

Visual Rock Characterization

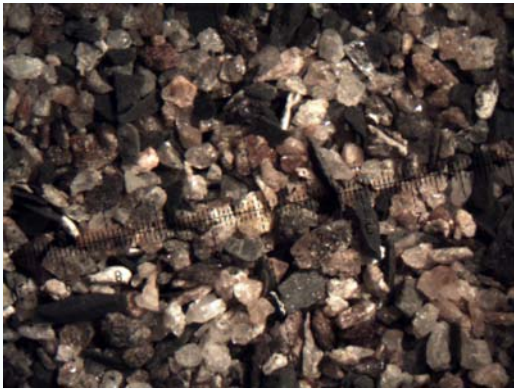
Robert K. Merrill, PhD
Catheart Energy, Inc.
Sugar Land, TX

Characterizing Oil & Gas Reservoirs

- Use as many tools as possible to measure reservoir properties at different scales
- Direct methods
 - Drilling and coring a well
 - Direct sampling of rock formations by cuttings and by cores
- Indirect methods
 - Standard suite of well logs.
 - More sophisticated logs
 - Borehole image logs for imaging the borehole wall and measuring stratigraphic and structural features
 - Nuclear magnetic resonance logs for evaluating fluids and rock permeability.
 - Seismic

Where we start

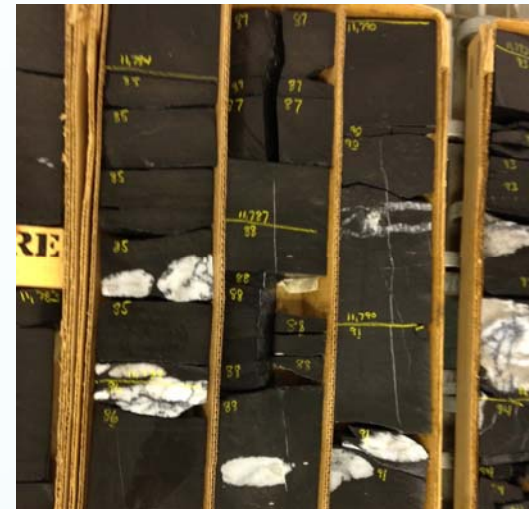
Cuttings



Sidewalls



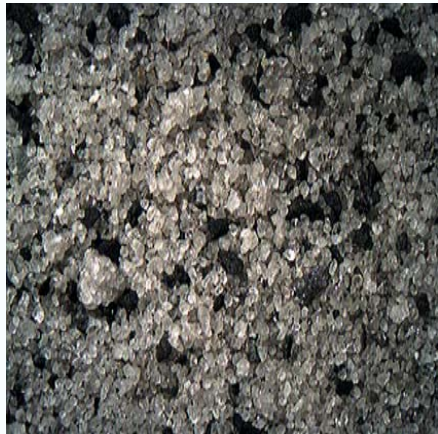
Whole Core



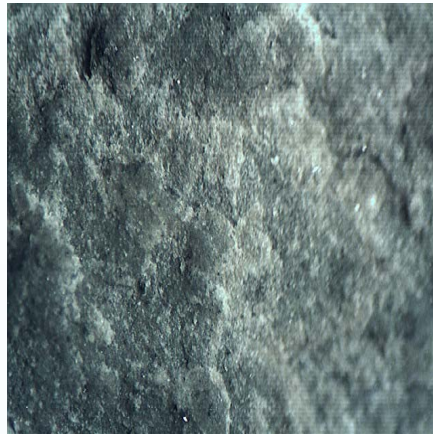
Visual Rock Characterization

- **Reservoir and Non-reservoir facies: sandstone, limestone, dolomite, and shale**
 - **Lithology and accessory minerals**
 - **Texture, Structures, Diagenesis**
 - **Porosity**
 - **Estimate mechanical properties**
 - **Test methods**
 - **Sources of error**
- **Systematic approach to describing drill cuttings and cores using the binocular microscope and reflected light**

