USEPA Hydraulic Fracturing SAB Example Photographs

Target rocks, reservoir rocks, thin sections, SEM images of shales, joints in boreholes

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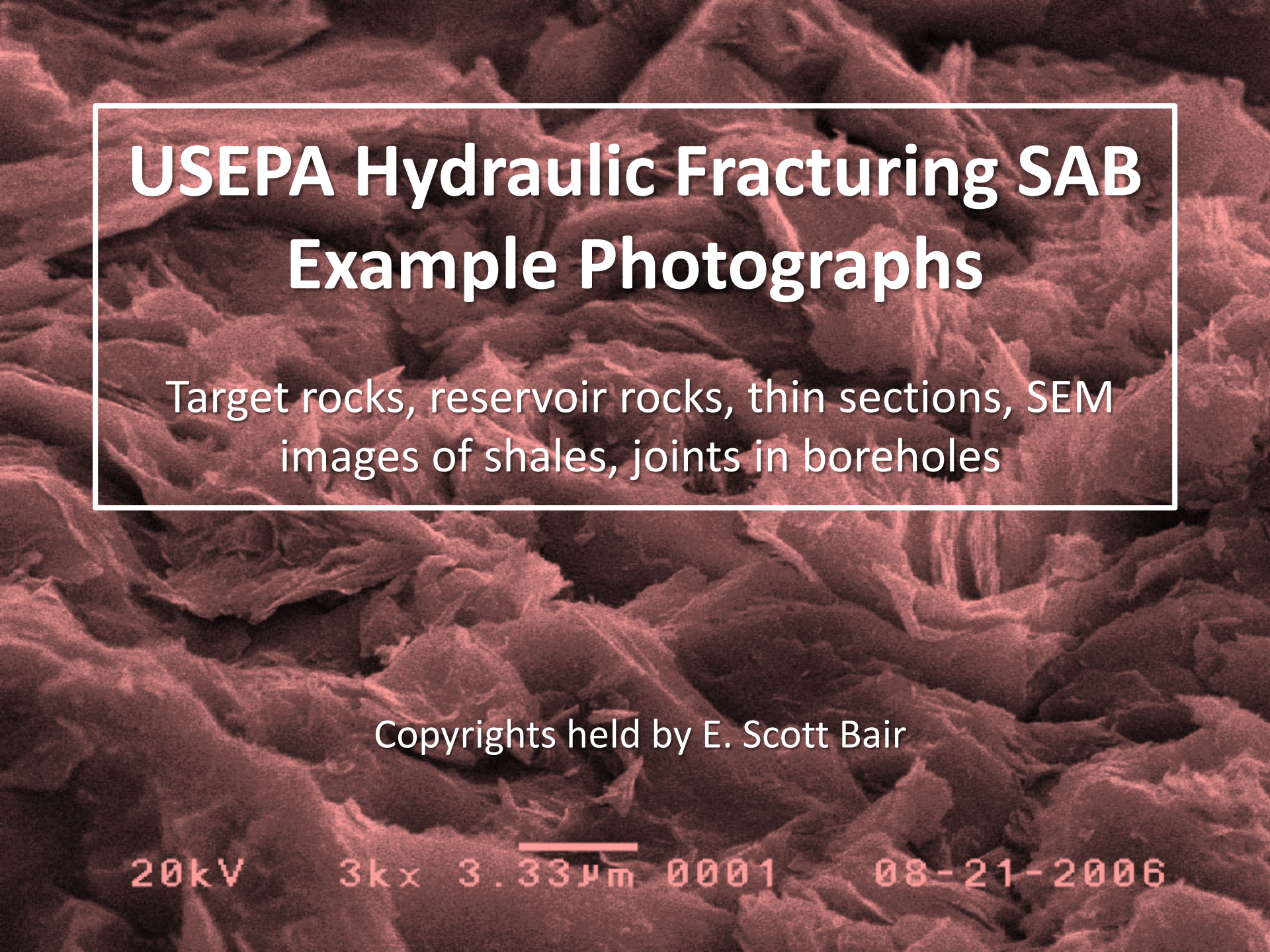
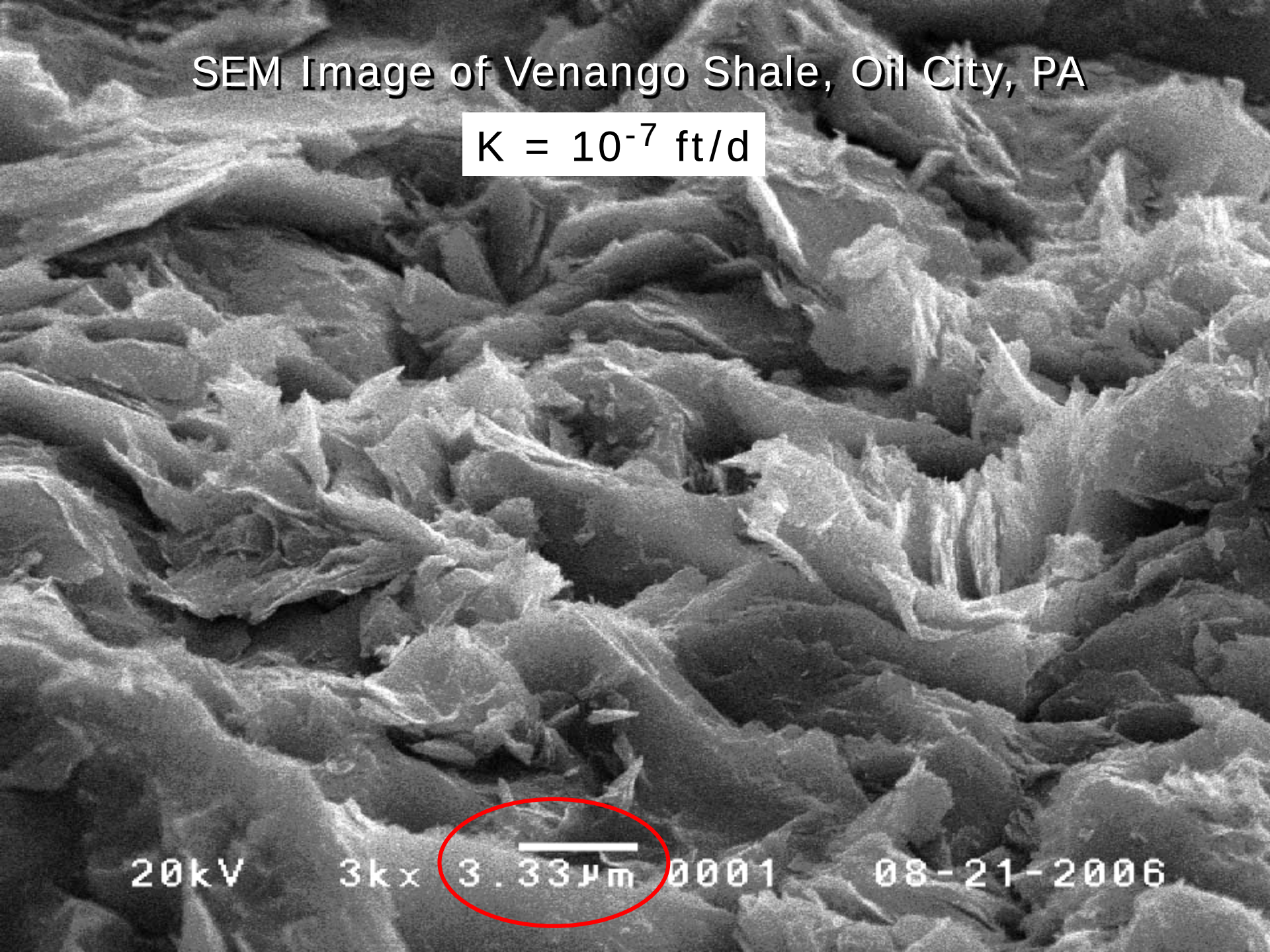


Ohio Shale

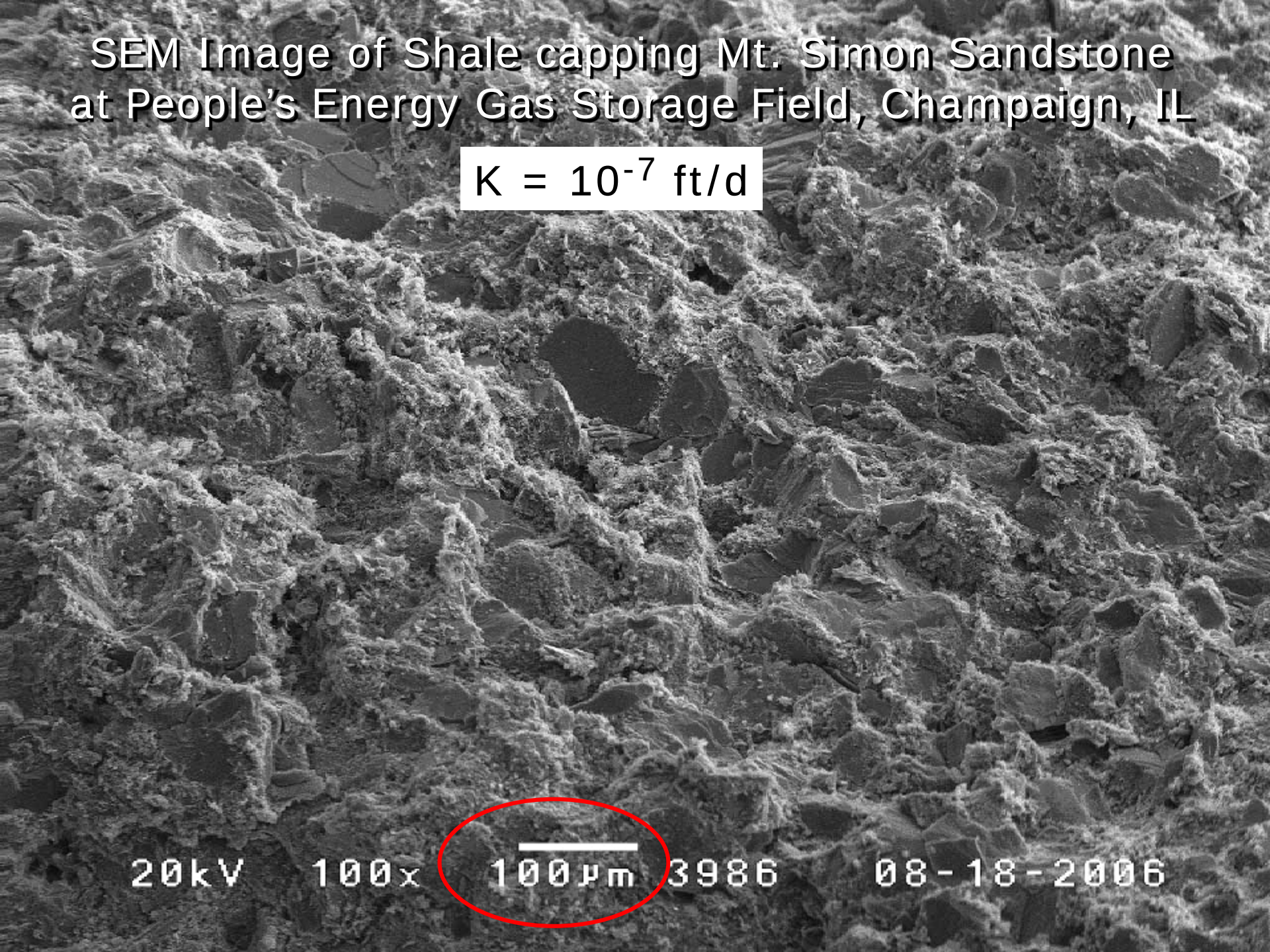
SEM Image of Venango Shale, Oil City, PA

$K = 10^{-7}$ ft/d



SEM Image of Shale capping Mt. Simon Sandstone at People's Energy Gas Storage Field, Champaign, IL

