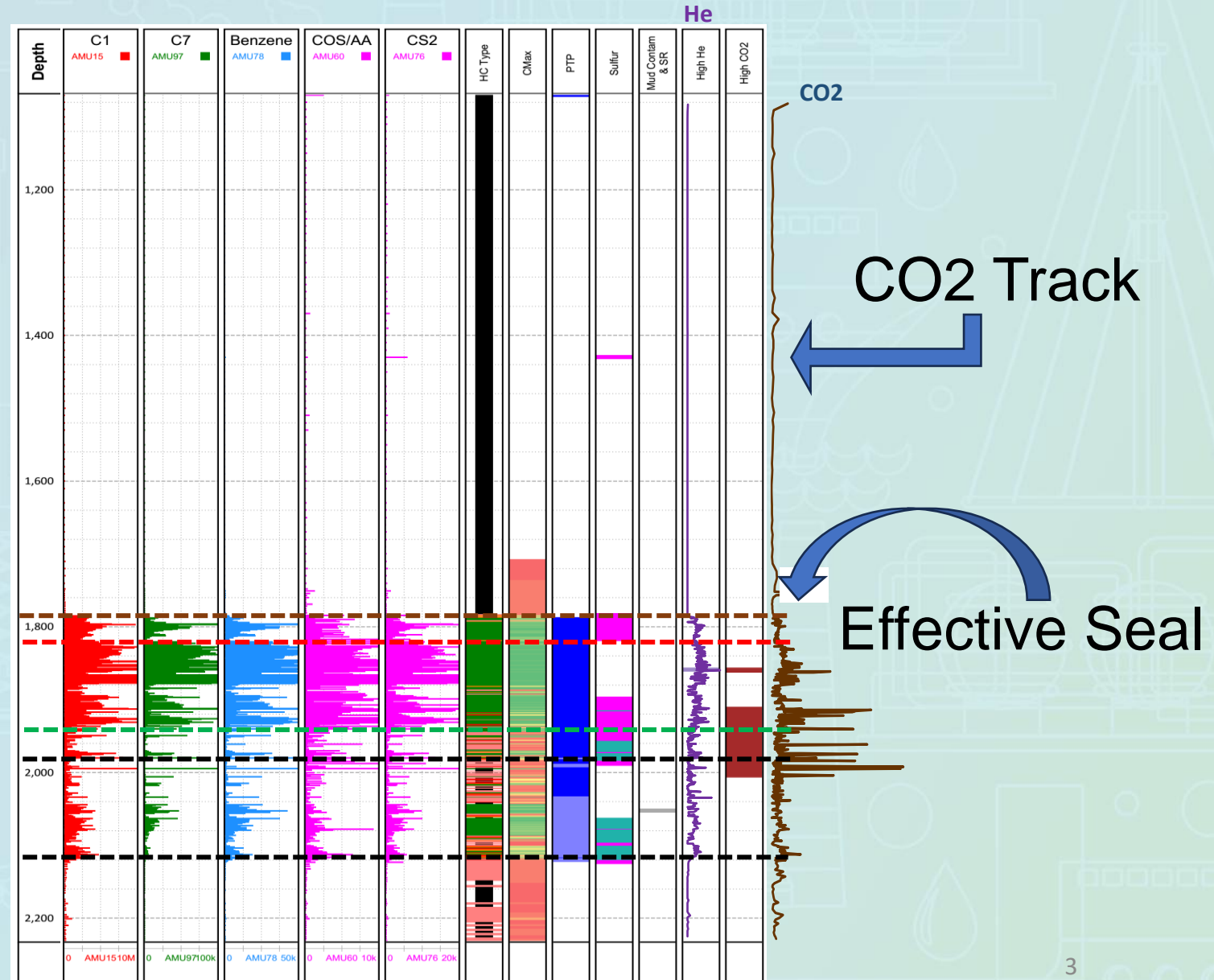
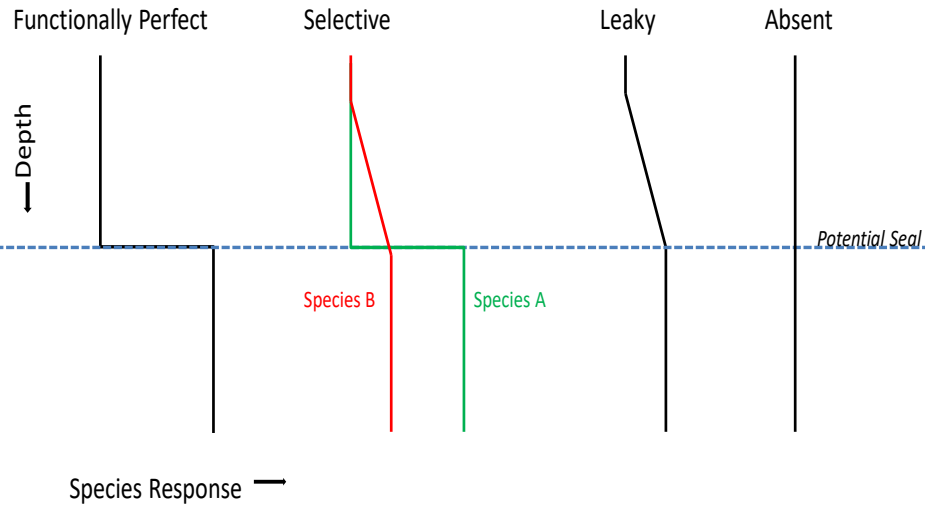
- Occur in all formations
- No shelf life
- Any rock material can be analyzed
- Minimal sample material (0.5g) required
- Not affected by drilling mud



