

Controls on Porosity Development and the Potential for CO₂ Sequestration or Waste Water Disposal in the Cambrian Potosi Dolomite (Knox Group): Illinois Basin*

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Abstract

The Midwest Geological Sequestration Consortium (MGSC), lead by the Illinois State Geological Survey, Archer Daniels Midland (ADM), Schlumberger Carbon Services, and the U.S. Department of Energy's National Energy Technology Laboratory (DOE), is implementing a large-scale study to confirm that carbon dioxide (CO₂) can be stored or sequestered permanently in the Cambrian Mount Simon Formation. Studies of other deep rock formations including the Cambrian Knox Group are ongoing to evaluate their geology and storage potential.

In 2009 and 2010, Schlumberger Carbon Services drilled two wells (injection and monitoring) down to the Precambrian basement at a depth of approximately 7,000 feet. During drilling through the Potosi Dolomite in the Knox Group, circulation was lost and bit drops occurred on both wells suggesting a zone of cavernous porosity. In one of the wells, approximately 30 feet of core was cut down to this lost circulation zone.

Regional studies of the Potosi Dolomite suggest this lost circulation zone may translate across the Illinois Basin implying paleo-karstification because of a regional unconformity. However, petrographic analyses show that porosity enhancement of the Potosi Dolomite is related to multiple events of dolomitization along fractures and specified facies. Although, later diagenetic events such as quartz precipitation occludes porosity and has been shown to translate across the Illinois Basin. Currently, petrographic and geochemical analyses are being completed to determine the paragenesis and controls on cavernous porosity development in the Potosi Dolomite throughout the Illinois Basin. The Potosi Dolomite may be a reliable and excellent reservoir for CO₂ sequestration and/or wastewater disposal throughout the Illinois Basin.

Reference

Willman, H.B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J.A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin no. 95, 261 p.

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Eastern Section AAPG, Sept. 25, 2012