$K = 10^{-7}$ ft/d



Vertical Joint in Shales in Residential Well, Bainbridge, OH

Vertical joint in shale in a residential well, Bainbridge, OH

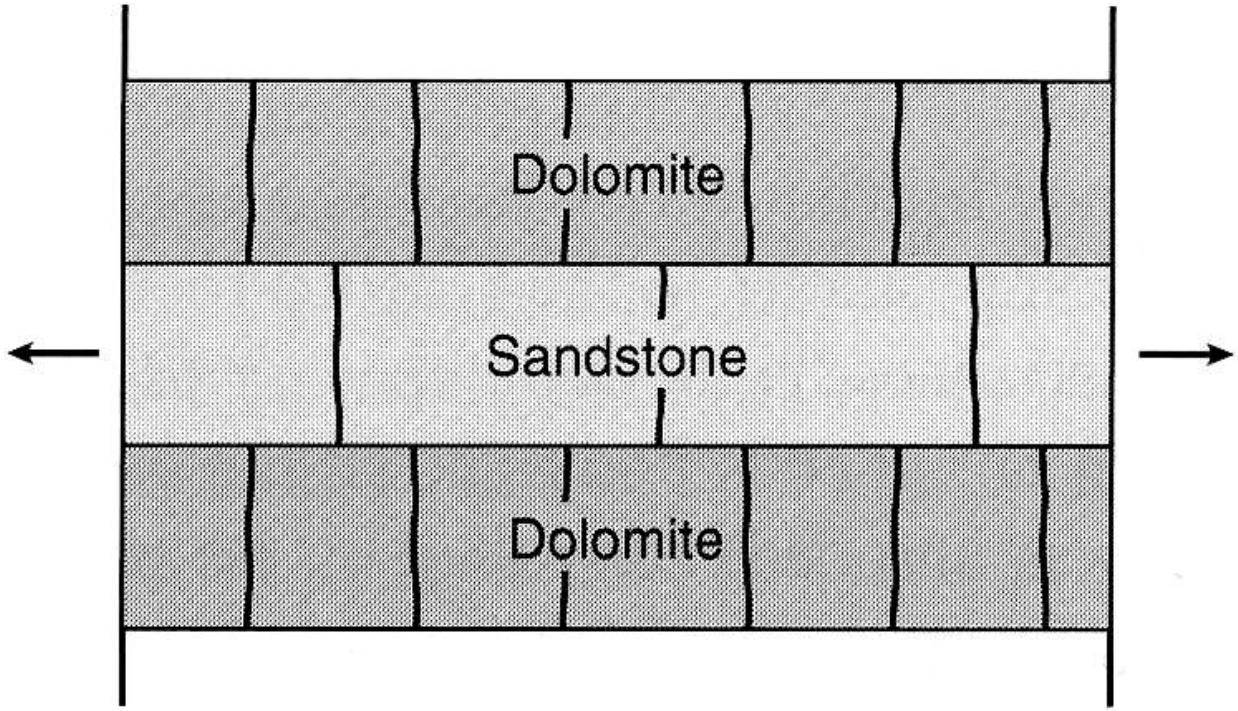
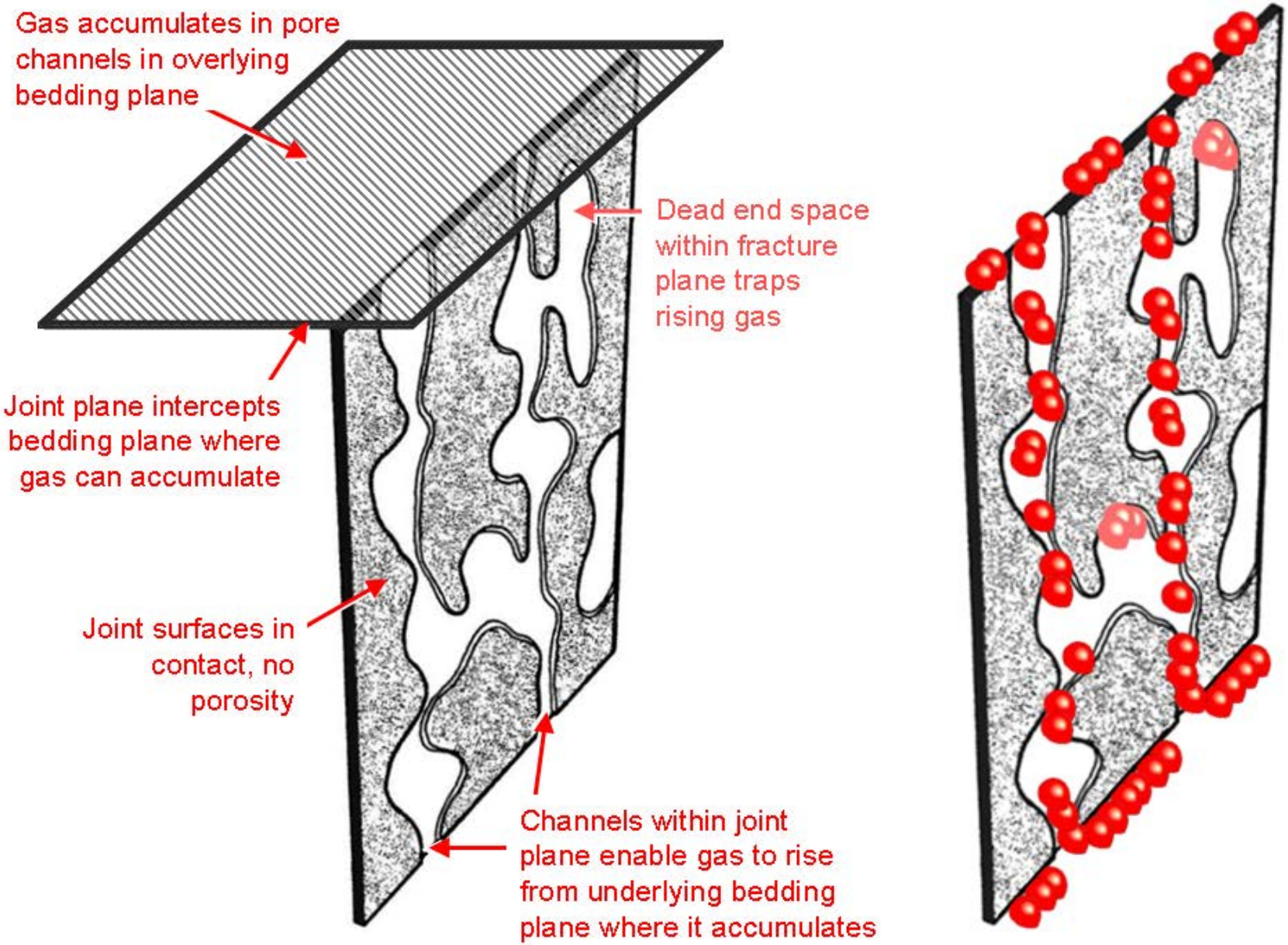
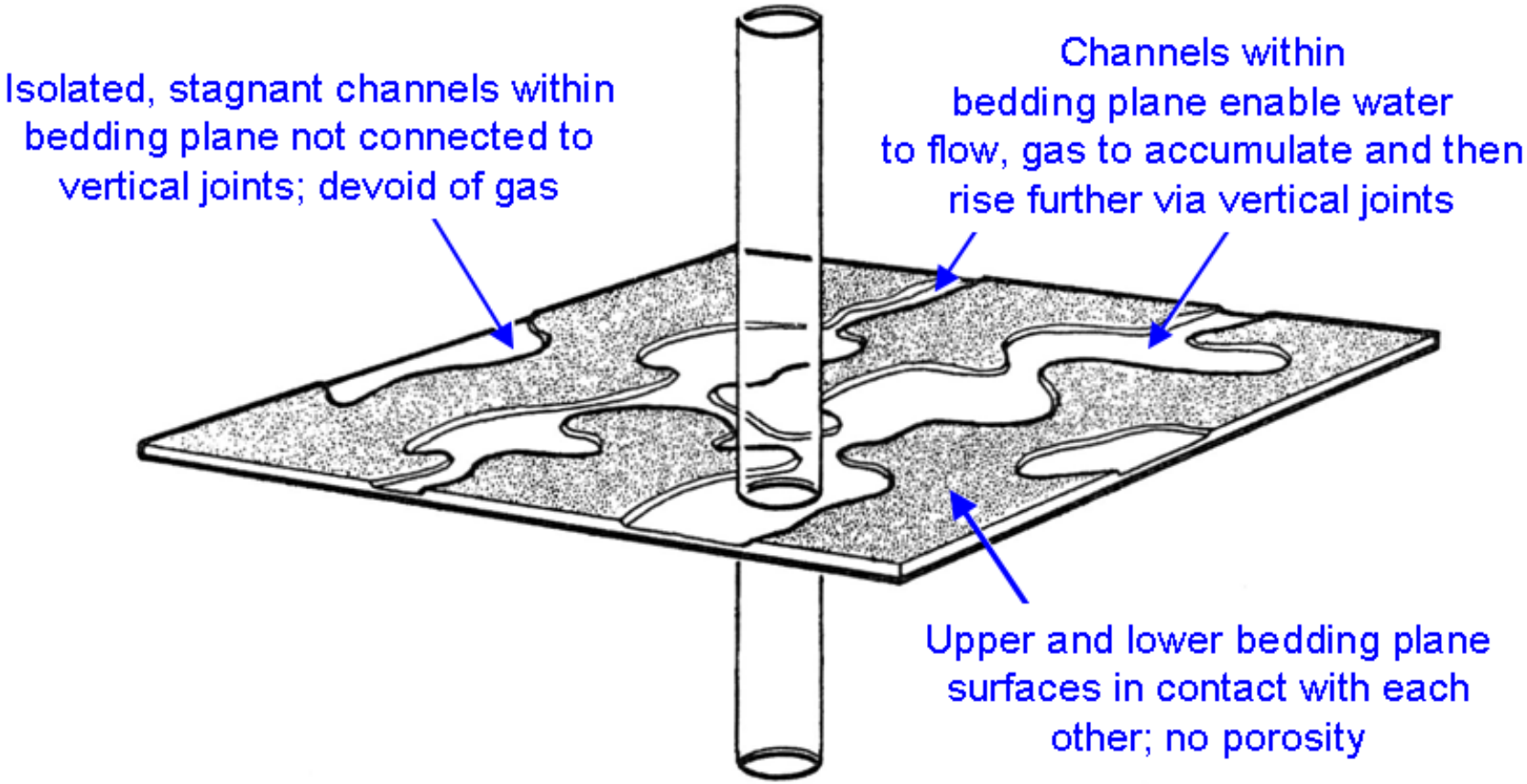