# Introduction

- Analyzing seal efficacy
- Legacy cuttings
- From proven CO2 injection site

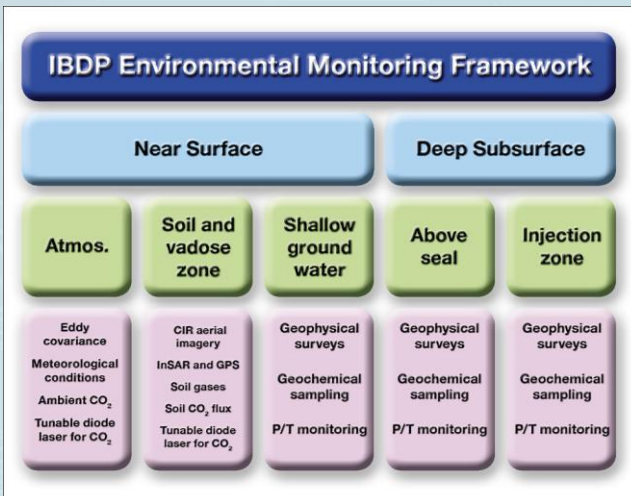
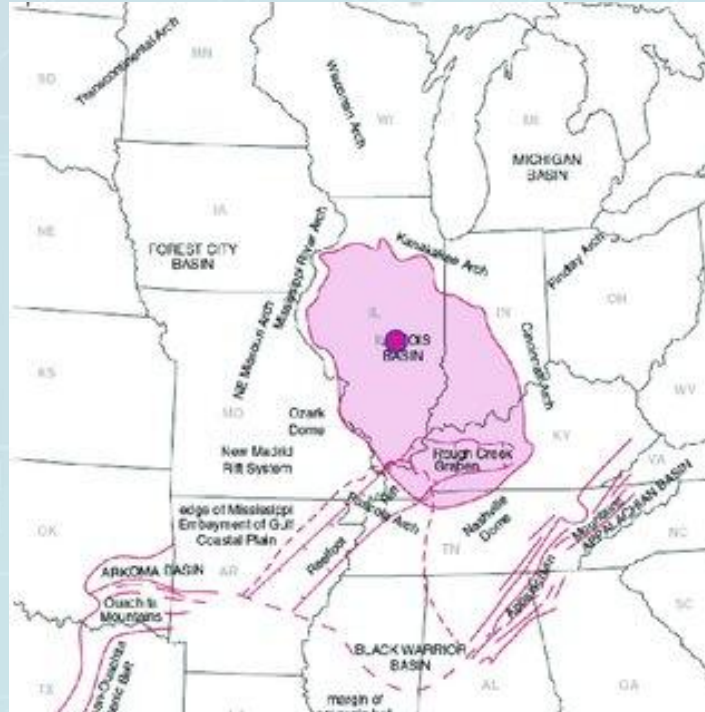
## Schematic FIS Seal Characteristics





# Illinois Basin Decatur Project (IBDP)

- 2011-2014 active CO<sub>2</sub> injection
- >1 million metric tons stored
- Principal target reservoir => Lower Mt. Simon Sandstone
- Anomalously high porosity
- VW1 approximately 0.7 miles from CCS1