Lithology



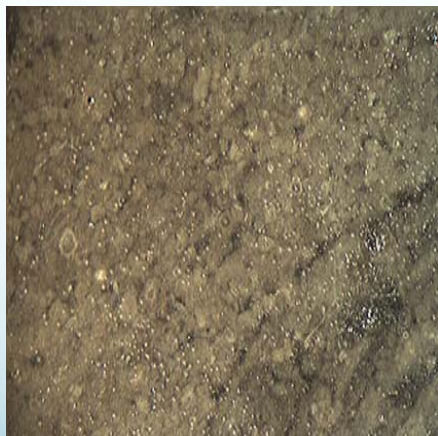
Sandstone



Siltstone



Shale



Limestone

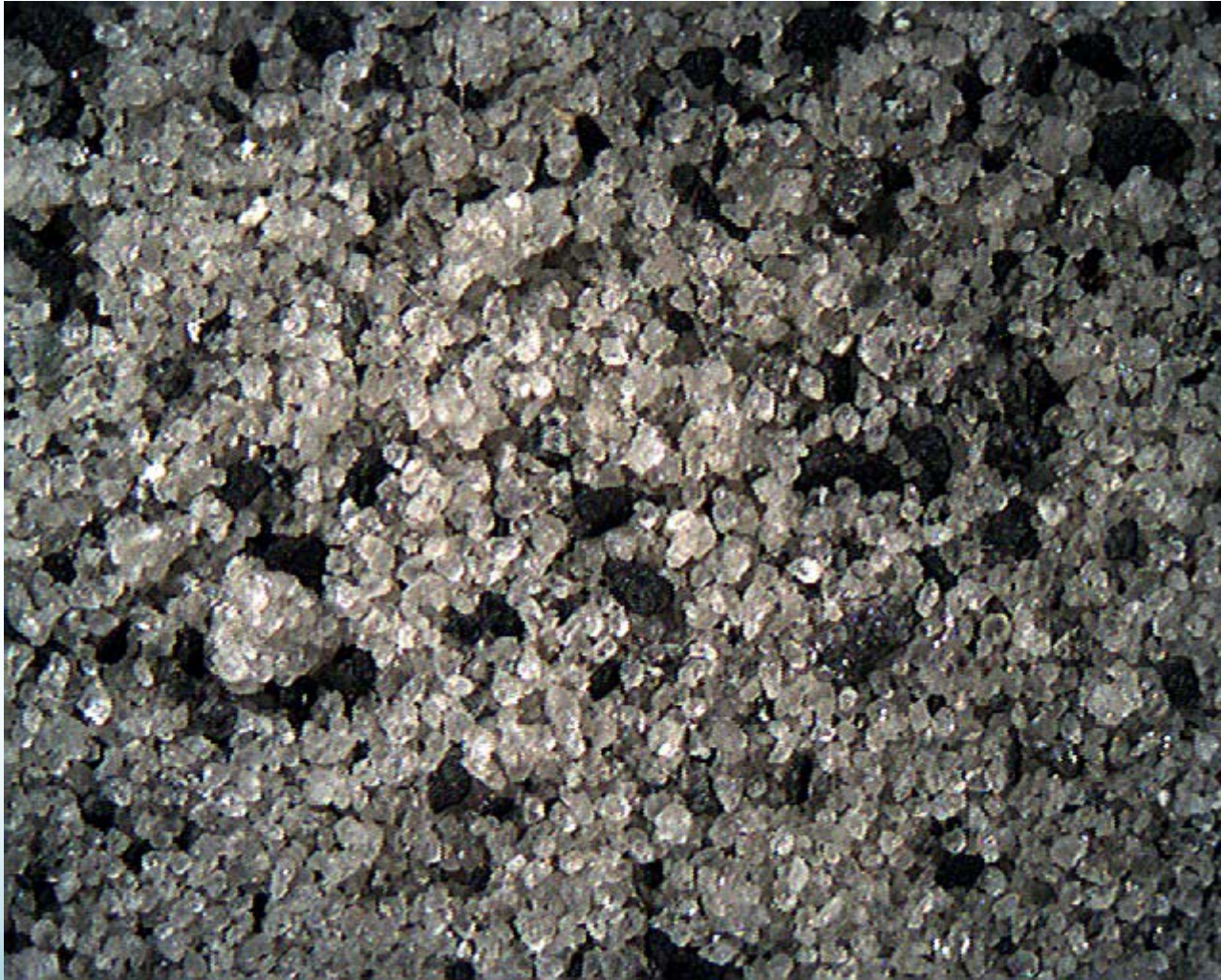


Dolomite



Chert

Sandstone Cuttings



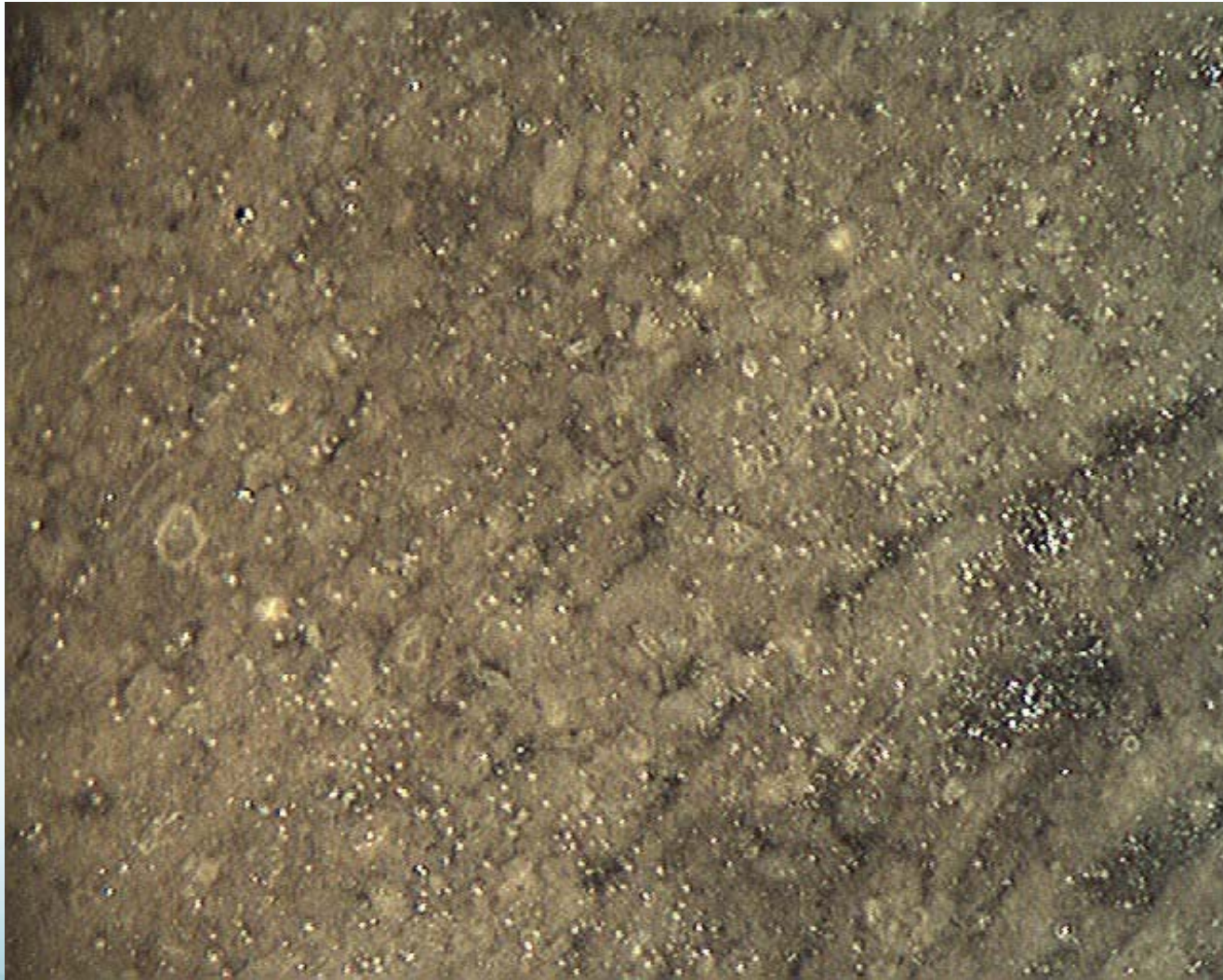
Siltstone Core



Shale Cuttings



Limestone Core



Dolomite Cuttings



Chert



Foreign Material

LCM: Walnut Hulls

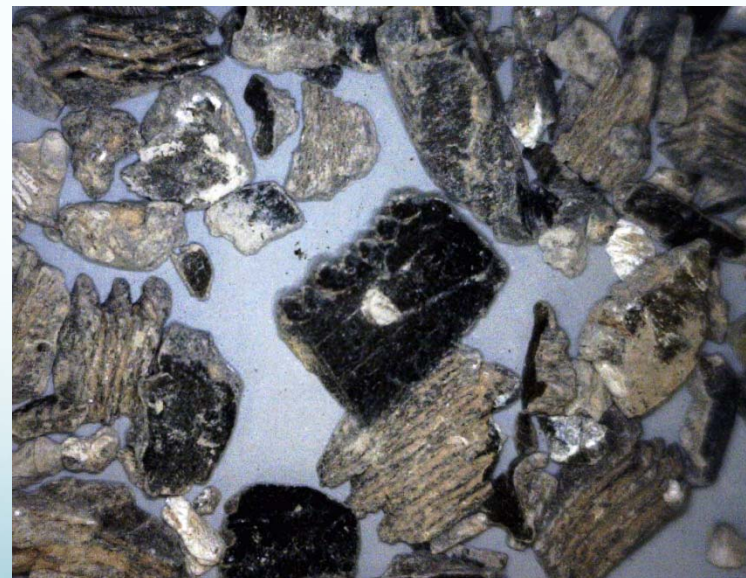
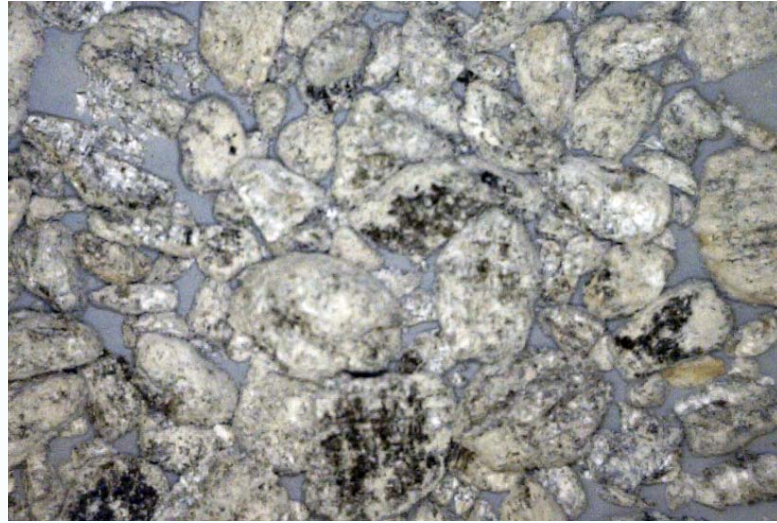
Pipe Shavings

Casing Shoe

Cavings



Bit Flour



Mechanical Properties

- **Rock Strength & Competence**
 - Mineralogy
 - Porosity
 - Diagenesis / Cementation
- **Texture**
- **Layer thickness**
- **Proportion of competent vs incompetent strata**
- **Frictional properties**
- **How a rock layer or multilayer responds to natural and induced fracturing**

Diagenesis

- **Metasomatism**
- **Dolomitization**
- **Recrystallization**
- **Fracturing**
- **Leaching**
- **Pressure Deformation**