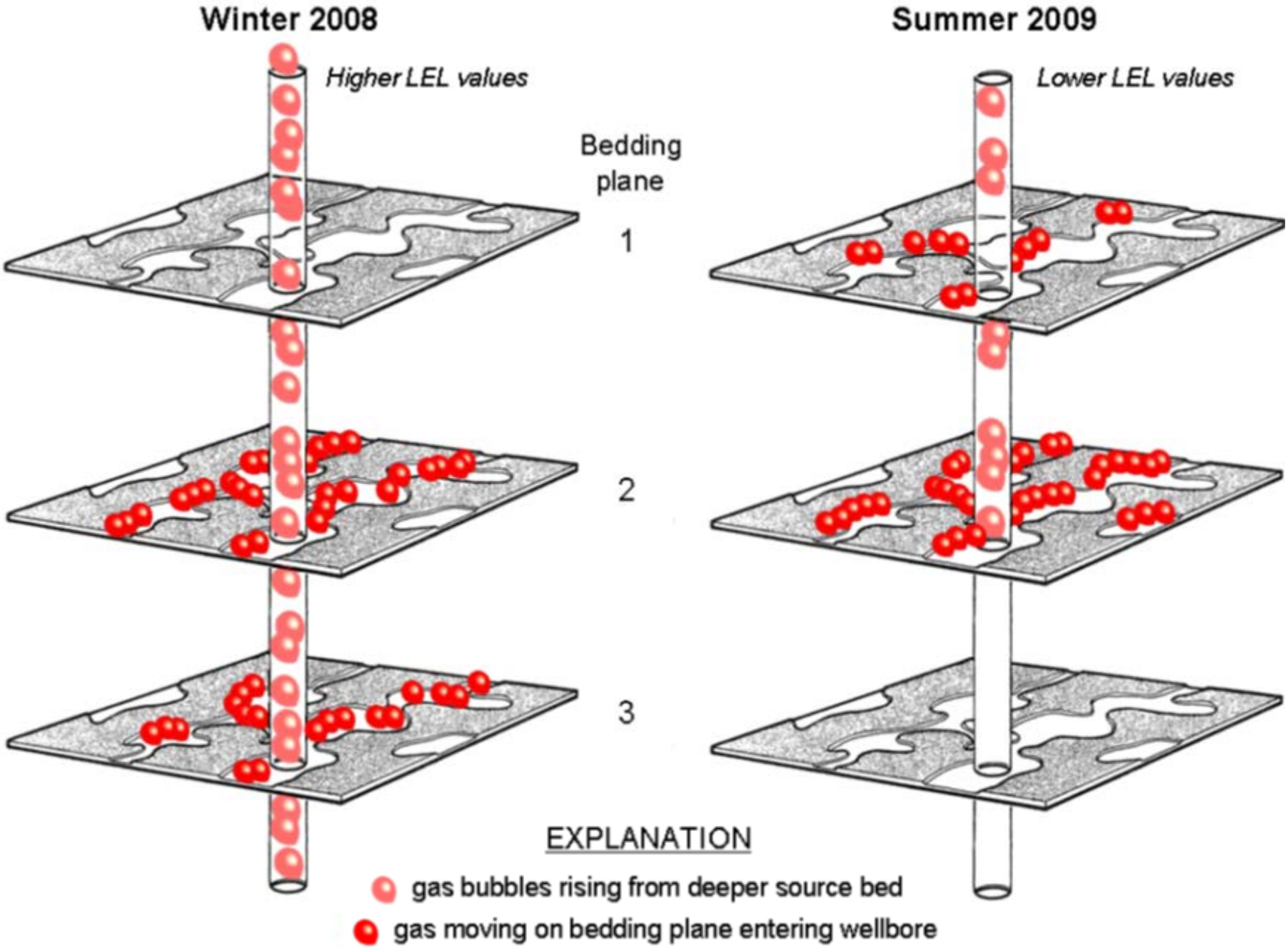
FIGURE 7.11 Cross-sectional sketch illustrating a multilayer that is composed of rocks with different values of Young's modulus. The stiffer layers (dolomite) develop more closely spaced joints.

Gas Migration Along Joints

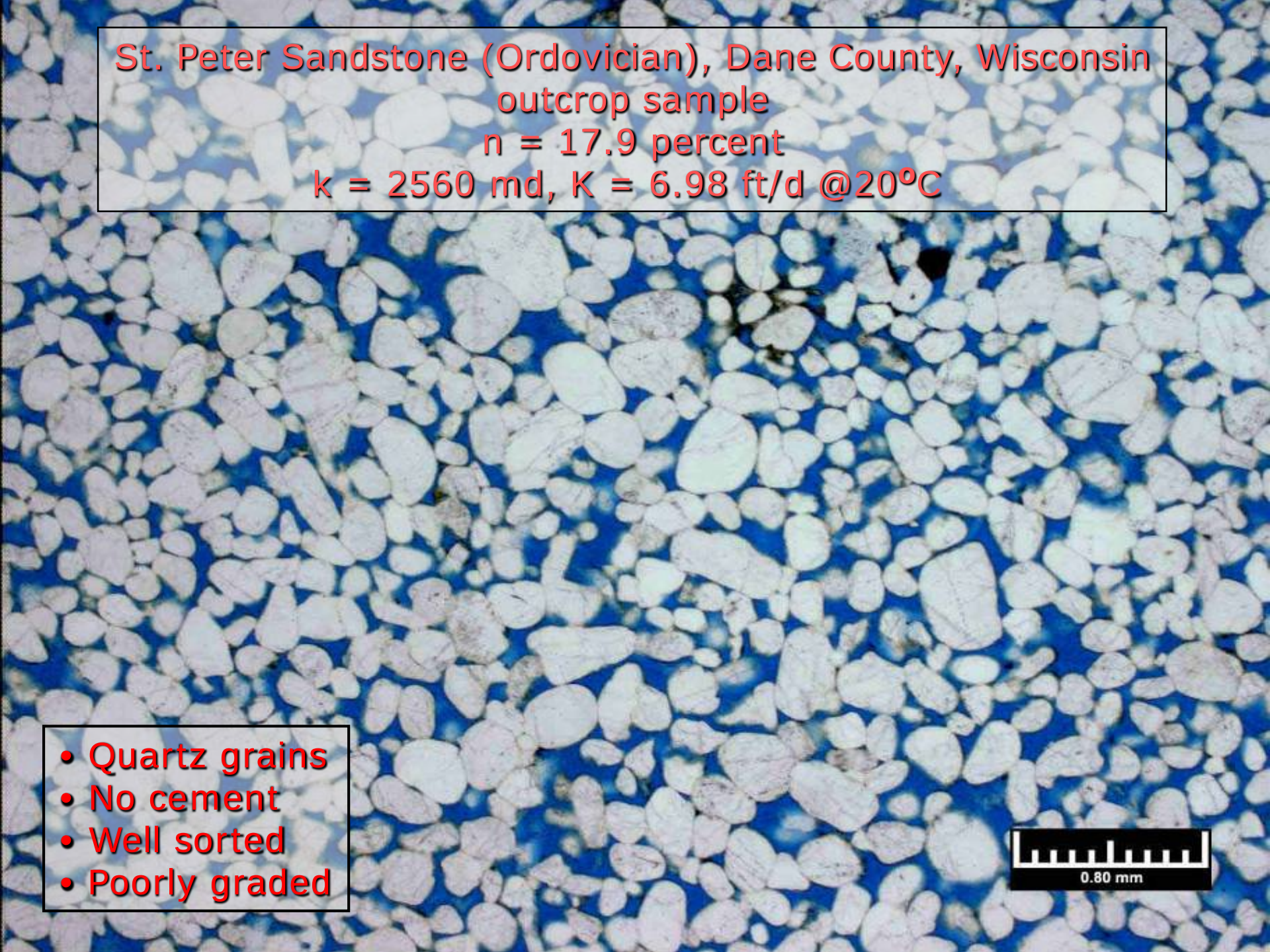


Gas Migration Along Bedding Planes

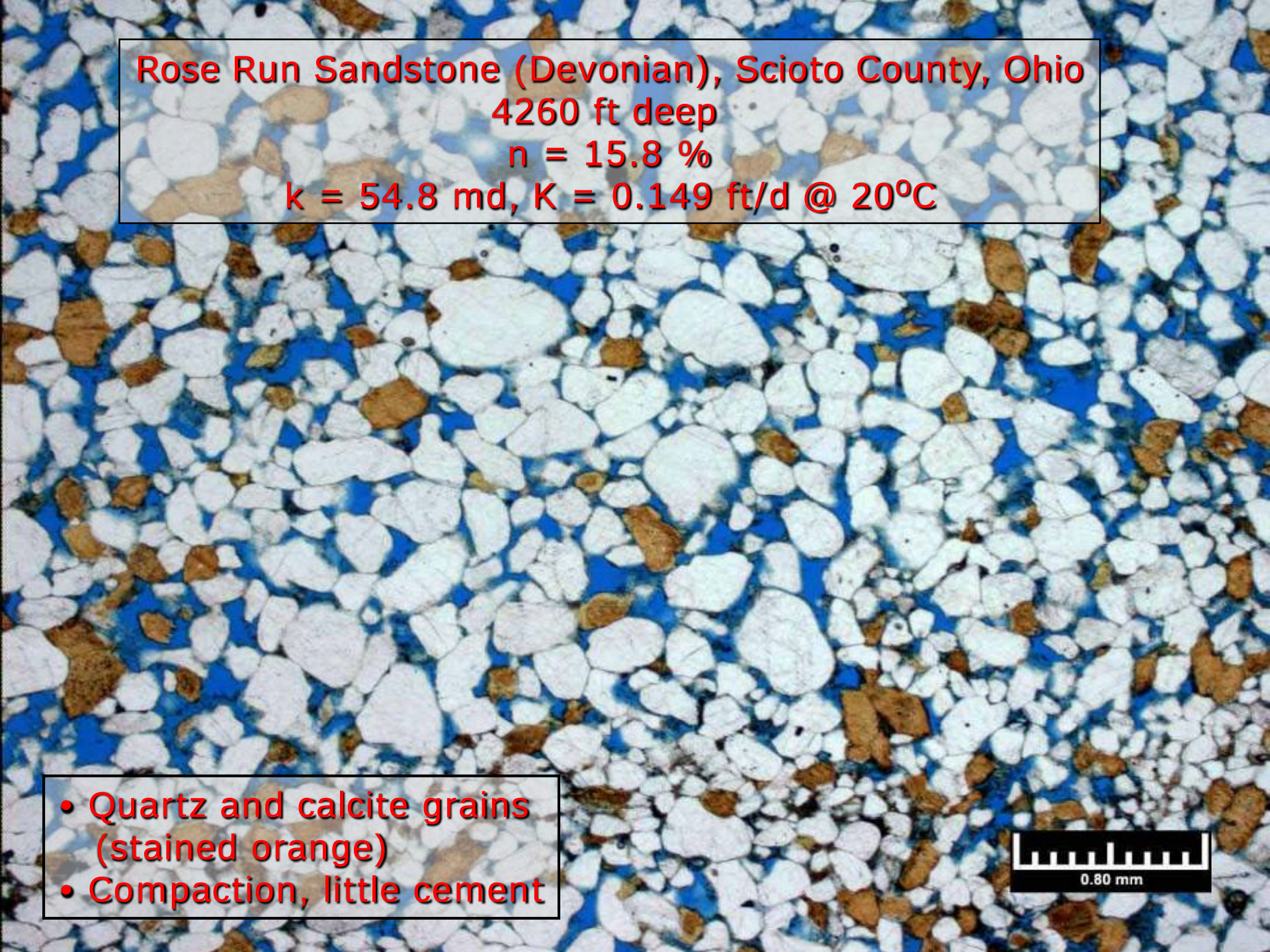



Winter 2008
Summer 2009
Higher LEL values
Lower LEL values
Bedding plane
1
2
3
EXPLANATION
gas bubbles rising from deeper source bed
gas moving on bedding plane entering wellbore