Reference: Illinois Basin – Decatur Project (IBDP) | netl.doe.gov

# Illinois Basin Decatur Project (IBDP)

- **Objectives**

- Understanding the efficacy of using legacy cuttings as a screening tool for site assessment prior to drilling the first well in a CO<sub>2</sub> sequestration project

- **Scope**

- Analysis of the composition of fluid inclusions from a full suite of wellbore cuttings obtained from the IBDP well VW#1

- **The Illinois Basin – Decatur Project (IBDP)**

- A large-scale CCS project
- Key participants

- **Purpose**

- Demonstrate safe and effective storage of CO<sub>2</sub> in a saline reservoir
- Monitor environmental safety and human health

- **3 Phases**

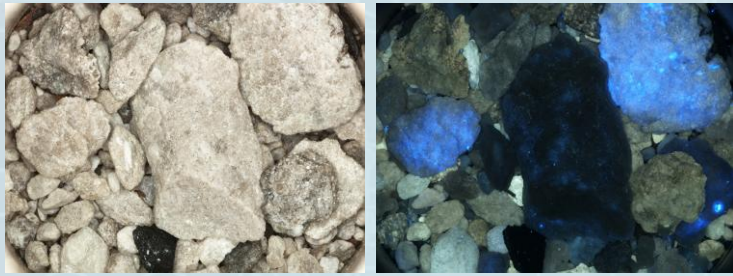
- Baseline data
- Operational injection (2011 - 2014)
- Post-injection monitoring (2014 - 2021)





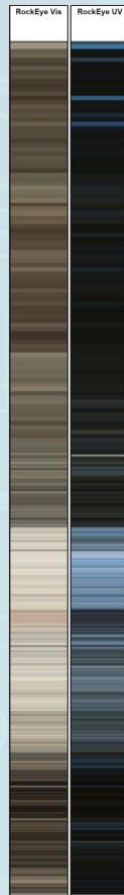
# Screening Process

## High-Resolution Photography

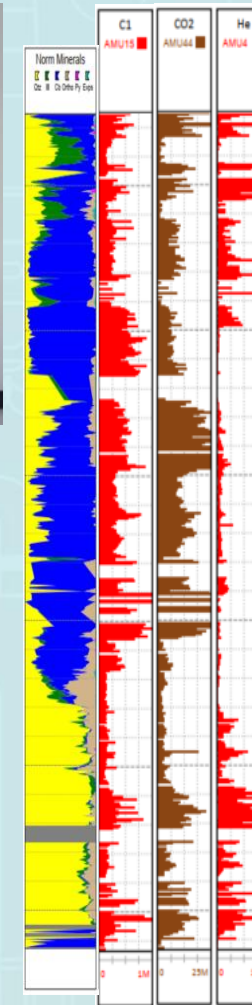


- Image in white light and UV
- Images are focus-stacked
- Grain scale details of porosity, texture, rock types, etc.
- Mineral fluorescence correlated with cement or rock types

## Fluid Inclusion Stratigraphy (FIS)



- Analysis of trapped organic and inorganic volatiles
- amu 1- 180, spectra info



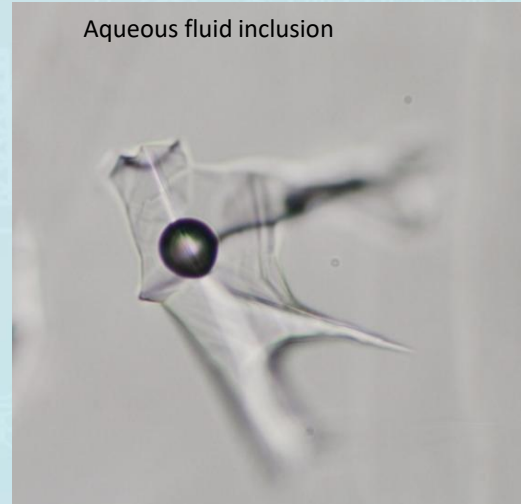
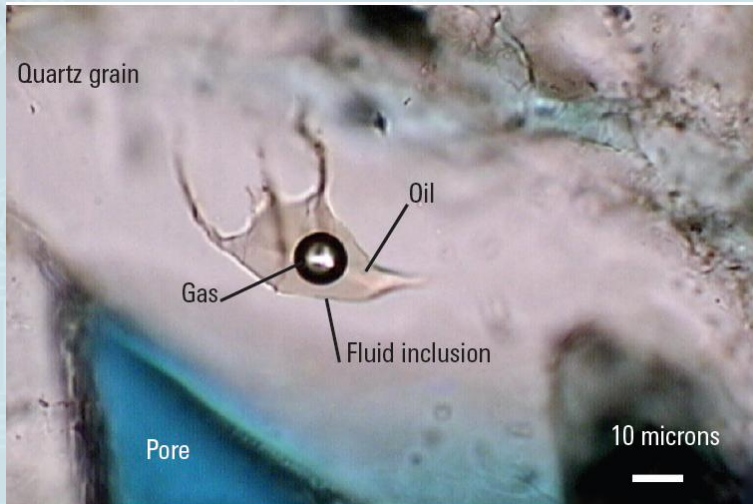
## ED X-Ray Fluorescence