**Jared T. Freiburg
and
Hannes E. Leetaru**



**ILLINOIS STATE
GEOLOGICAL SURVEY**
PRAIRIE RESEARCH INSTITUTE



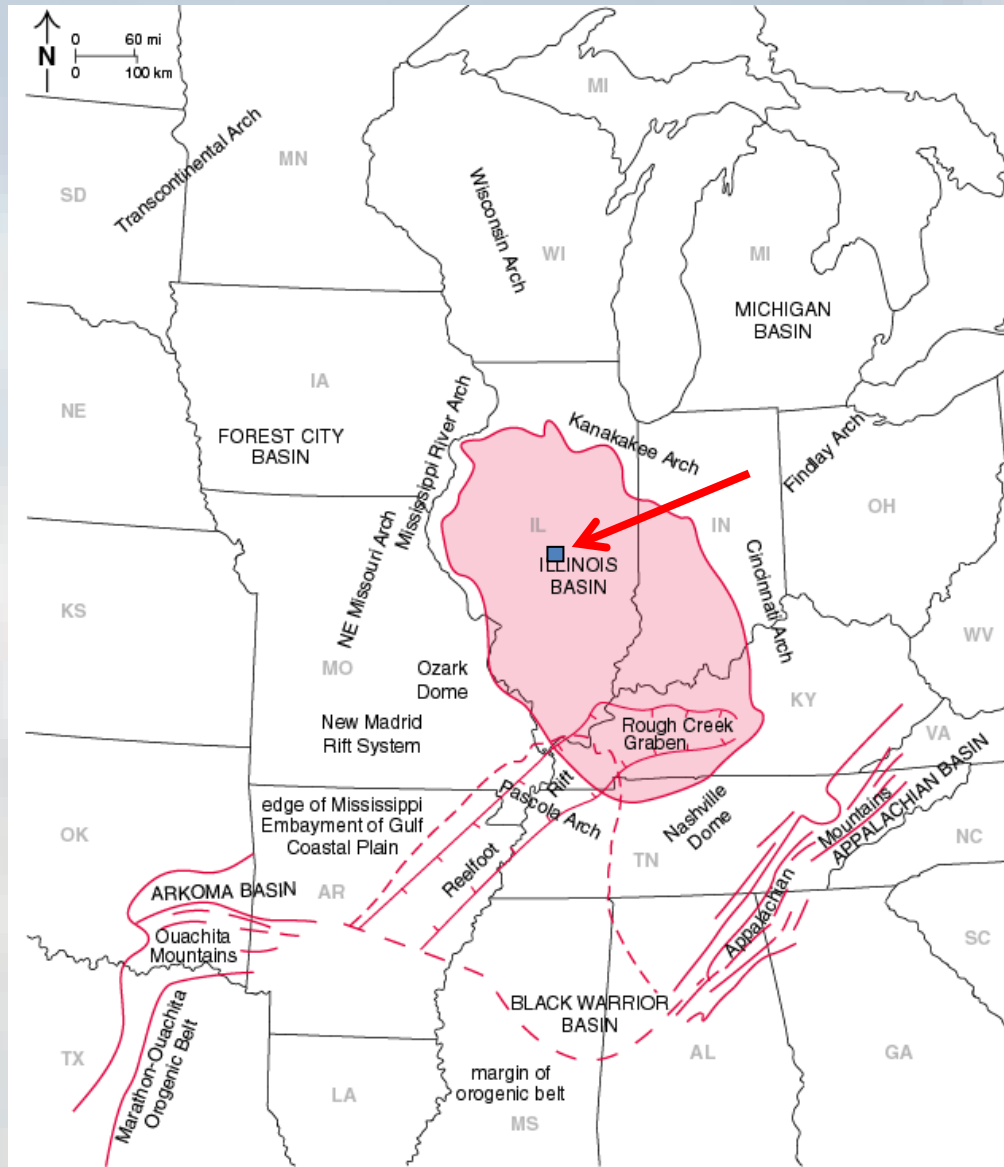
Introduction

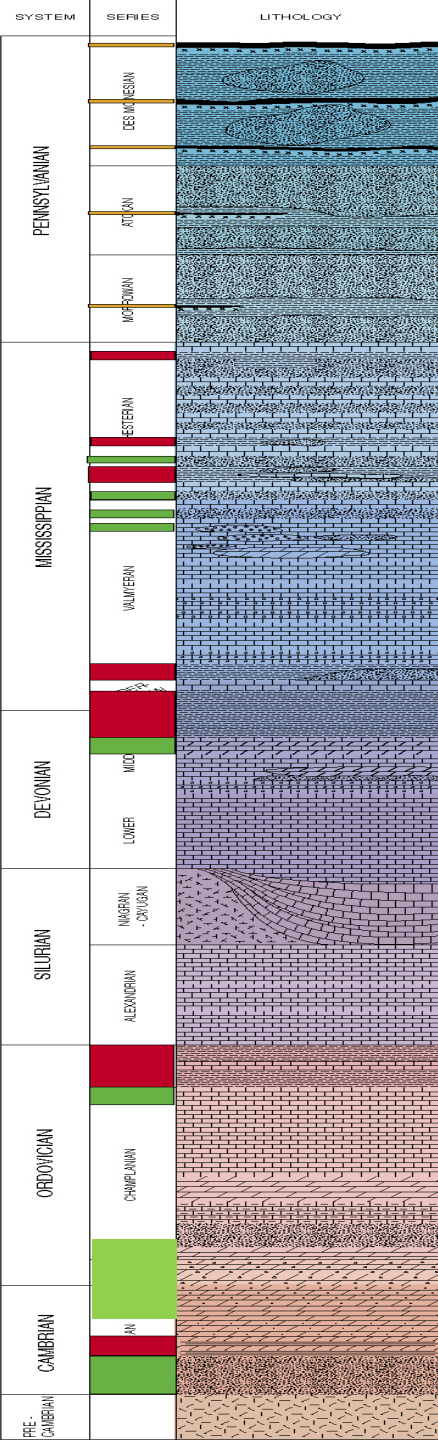
- Two holes at the Illinois Basin Decatur Project (IBDP), a Carbon Capture Sequestration (CCS) Project, have penetrated the Precambrian basement.
- Significant lost circulation and bit drops were encountered during drilling through the Upper Cambrian Potosi Dolomite.
- First core cut and preserved in the Potosi Dolomite from the Illinois Basin

Questions

- How extensive is cavernous porosity in the Potosi Dolomite?
- What are the geologic controls on porosity development in the Potosi; stratigraphic, structural?
- Is the Knox Unconformity a major control on cavernous porosity development in the Potosi?