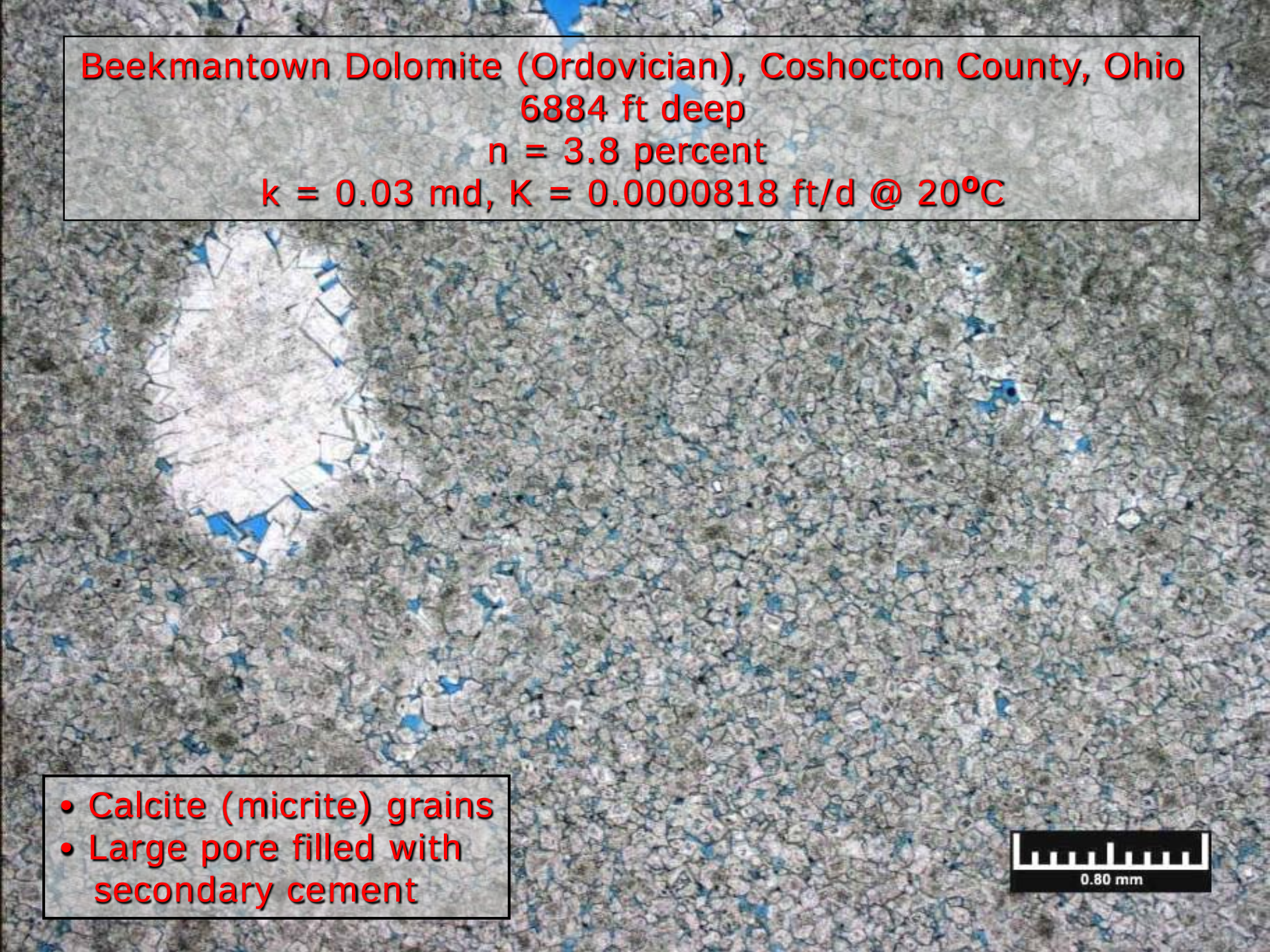
St. Peter Sandstone (Ordovician), Dane County, Wisconsin
outcrop sample


St. Peter Sandstone (Ordovician), Dane County, Wisconsin
outcrop sample
n = 17.9 percent
k = 2560 md, K = 6.98 ft/d @20°C
• Quartz grains
• No cement
• Well sorted
• Poorly graded
0.80 mm

Rose Run Sandstone (Ordovician), Scioto County, Ohio
4260 ft deep

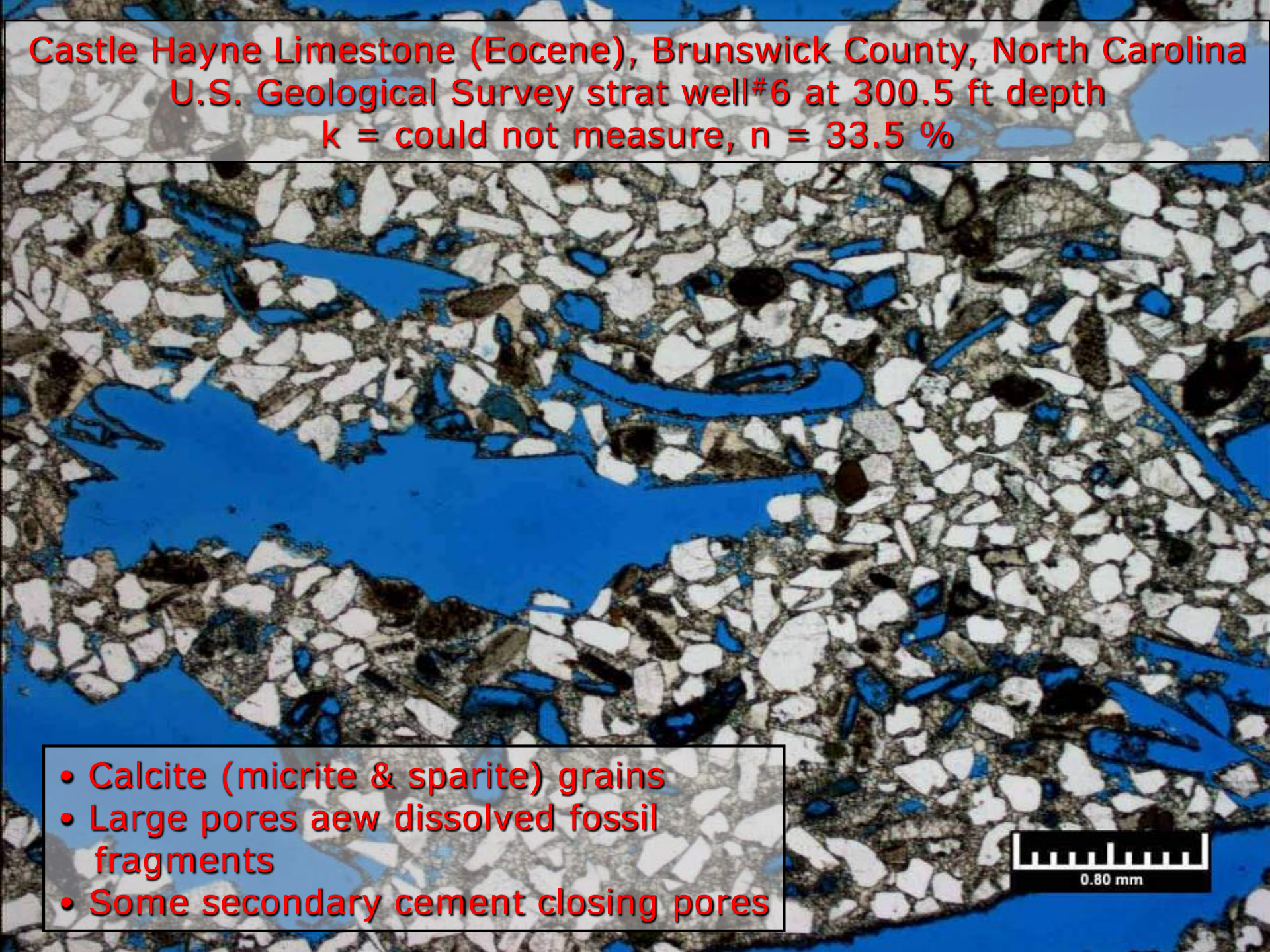

Rose Run Sandstone (Devonian), Scioto County, Ohio
4260 ft deep
n = 15.8 %
k = 54.8 md, K = 0.149 ft/d @ 20ºC
• Quartz and calcite grains (stained orange)
• Compaction, little cement
0.80 mm

Beekmantown Dolomite (Ordovician), Coshocton County, Ohio
6884 ft deep
k = 0.03 md, n = 3.8 %


Beekmantown Dolomite (Ordovician), Coshocton County, Ohio
6884 ft deep
n = 3.8 percent
k = 0.03 md, K = 0.0000818 ft/d @ 20°C
• Calcite (micrite) grains
• Large pore filled with secondary cement
0.80 mm

Castle Hayne Limestone (Eocene), Brunswick County, North Carolina
U.S. Geological Survey well #6 at 300.5 ft depth

Castle Hayne Limestone (Eocene), Brunswick County, North Carolina
U.S. Geological Survey strat well#6 at 300.5 ft depth
k = could not measure, n = 33.5 %

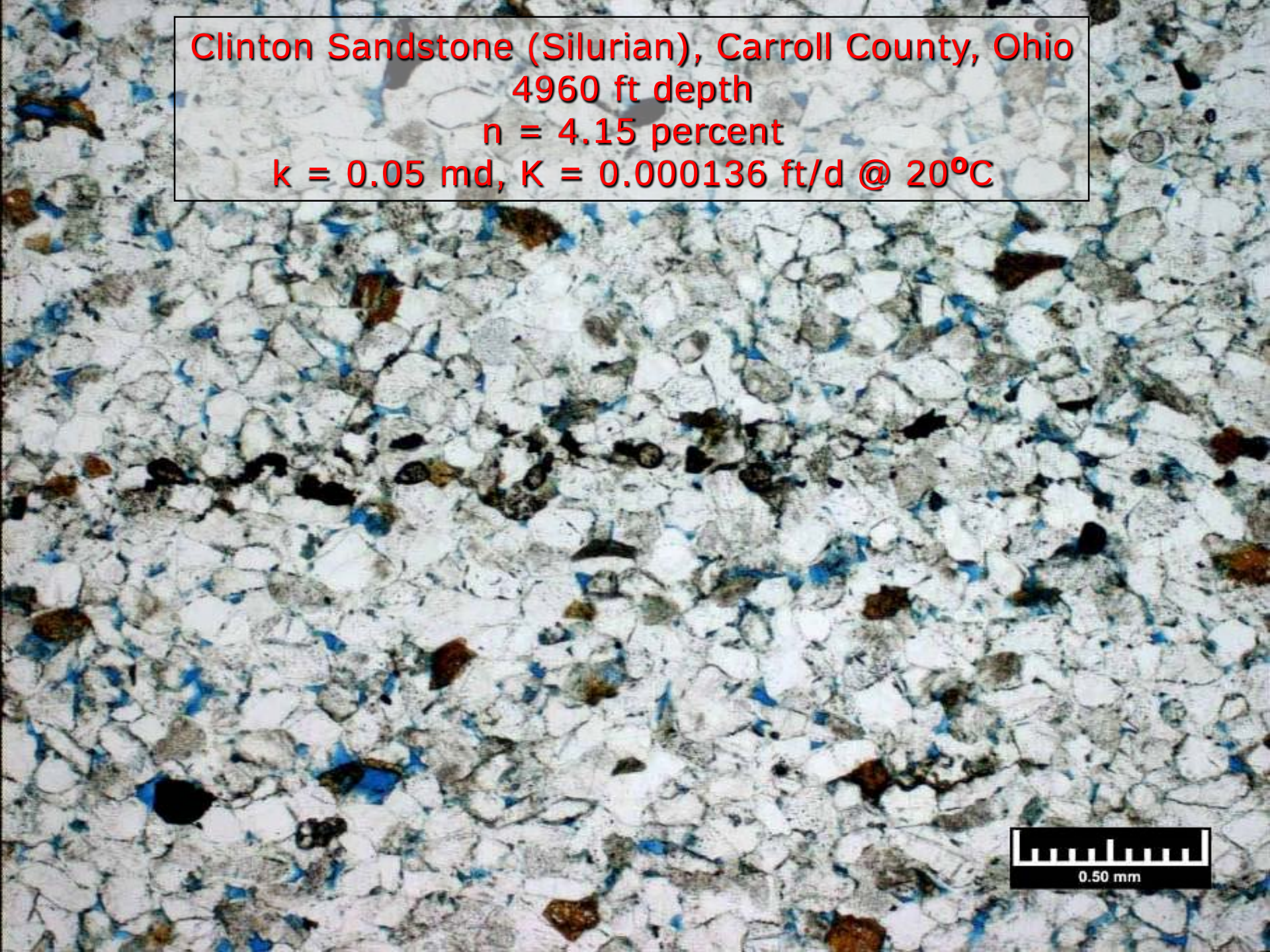


- Calcite (micrite & sparite) grains
- Large pores aew dissolved fossil fragments
- Some secondary cement closing pores