- Normative mineralogy and lithology
- Chemical stratigraphy for correlation

# Fluid Inclusion Petrography & Microthermometry

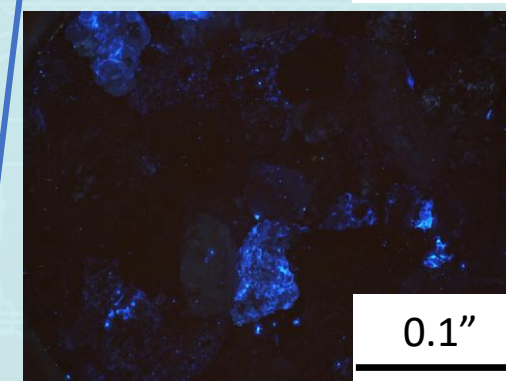
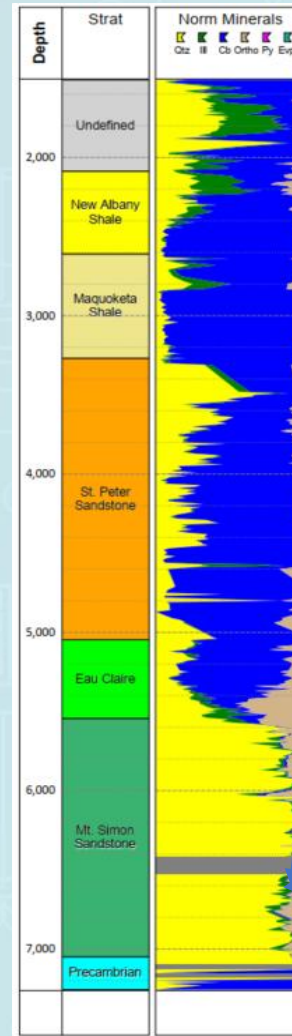
- **Fluid Inclusion Petrography**
  - Microscopic examination of rock material for trapped aqueous fluids and hydrocarbons
- **Microthermometry**
  - Salinity





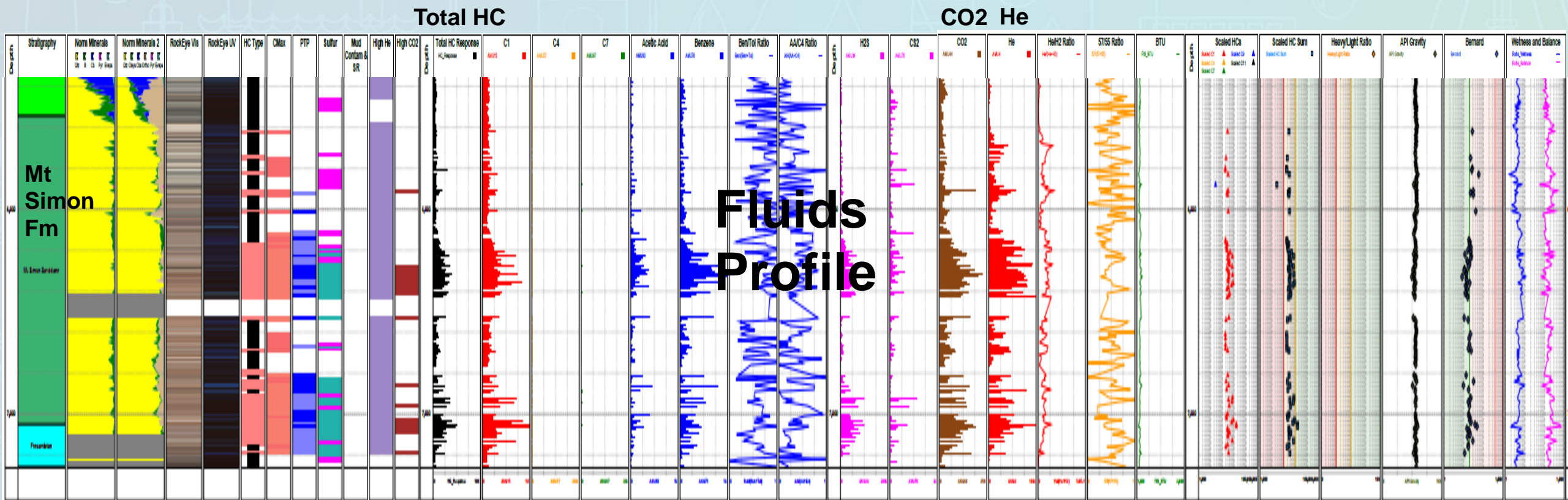
# Illinois Basin Decatur Project (IBDP) Fluid Inclusion Analysis