Illinois Basin - Decatur Project



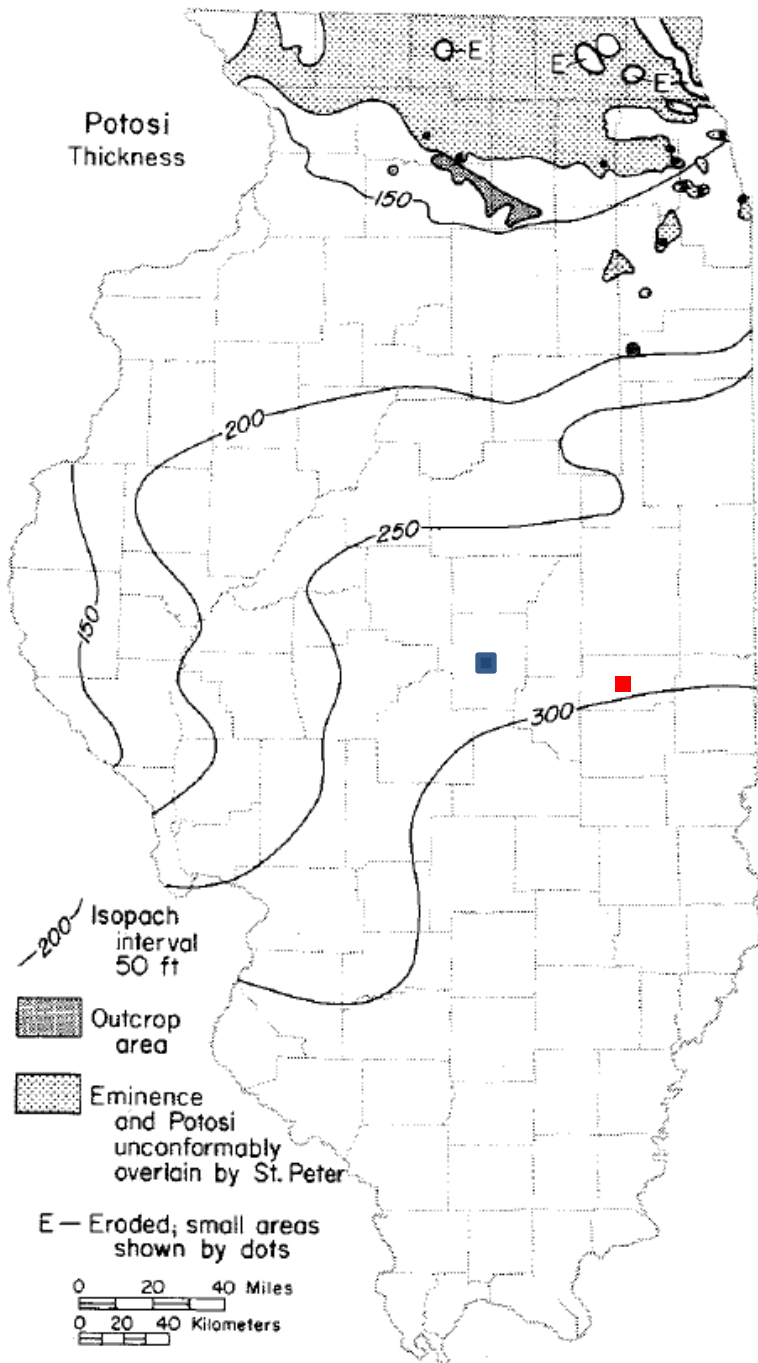


Stratigraphy with Potential Seals and Sinks in the Illinois Basin

SYSTEM	SERIES	GROUP	FORMATION	GRAPHIC COLUMN
ORDOVICIAN	CHAMPLAINIAN	Ancell	Glenwood St. Peter Ss.	
	CANADIAN	Prairie du Chien (undiff.)	Shakopee New Richmond Oneota	
CAMBRIAN	CROIXIAN		Eminence	
			Potosi	