Carbonate Reaction



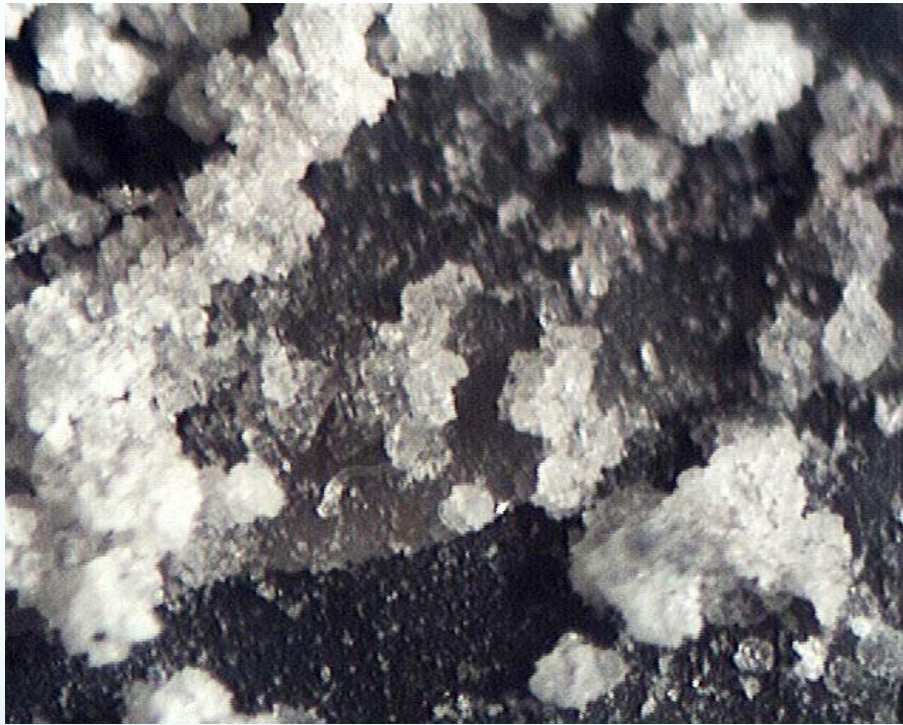
Limestone



Dolomite

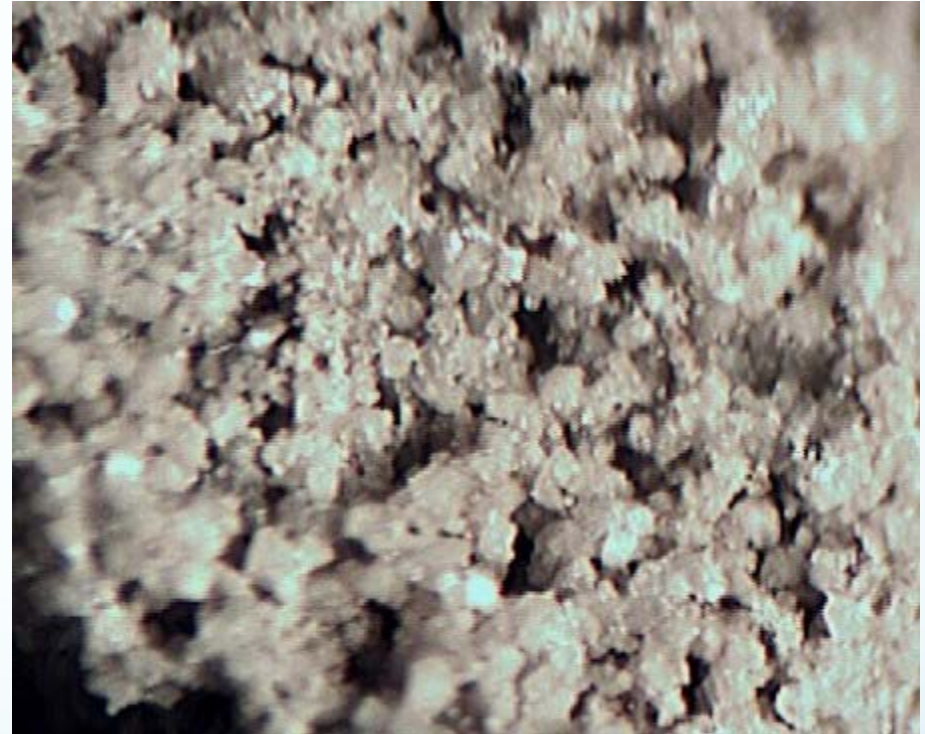


Dolomitization



—
1 mm

Dolomitic Limestone



—
4 mm

Dolomite

Leaching

Pinpoint

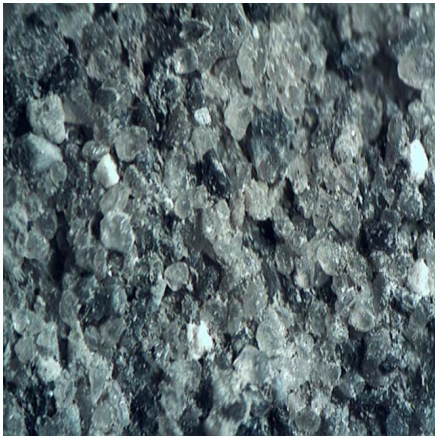


Vuggy

Fracturing



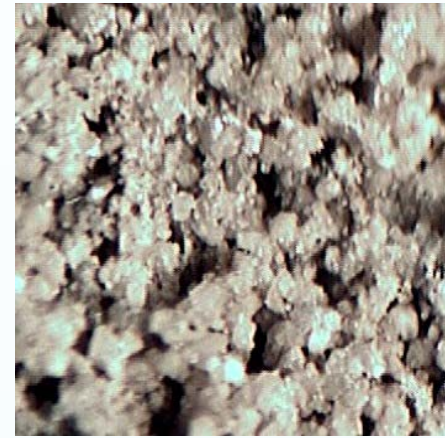
Porosity



Intergranular