- **Initial Screening**
  - 488 cuttings analyzed
  - Depth range from 1510 – 7257 Ft.
  - High-Resolution Photography
  - XRF analysis
  - 20 depth intervals passed screening
- **Mineralogical Screening**
  - XRD on 29 samples
- **Optical Screening**
  - Petrography on 20 intervals
  - Microthermometry on 4 intervals





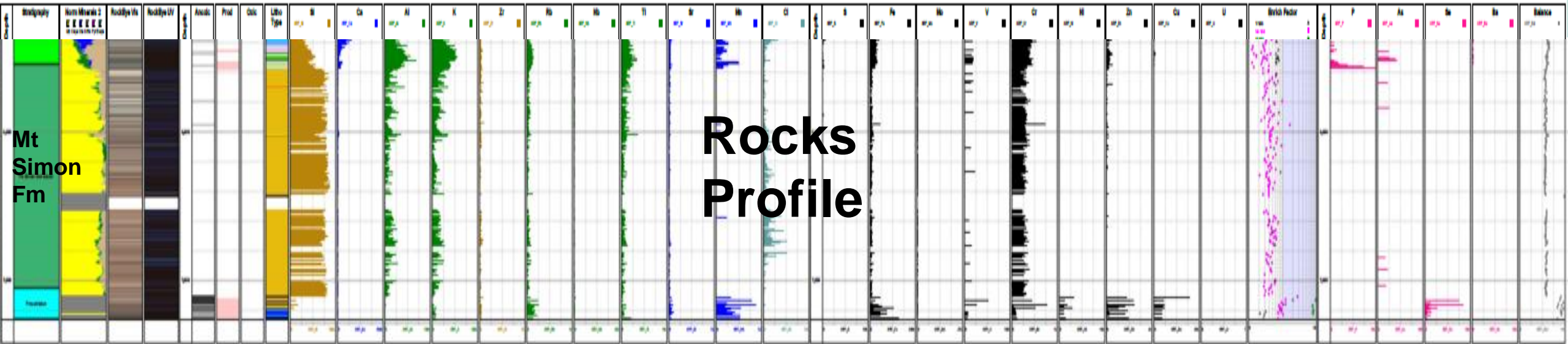
# Full Panel



# Full Panel

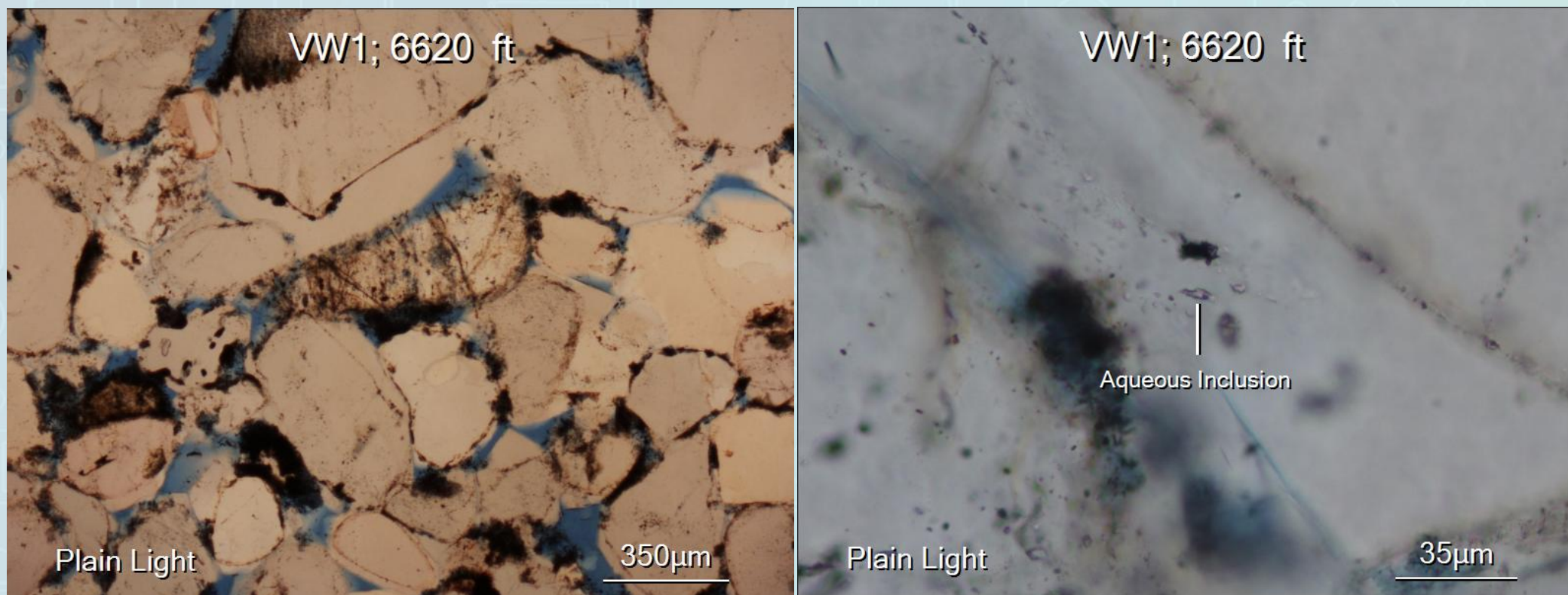