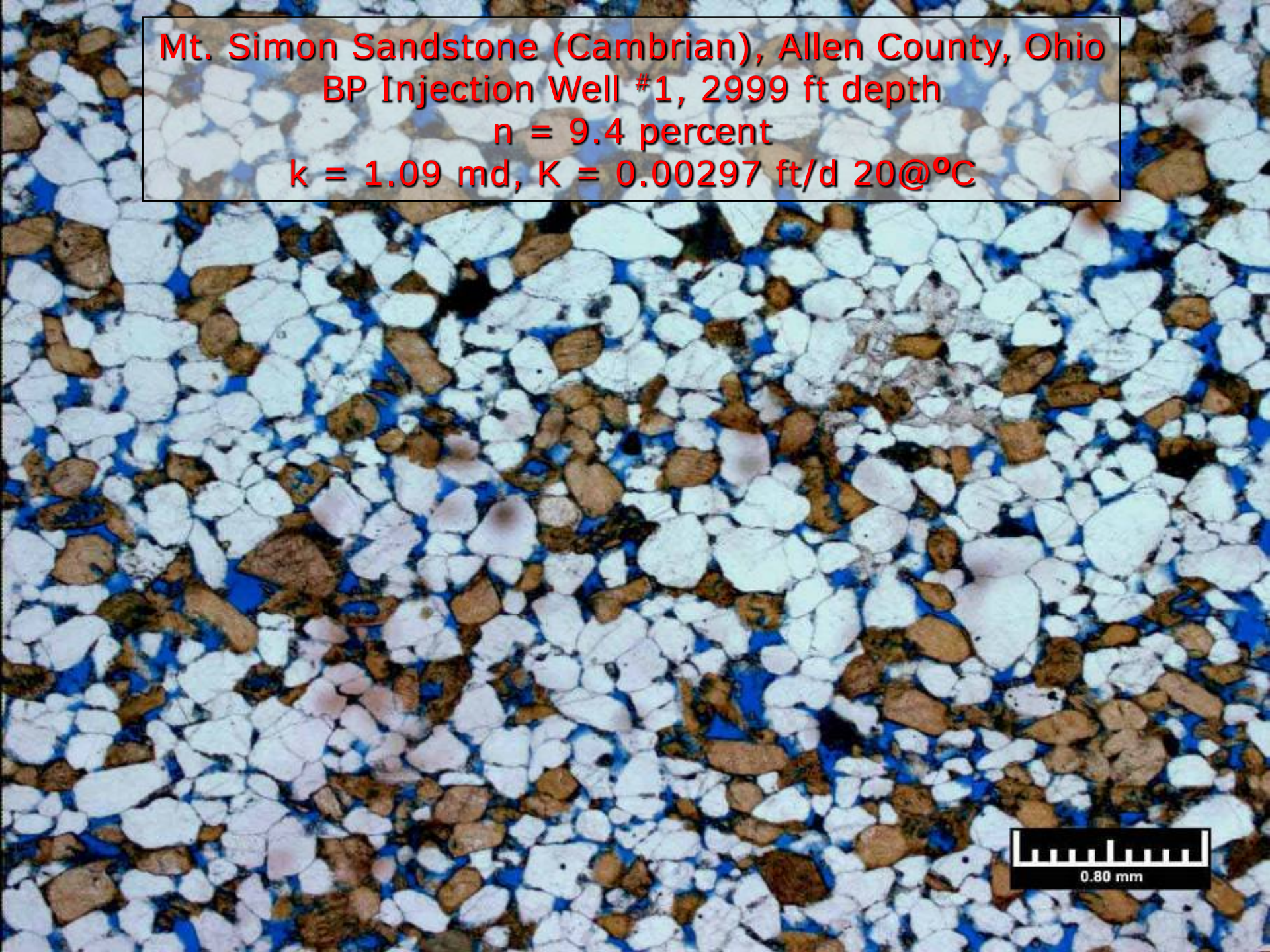
Berea Sandstone (Silurian), Ashland County, Ohio
553 ft deep

Berea Sandstone (Silurian), Ashland County, Ohio
553 ft deep
n = 18.1 percent
k = 34.2 md, K = 0.0932 ft/d @ 20°C
• Quartz and calcite grains
• Many small pores with secondary cement
• Some compaction of clay minerals
0.50 mm

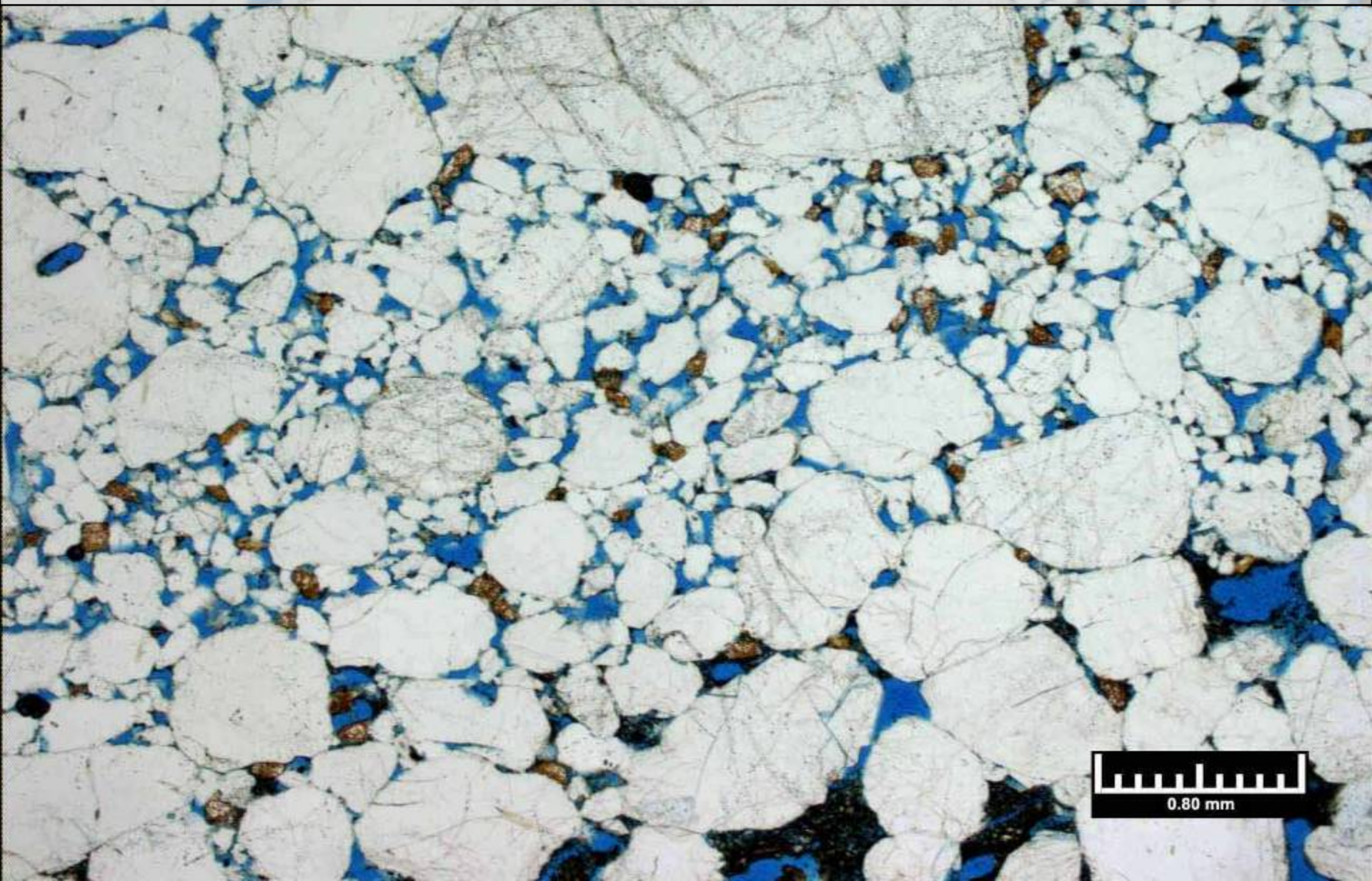
Clinton Sandstone (Silurian)
Carroll County, Ohio
4960 ft deep


Clinton Sandstone (Silurian), Carroll County, Ohio
4960 ft depth
n = 4.15 percent
k = 0.05 md, K = 0.000136 ft/d @ 20ºC
0.50 mm

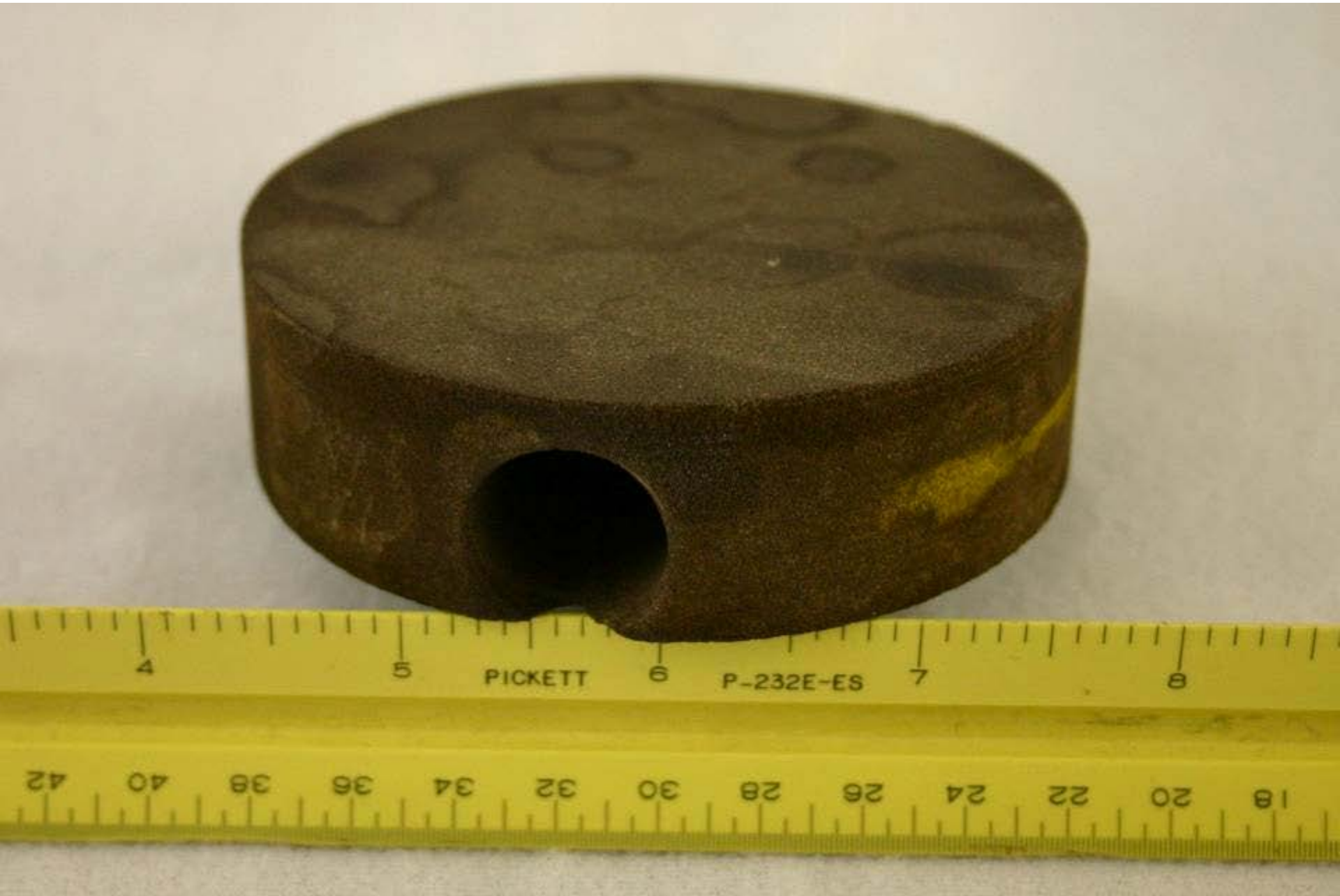
Mt. Simon Sandstone (Cambrian), Allen County, Ohio
BP Injection Well #1, 2999 ft depth