Intergranular



Intercrystalline



Fenestral



Leached

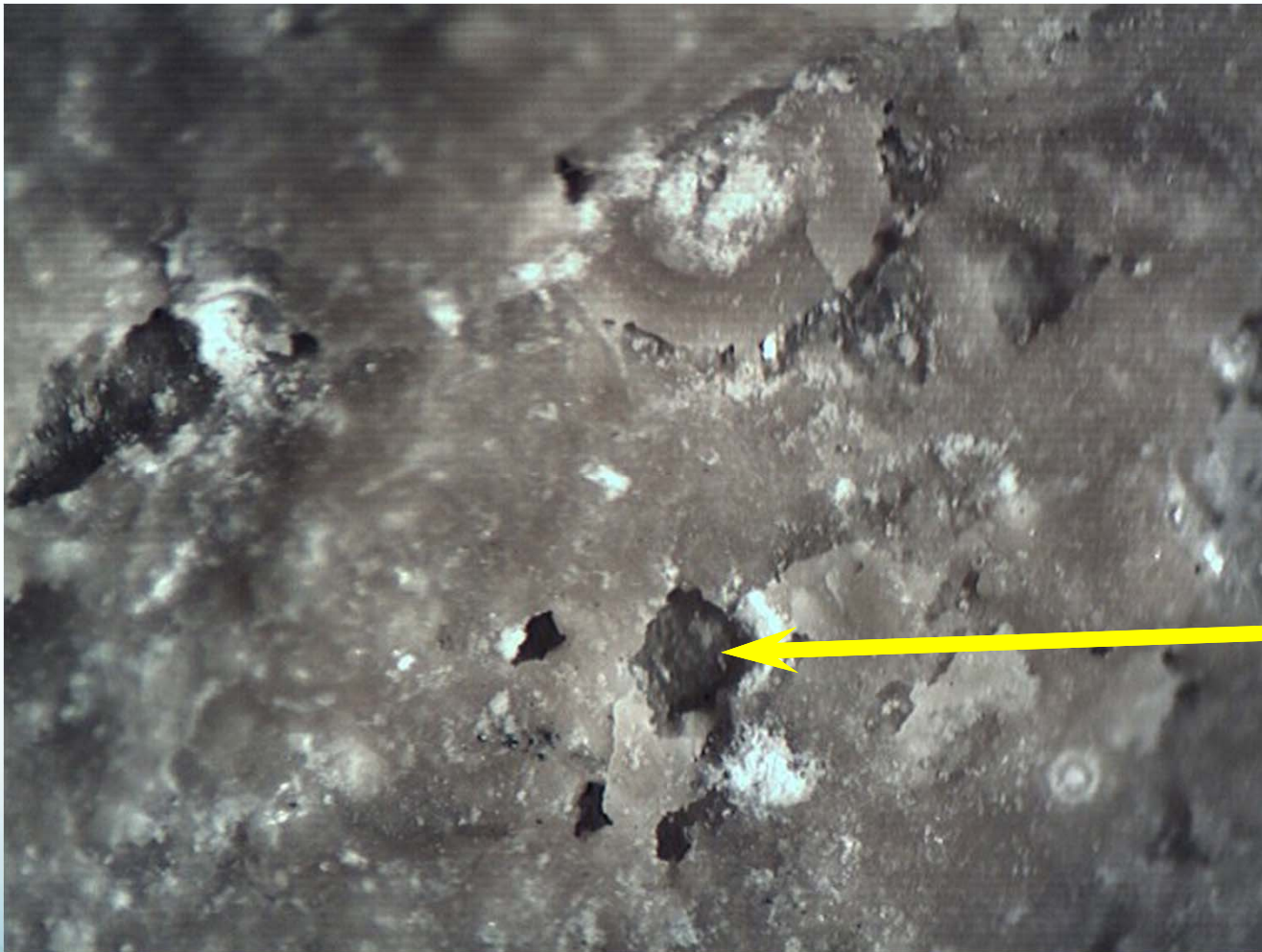


Fracture

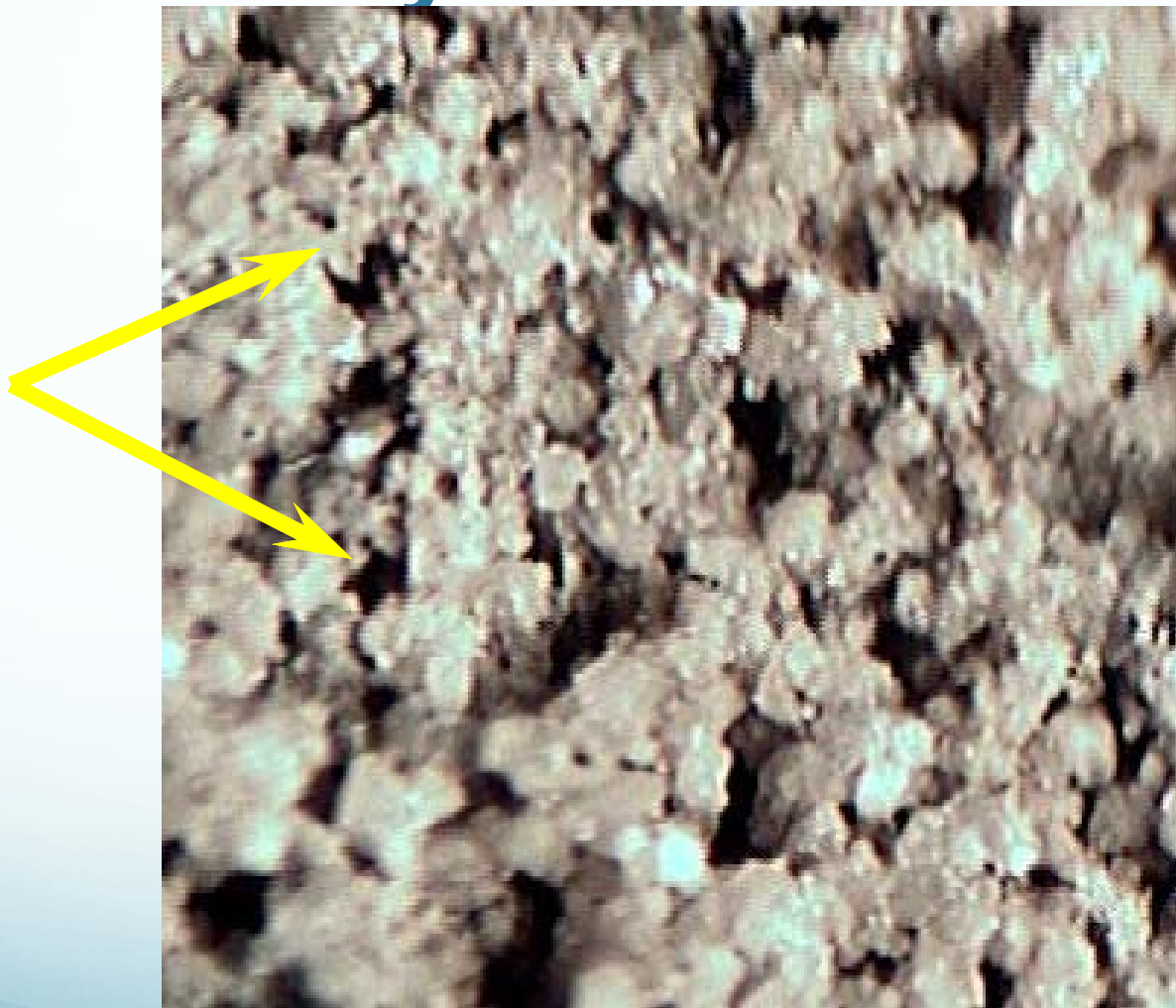
Intergranular Porosity



Intergranular Porosity



Intercrystalline Porosity



Fenestral Porosity



Leached Porosity



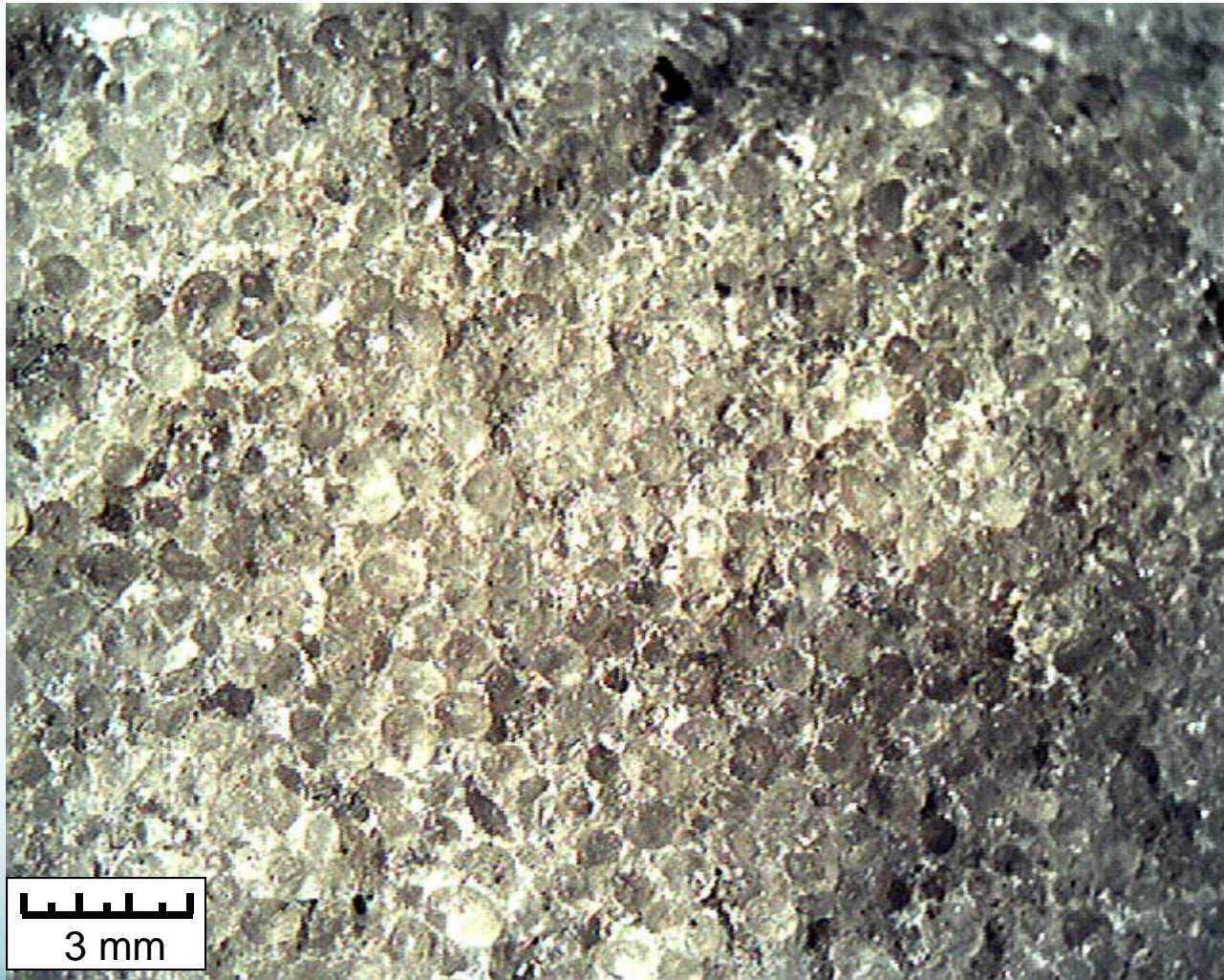
Fracture Porosity