Norm.  
Mineralogy

Ca Al





## Illinois Basin Decatur Project (IBDP) 6620 ft.



Detailed Photo Micrographs at 4x and 40x zoom

## Illinois Basin Decatur Project (IBDP) Fluid Inclusion Analysis

Eau Claire

Seal Bottom of Eau Claire

Mt. Simon

- Eau Claire Formation inclusion data:

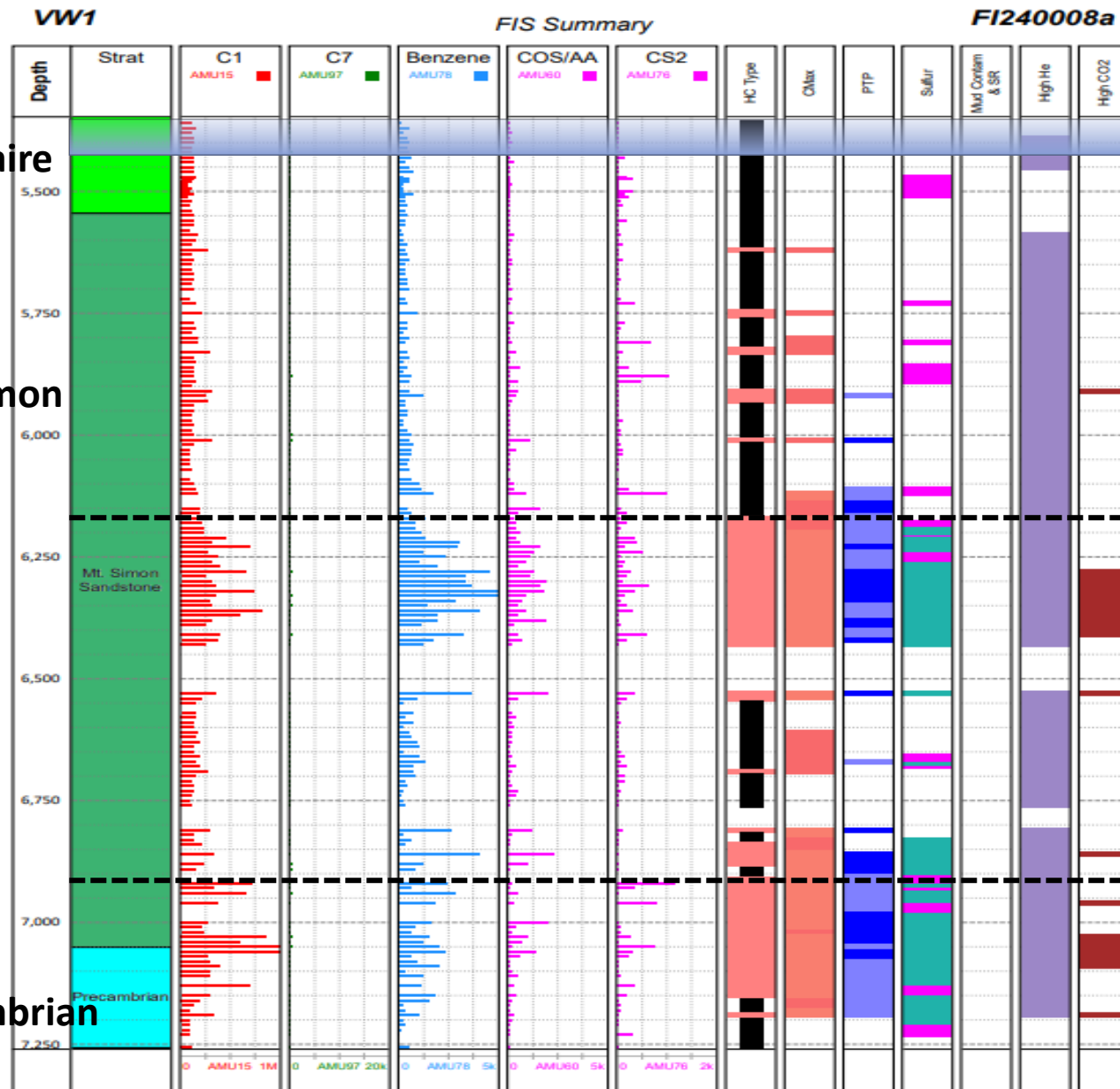
- Illustrates a sealing zone at the base of the formation