Mt. Simon Sandstone (Cambrian), Allen County, Ohio
BP Injection Well #1, 2999 ft depth
n = 9.4 percent
k = 1.09 md, K = 0.00297 ft/d 20@ºC
0.80 mm

Mt. Simon Sandstone (Cambrian), outside Champaign, Illinois
People's Energy Injection Well#5 at 4089 ft depth
k = 8440 md, K = 23 ft/d, n = 12.7 percent



The Bradford Sandstone was a major producer of oil / gas in PA and was tapped by Kendall, Quaker State, and Pennzoil wells



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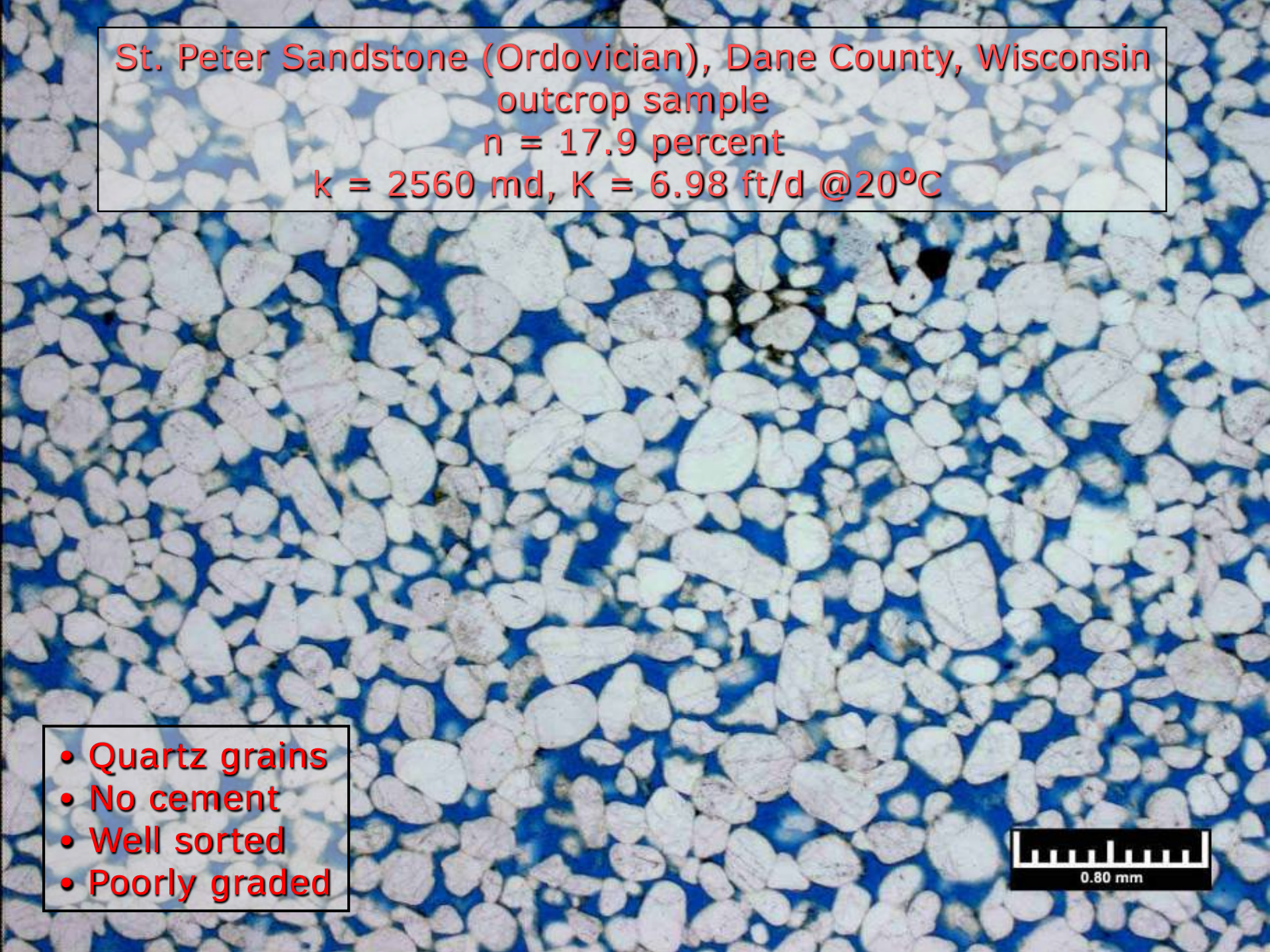
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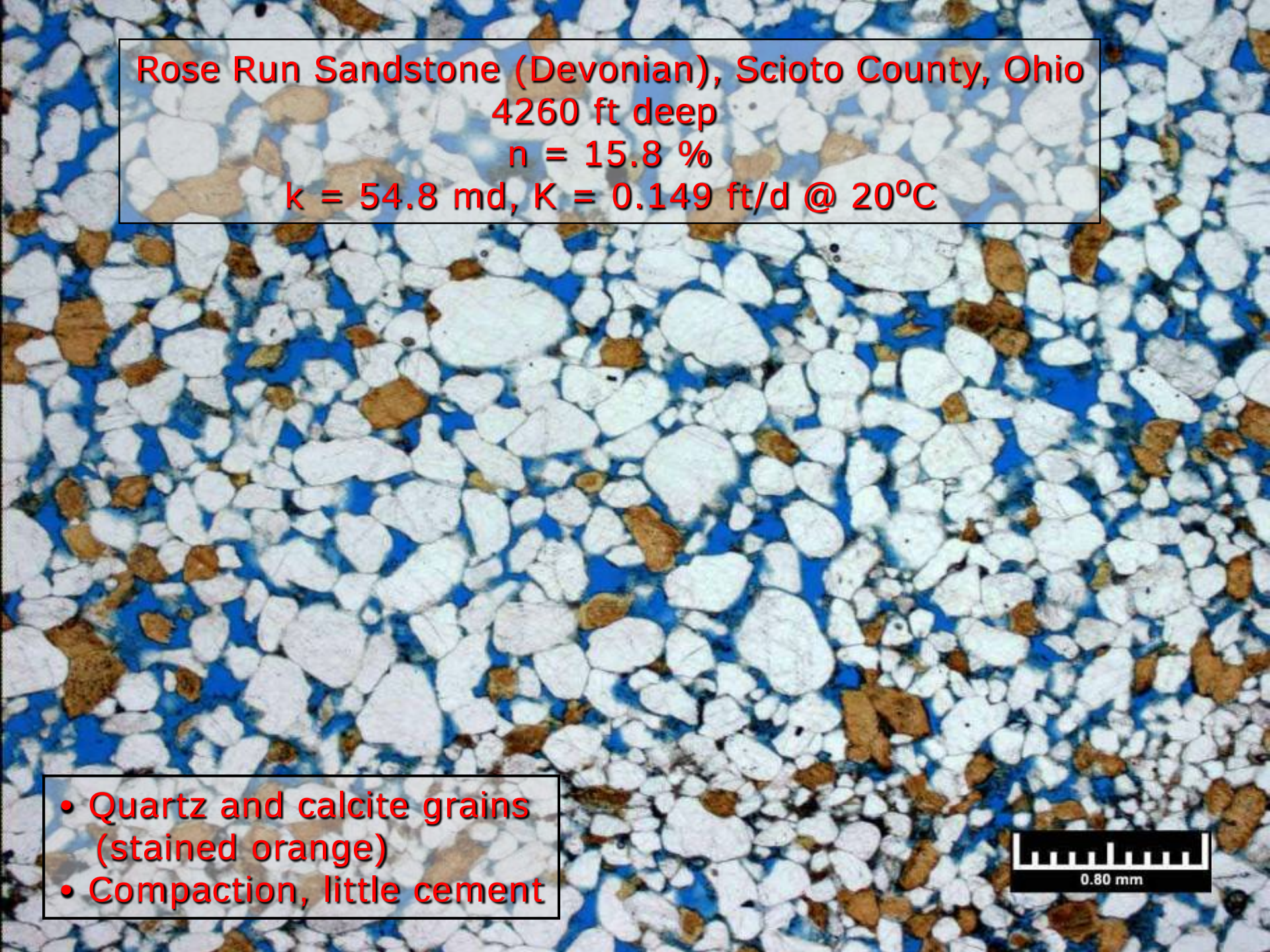
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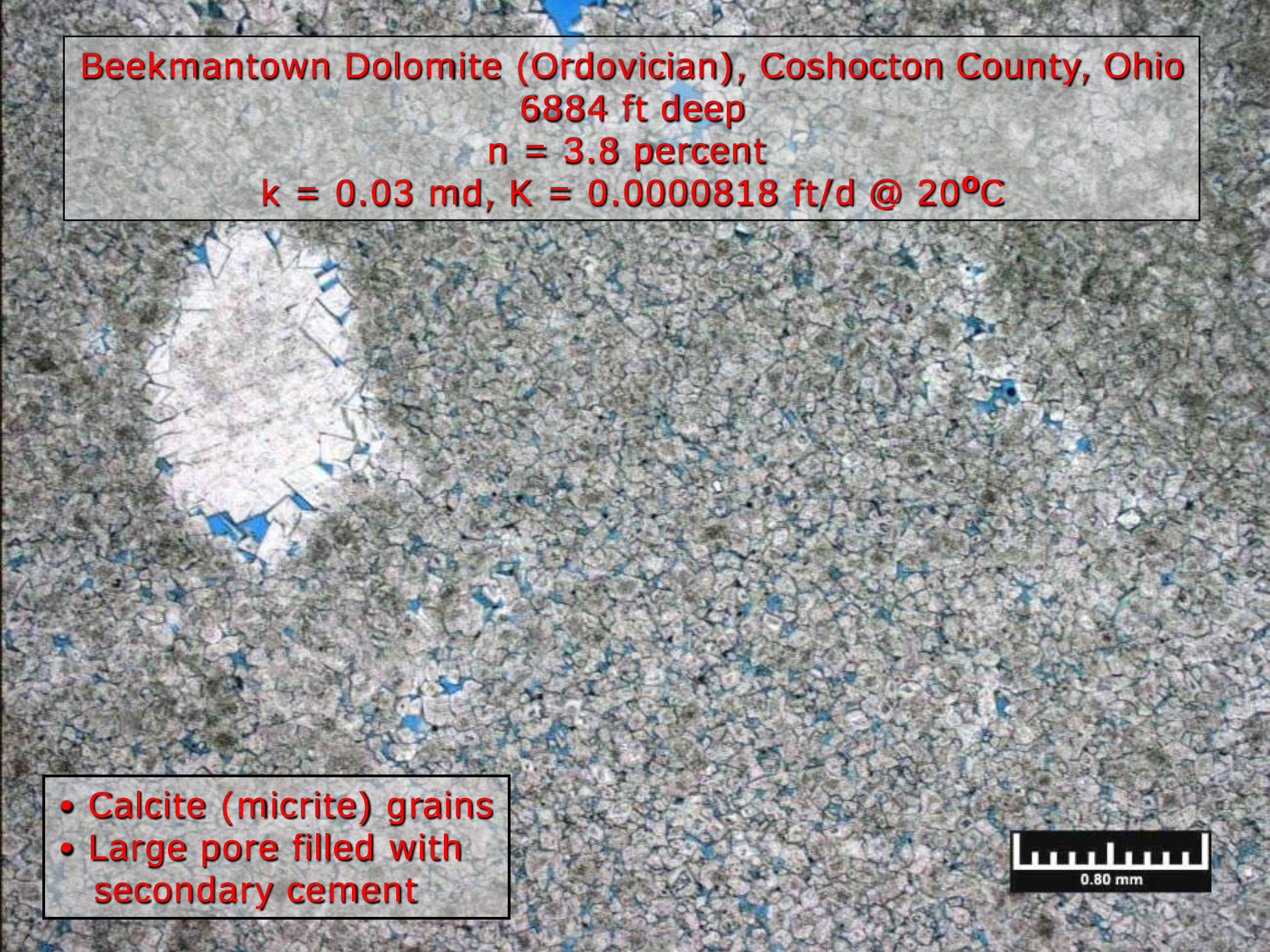
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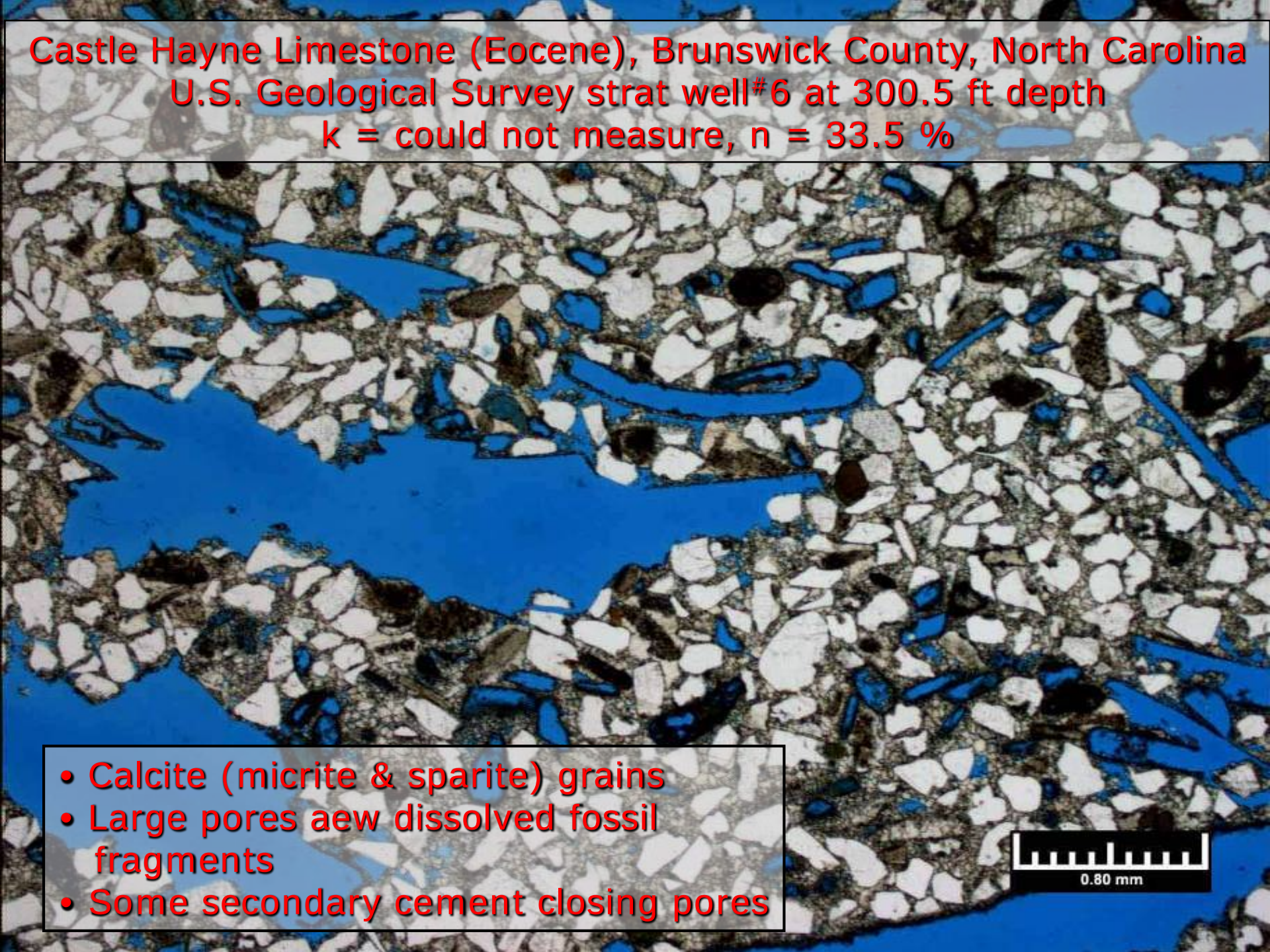