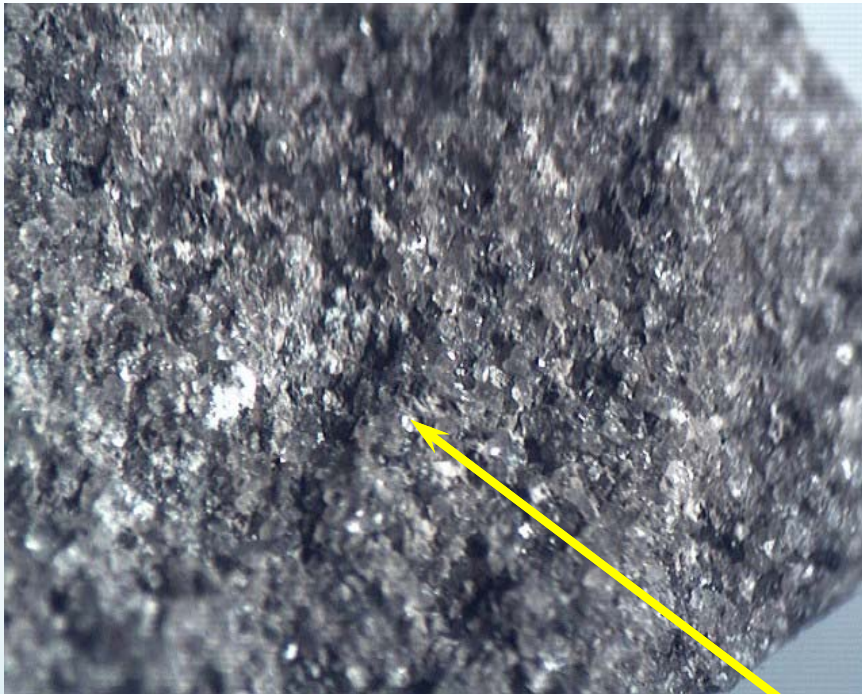
Cementation

- **Void fillers**
 - Precipitated after deposition to fill pore space
 - Void-filling crystals usually larger and lighter in color than host rock
- **Mineralogy**
 - Silica
 - Calcite
 - Dolomite
 - Anhydrite and Gypsum
 - Kaolinite
 - Siderite
 - Others such as Pyrite, Halite, & Bitumen