-  Potential Seal
-  Potential Sink
-  Coal Bed
-  Potential Sink and Seal

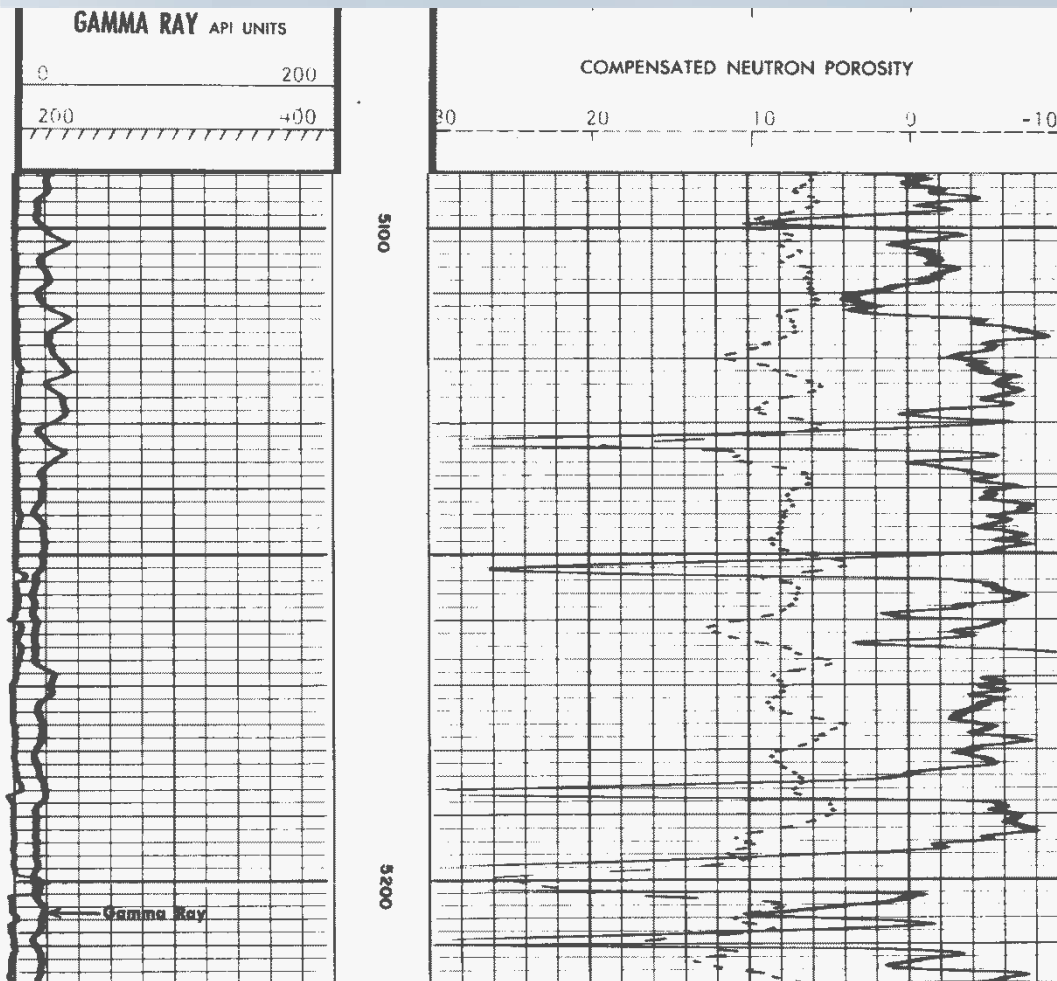
Potosi Thickness in Illinois



- IBDP Verification #1 Well
- Cabot #2 Chemical Disposal Well

Cabot #2 Disposal Well, Douglas Co.

API# 120412122000



**73 Million Gallons of
Waste Injected
Annually From
1976-1990**

Lost Circulation

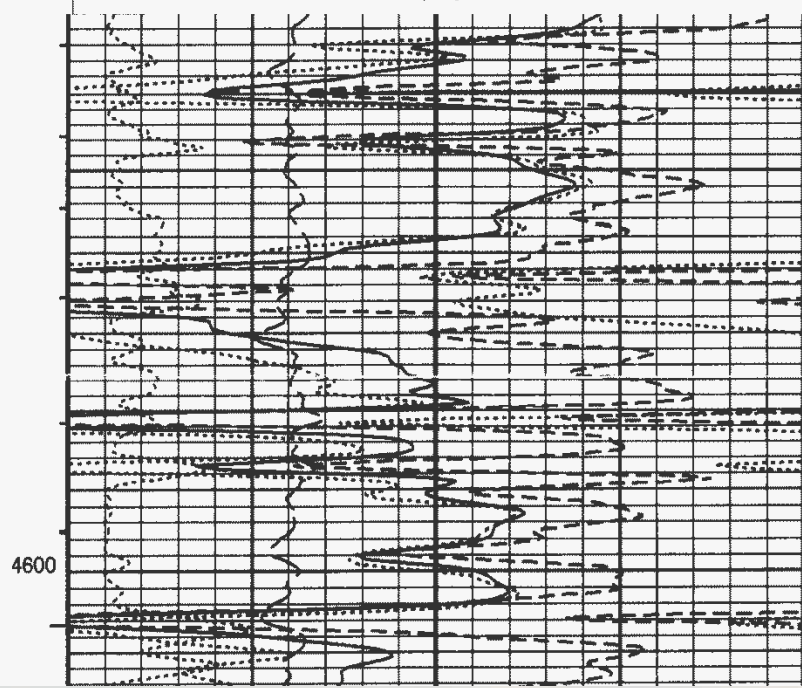
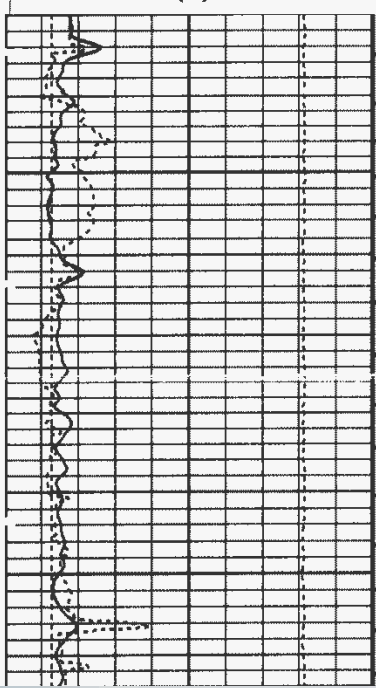
Lost Circulation

CCS-1 Well, Macon Co.