- Overlain by a more porous and permeable zone

Baffle

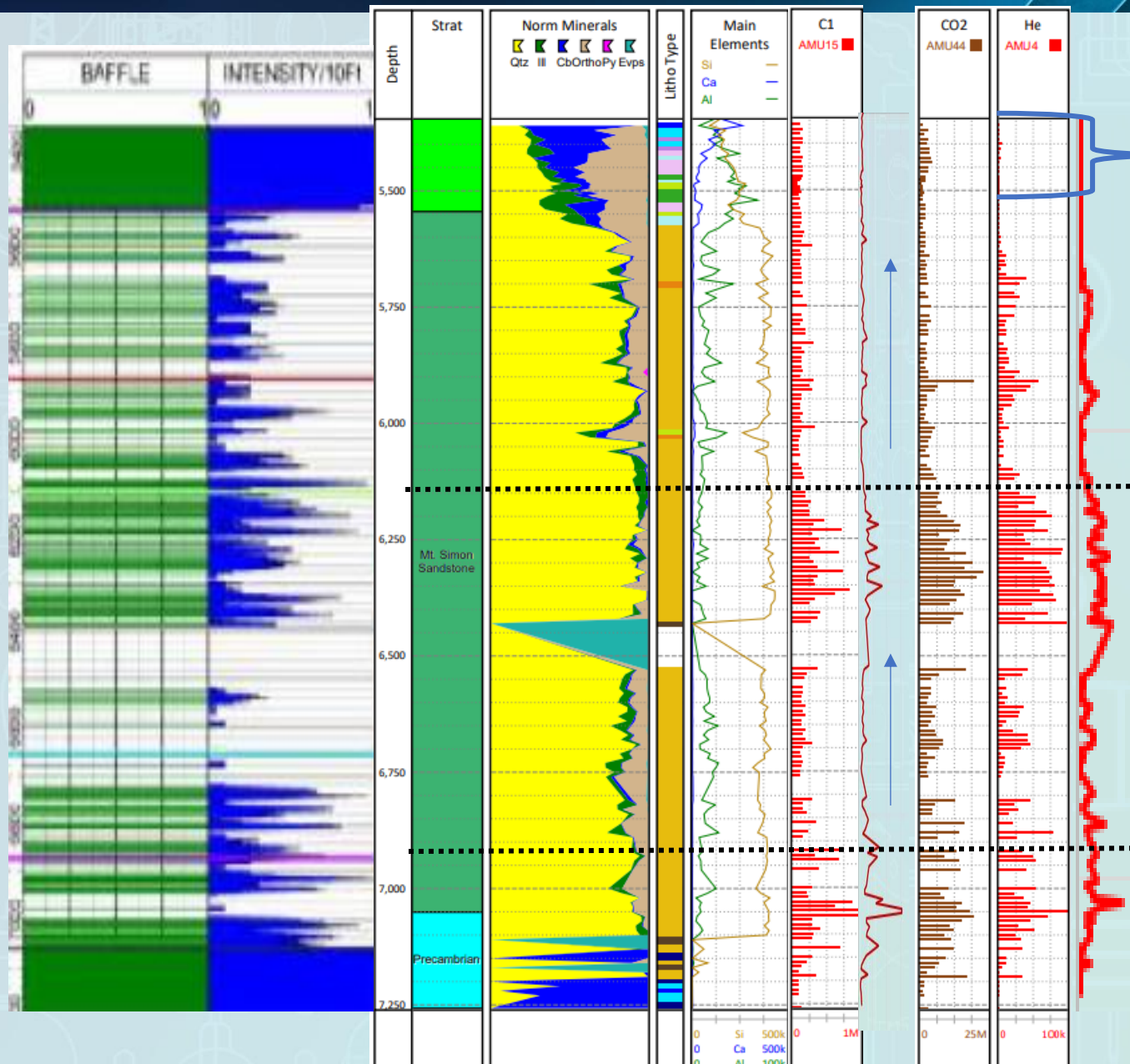
Baffle

Precambrian





- Baffle Track
- Stratigraphy
- Normative Mineralogy
- Litho Type
- Tracks
- C1 Methane
- CO2
- Helium



- Continuous profile of volatile species within fluid inclusions:

Seal

- Indicates presence of internal baffles in the Mt. Simon Formation and the Eau Claire Formation

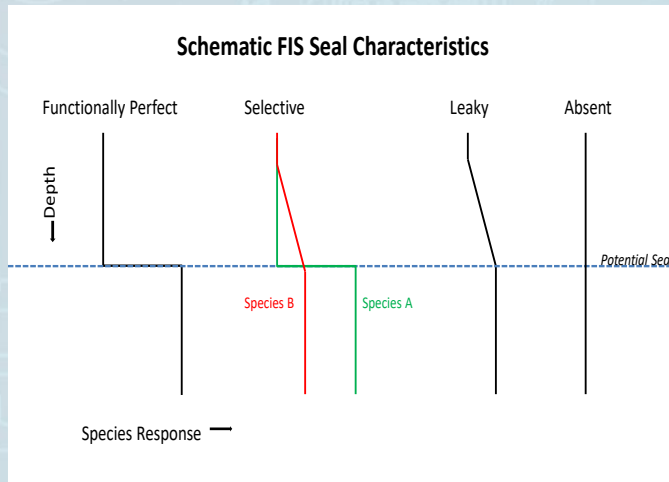
- Repeated highly anomalous signals in the Mt. Simon Formation suggest vertically discontinuous leaky seals

- Zones with highly anomalous volatile signals:

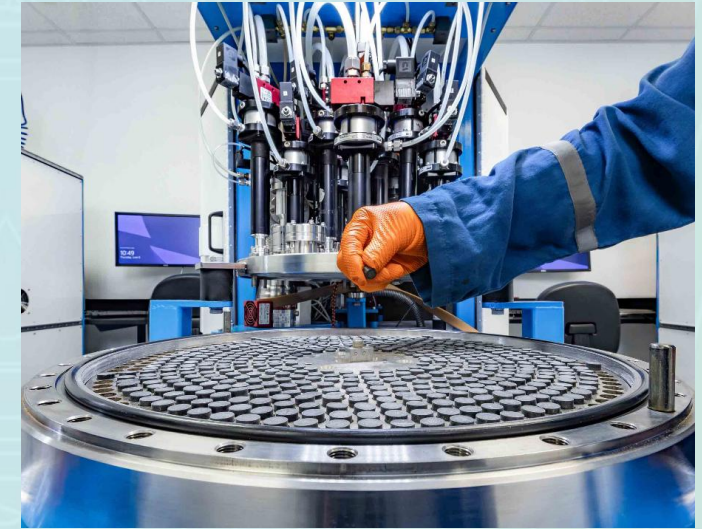
- Shown by XRF analysis to be quartz and feldspar rich

- Zones with depressed volatile signals:

- Contain a higher percentage of clays



## Results



- **Effective screening tool:**
  - Validates seal integrity
  - Locates potential baffles within injection zones of interest
- **Utilizes available archived legacy cuttings:**
  - Conducted prior to drilling the first stratigraphy well in a CO2 sequestration project



# Acknowledgments

- **Illinois State Geological Survey**
  - Nathan Webb
  - Jared Thomas
- **University of West Virginia**
  - Dr. Tim Carr
- **SLB Team**
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