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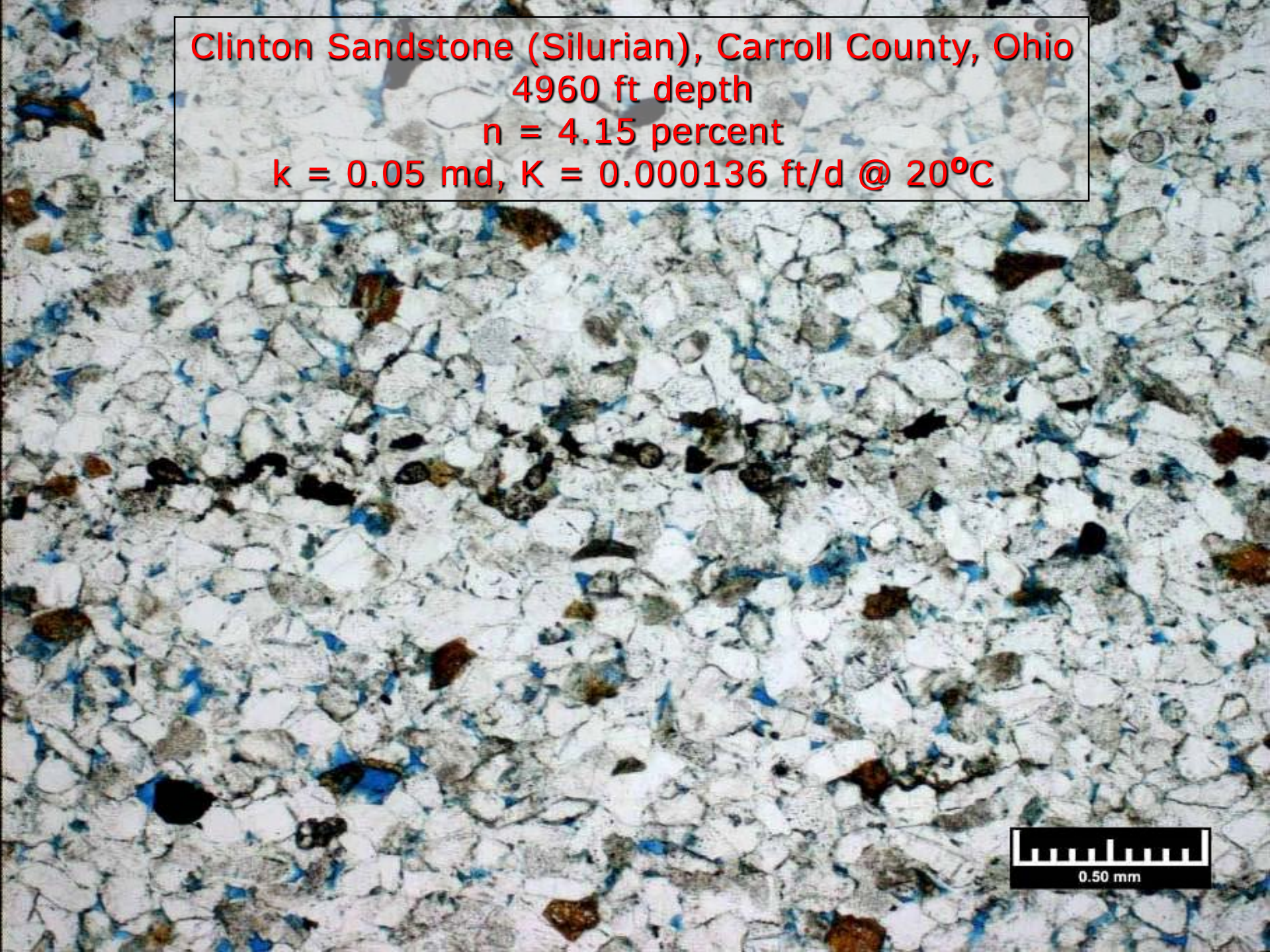
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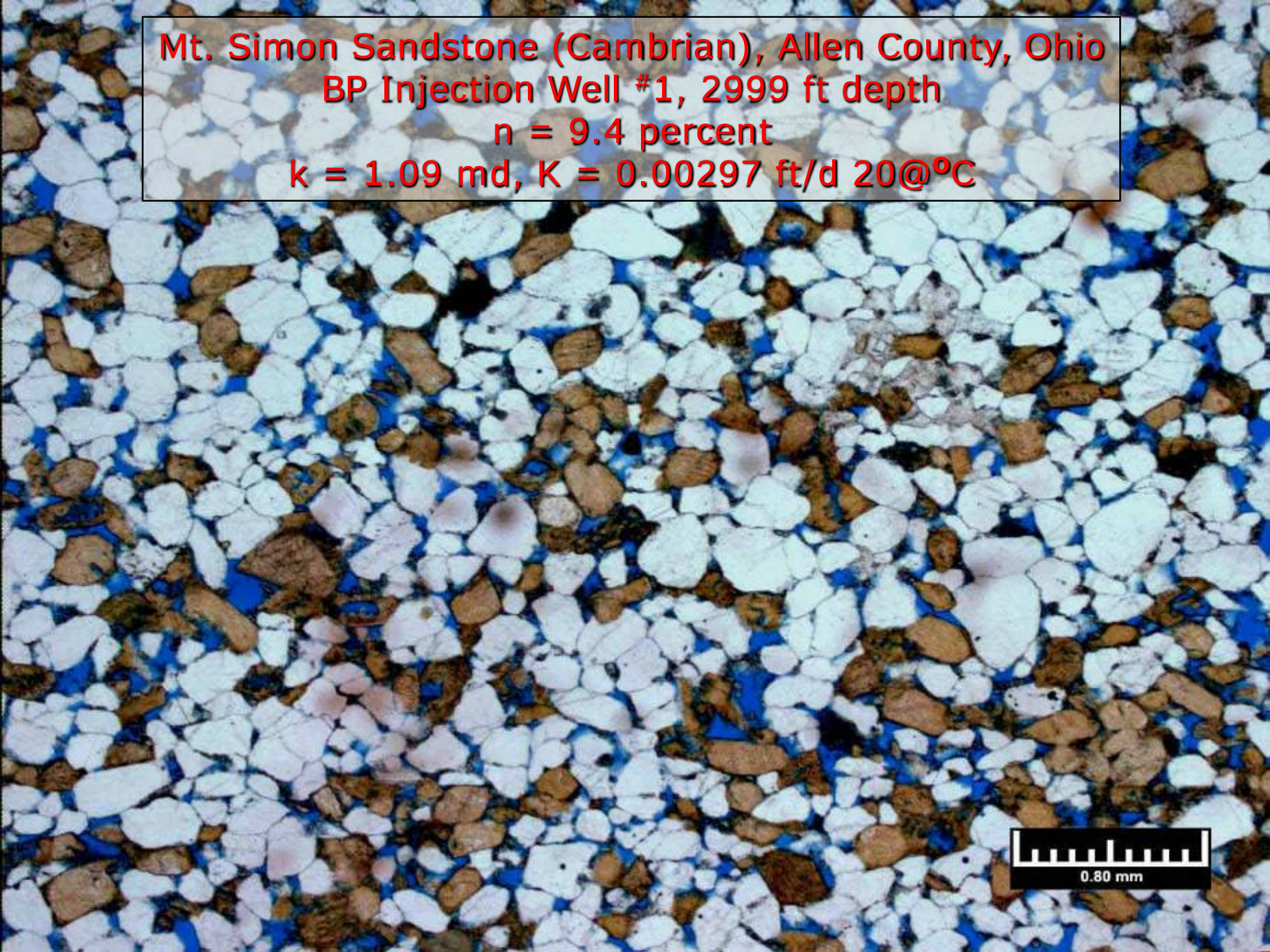
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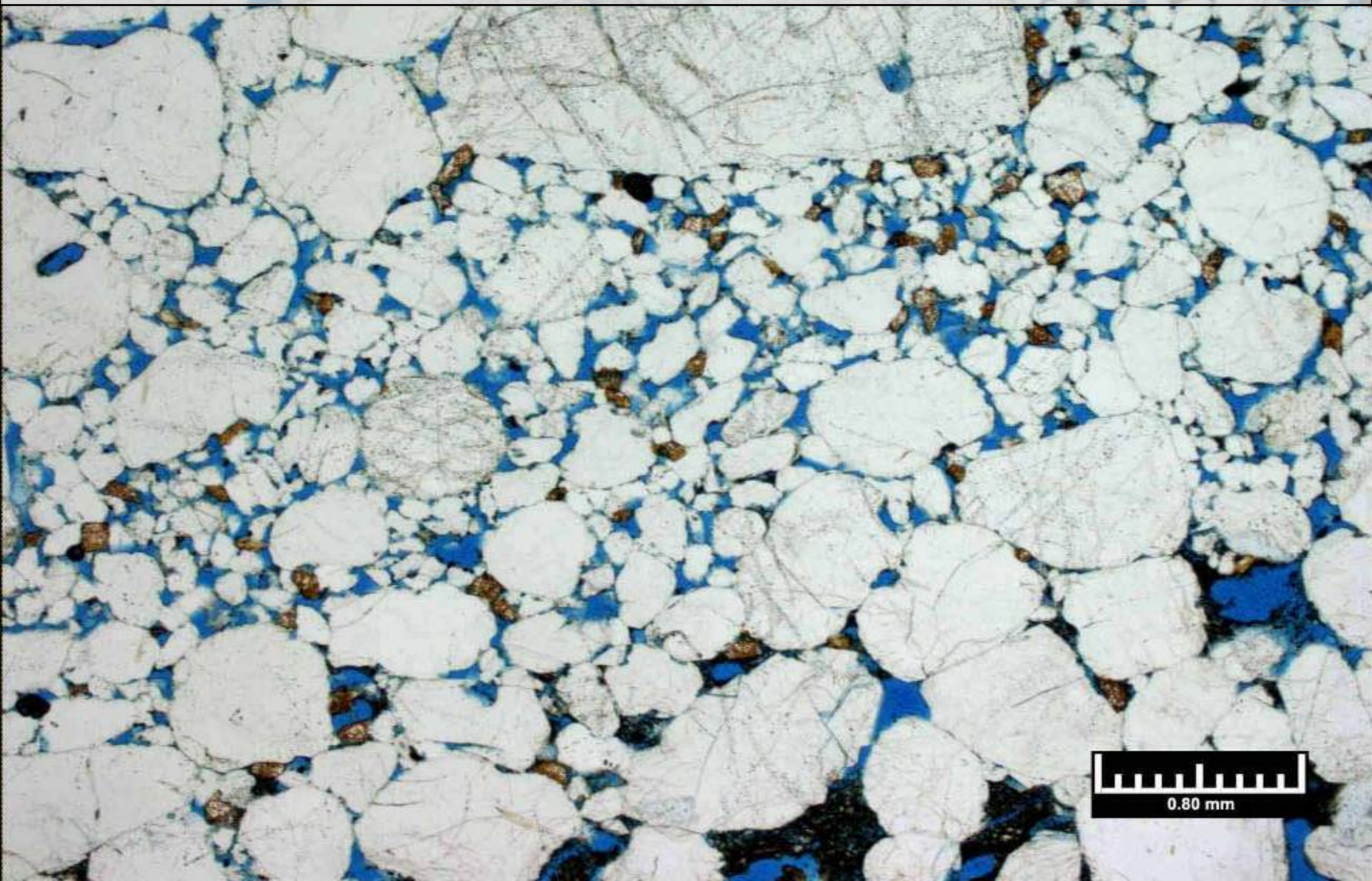