API# 121152341500

Integrated Cement Volume (ICV) (E3)	
GR > 150 From LHT1 to GR1	
Tension (TENS) (LBF)	
10000	0
HILT Caliper (HCAL) (IN)	
15	35
Gamma Ray (GR) (GAPI)	
0	150
Bit Size (BS) (IN)	
15	35

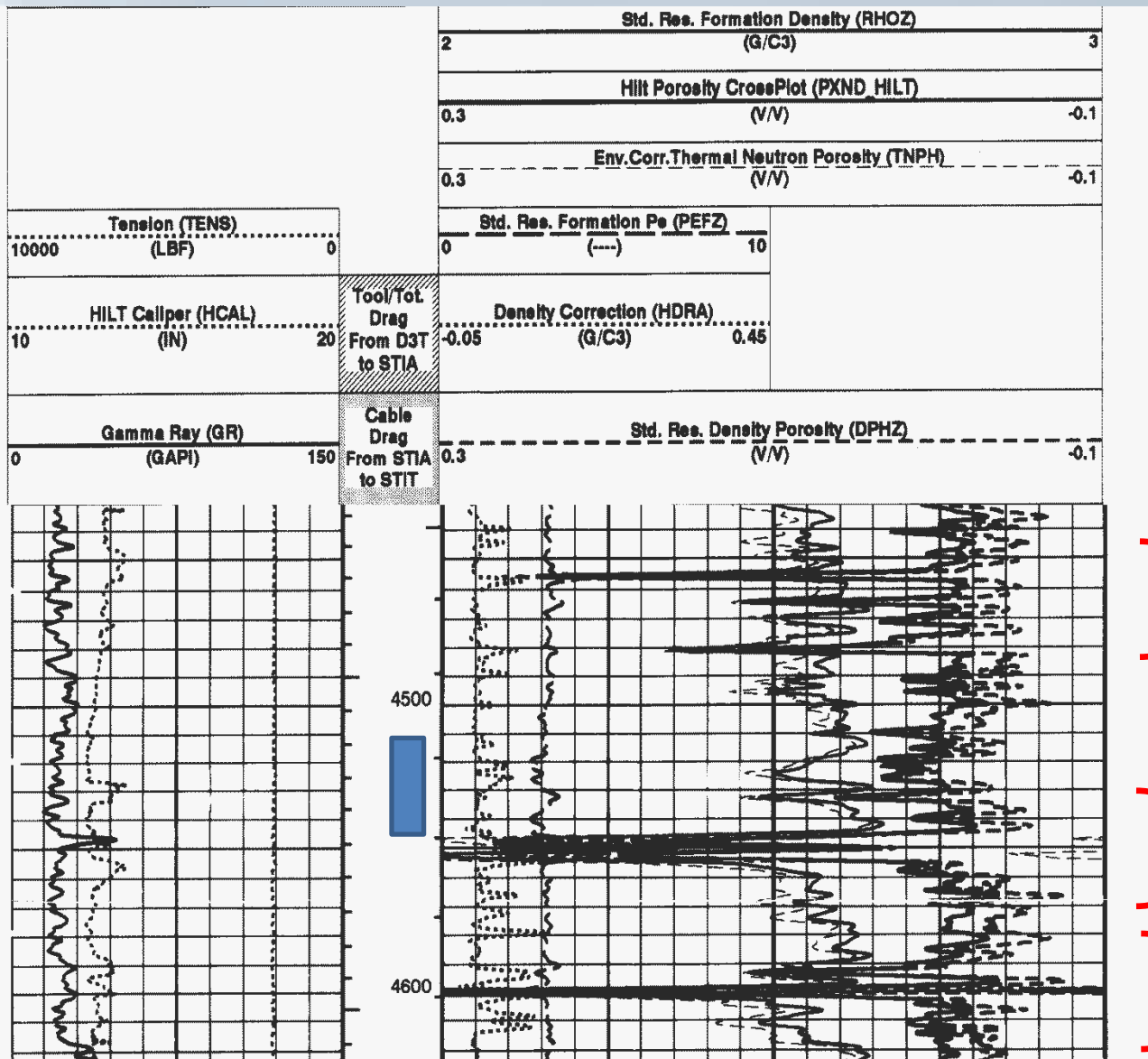
Hilt Porosity CrossPlot (PXND_HILT)	
0.3	-0.1
(V/V)	
Std. Res. Formation P _e (PEFZ)	
0	10
(-)	
Neutron Porosity (NPHI)	
0.3	-0.1
(V/V)	
Density Correction (HDRA)	
-0.05	0.45
(G/C3)	
Std. Res. Density Porosity (DPHZ)	
0.3	-0.1
(V/V)	



} Lost Circulation
}
} Lost Circulation
}
} Lost Circulation

Verification-1 Well, Macon Co.