Sandstone Cementation

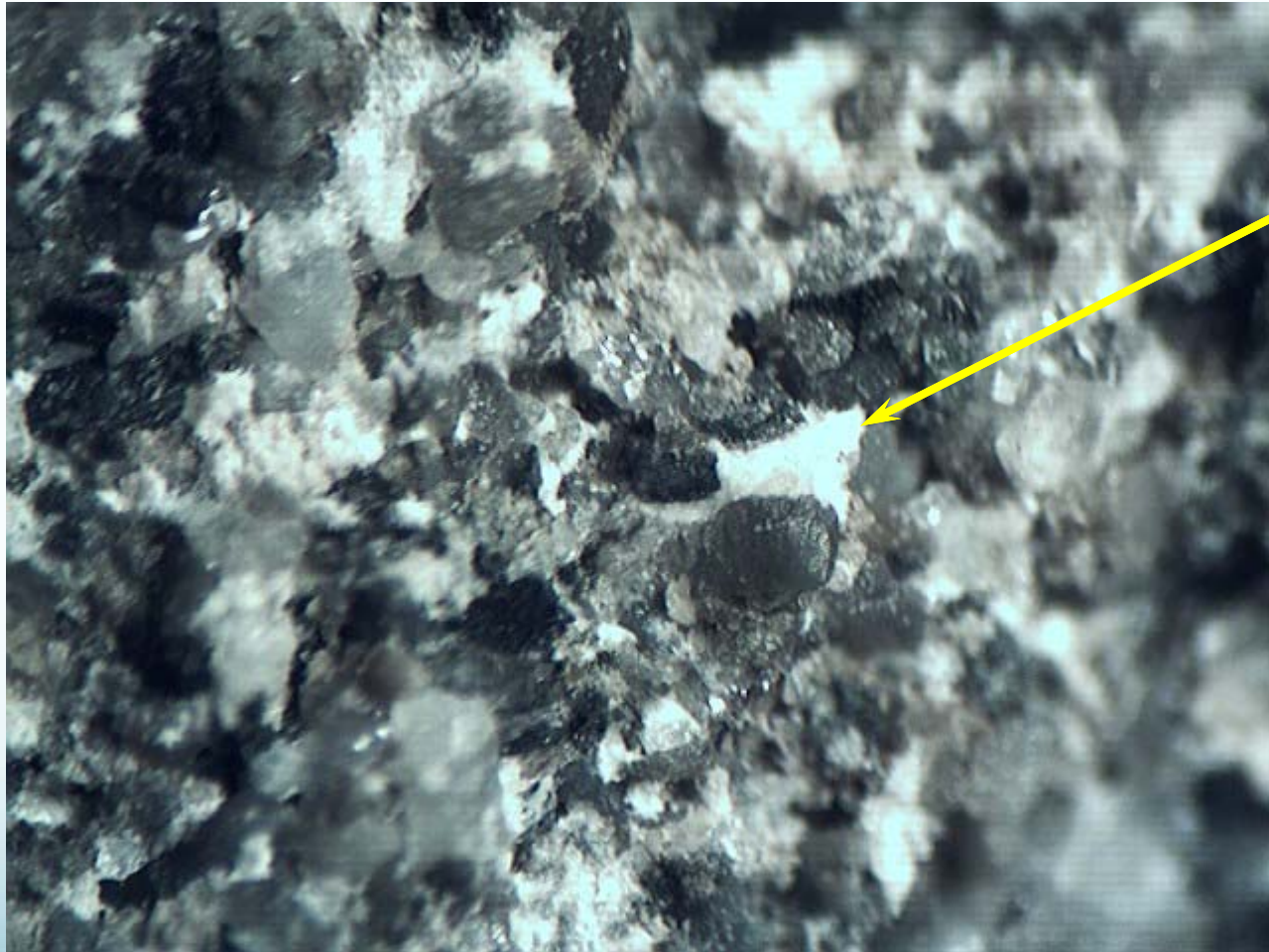


Silica Cementation



Quartz Overgrowths

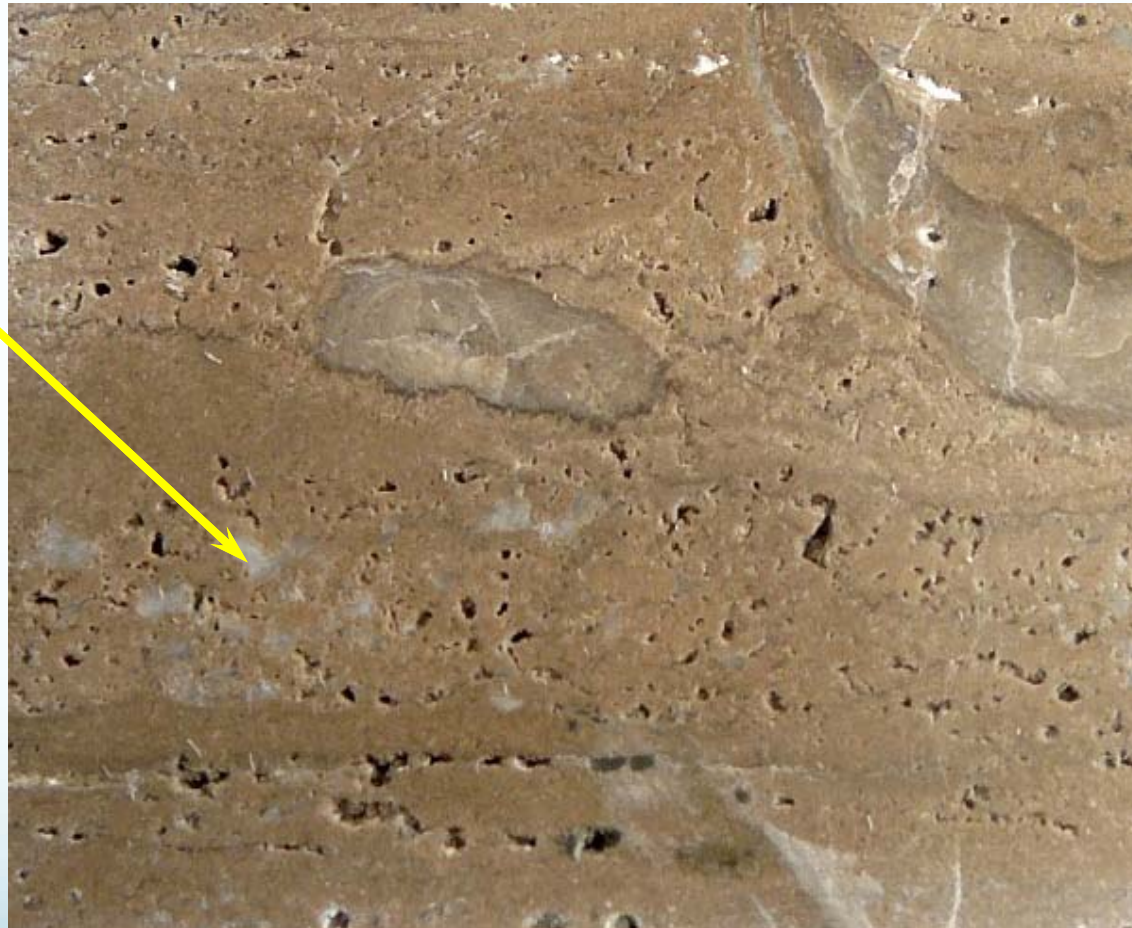
Clay Occluding Pores



Clay

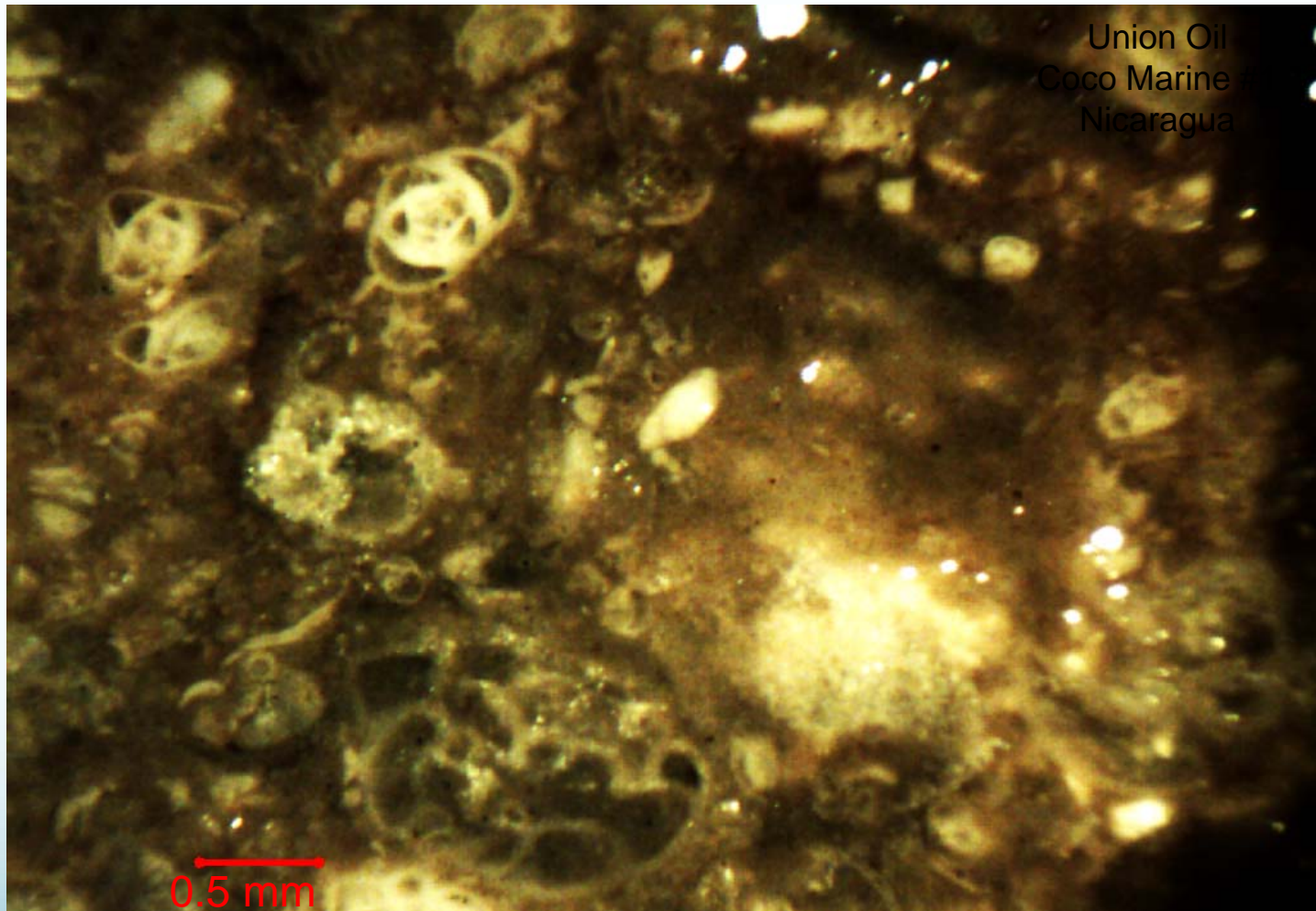
Anhydrite Cement

Anhydrite
Cement



1 cm

Fossils



Visual Rock Characterization

- **Lithofacies**
 - Depositional architecture
- **Rock & Pore Types**
 - Petrology
 - Mineralogy
 - Diagenesis
 - Porosity
 - Pore distribution
- **Formation Evaluation**
 - Lithology
 - Porosity
 - Mechanical Properties
- **Reservoir compartmentalization**