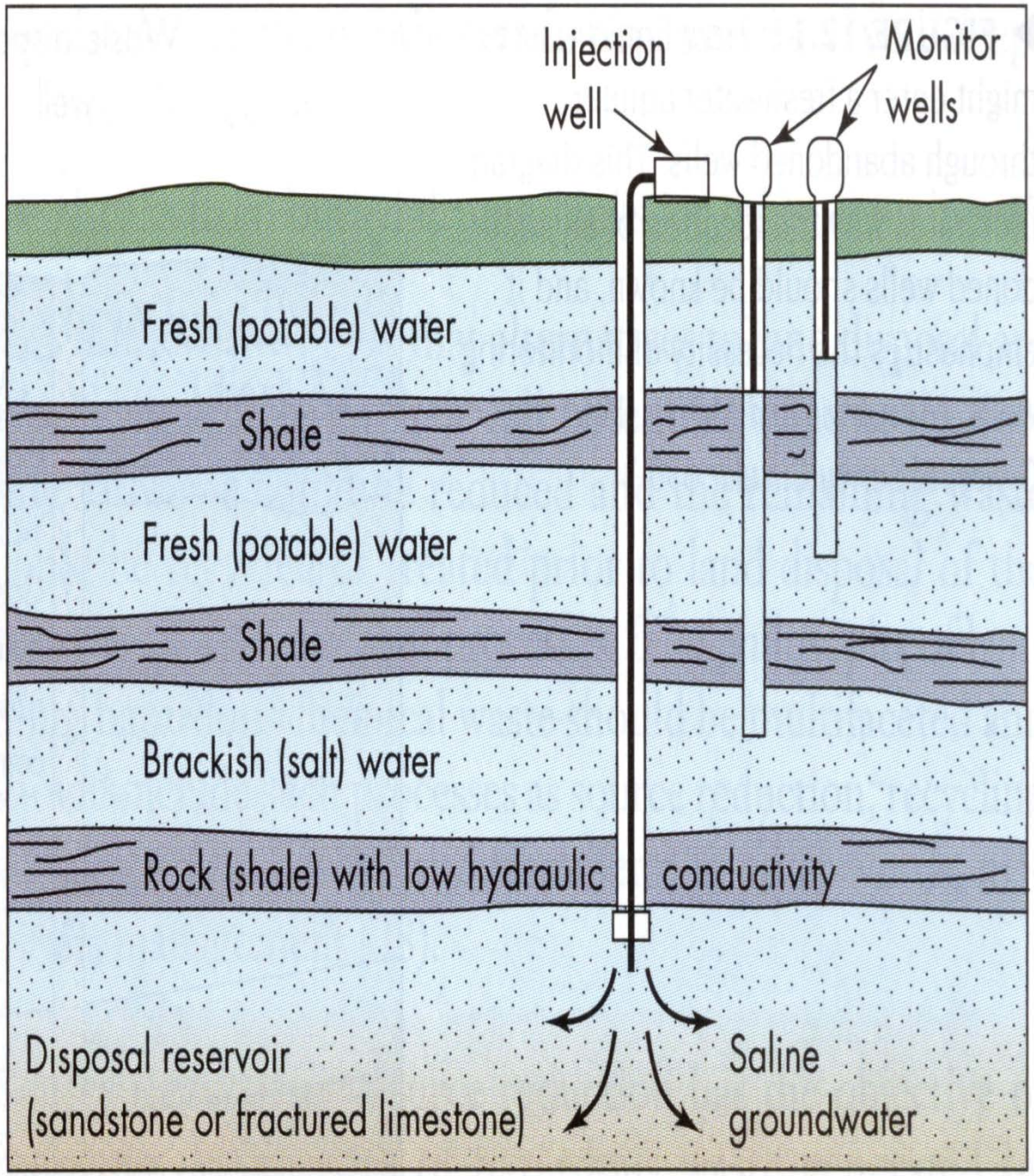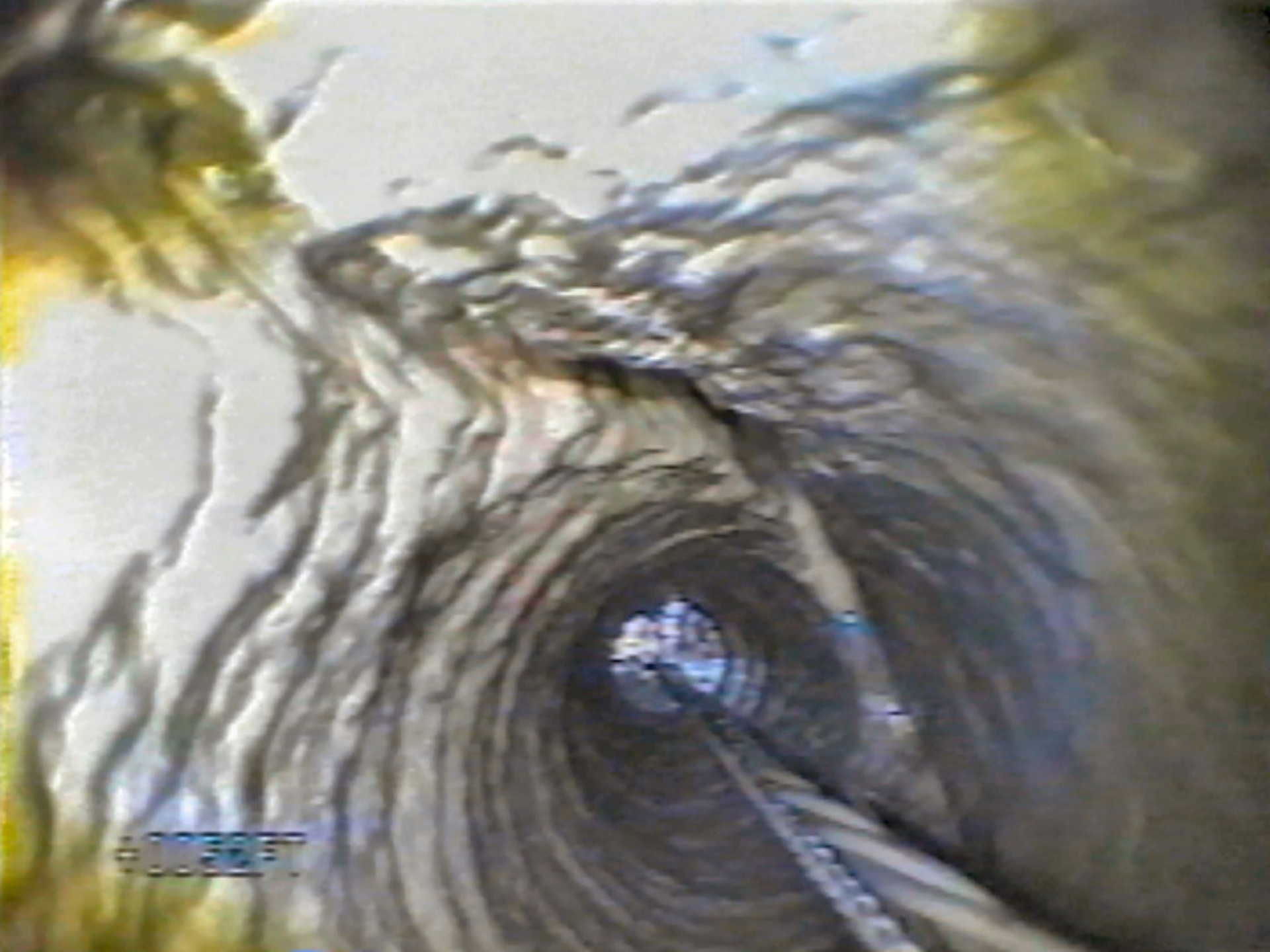
Injection well
Monitor wells
Fresh (potable) water
Shale
Fresh (potable) water
Shale
Brackish (salt) water
Rock (shale) with low hydraulic conductivity
Disposal reservoir (sandstone or fractured limestone)
Saline groundwater