API# 121152346000



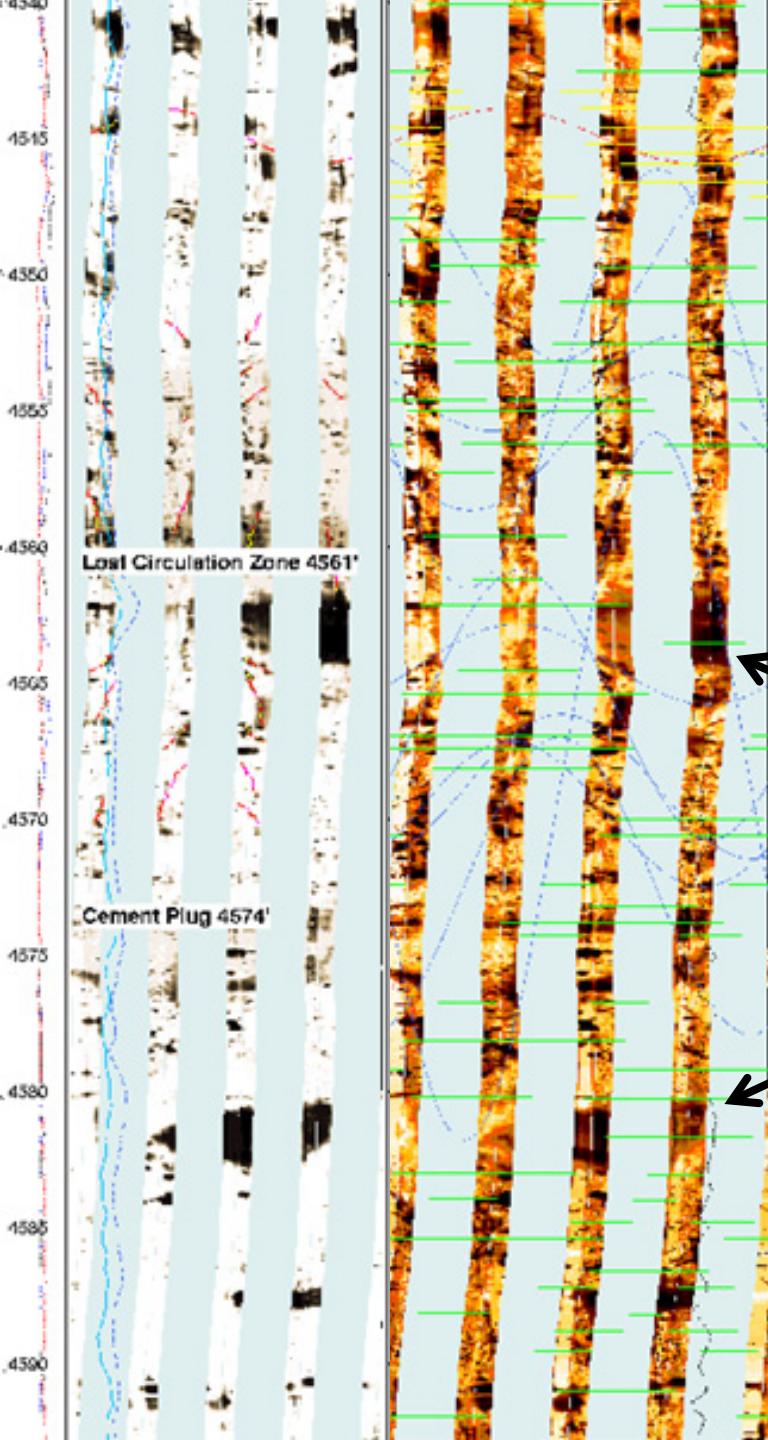
Cored
4513-4544

} Lost Circulation
Took 236 Bbls

} Lost Circulation
Took 372 Bbls

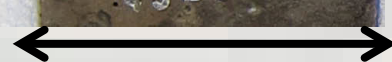
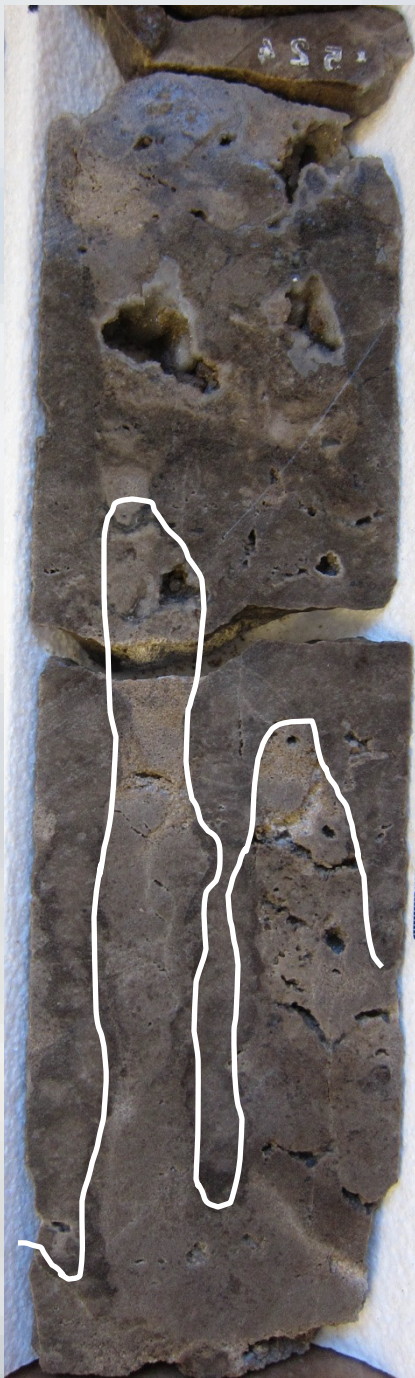
} Lost Circulation

Fullbore Formation MicroImager Log (FMI)

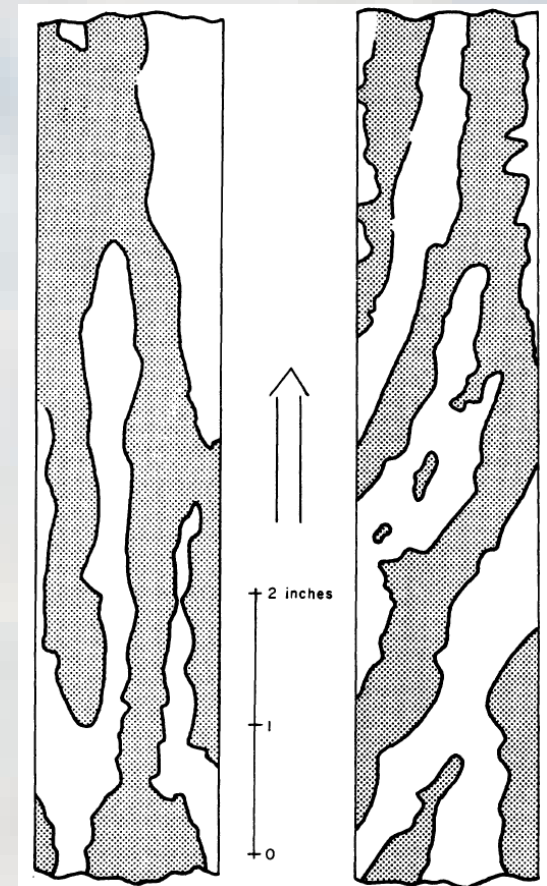


Lost Circulation Zone
Solution Cavities

Digitate Stromatolites; Solution Enhanced Fenestral Porosity



4 "



Howe, 1966

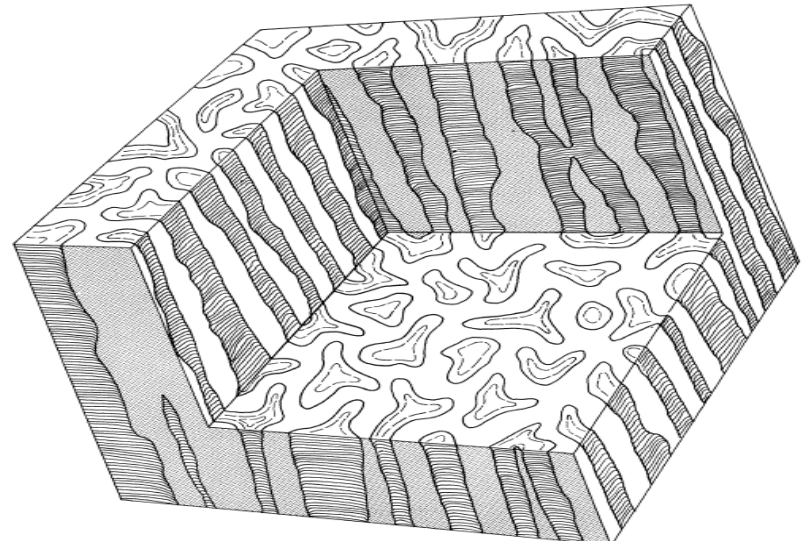
Digitate Stromatolite Colonies, Missouri



Oneota

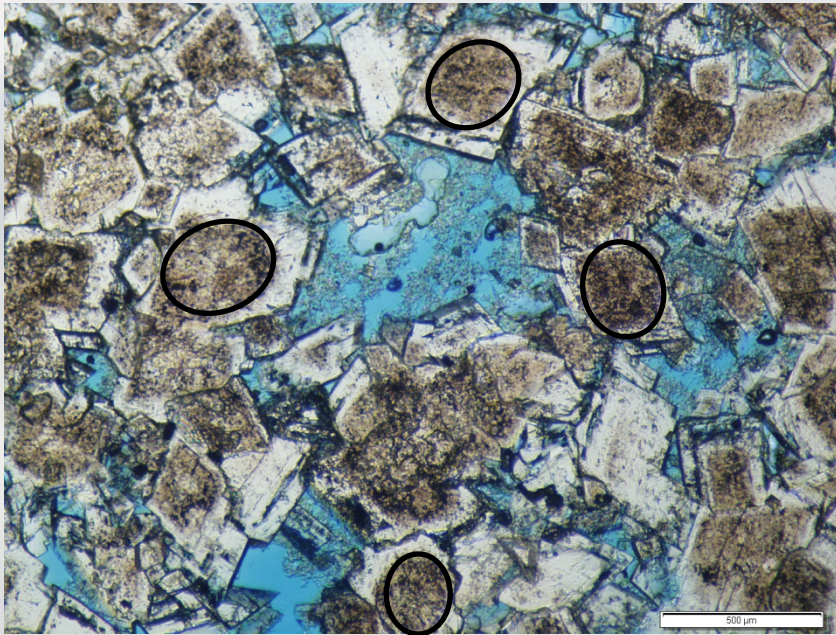


Potosi

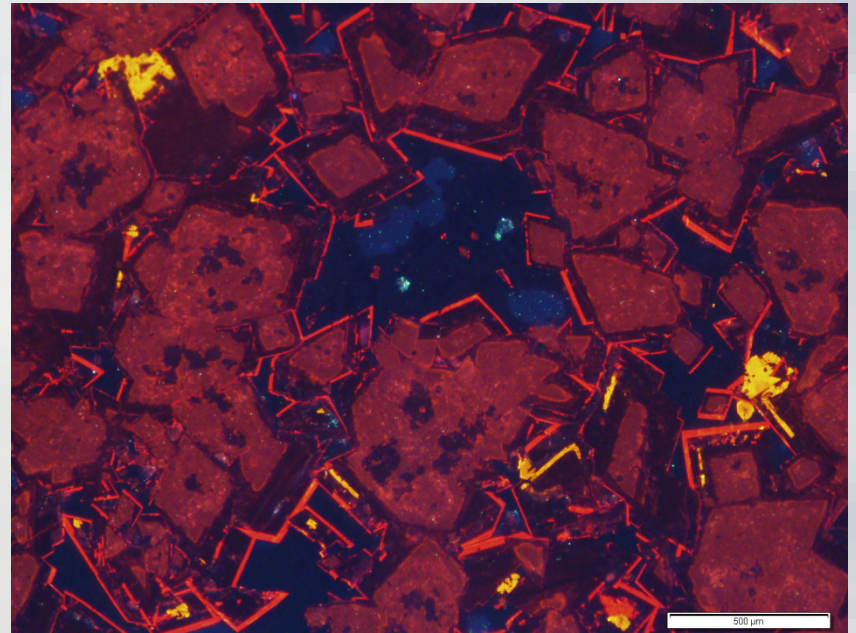


Dolomitized Peloidal Microbialites

- Microbial Carbonate Building Blocks



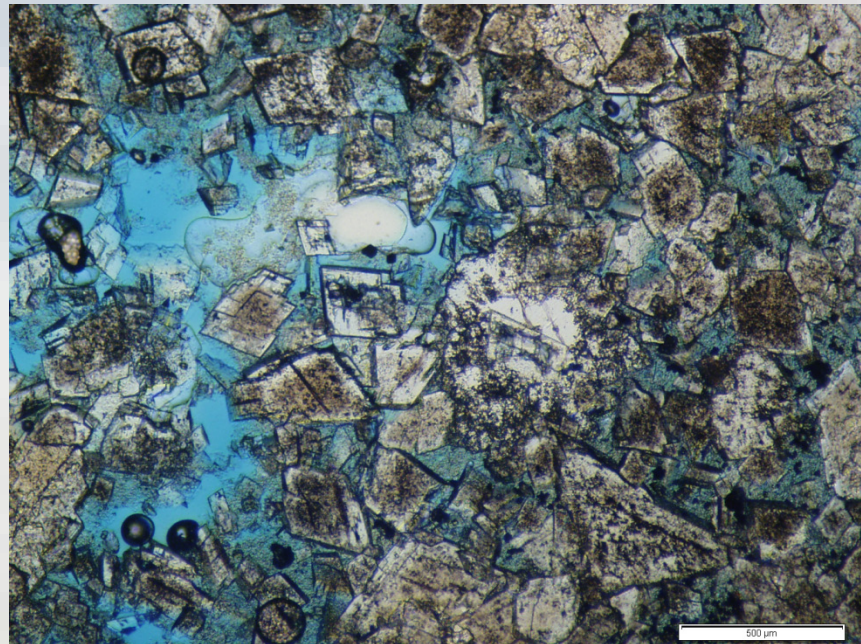
Plane-Light



Cathodoluminescence

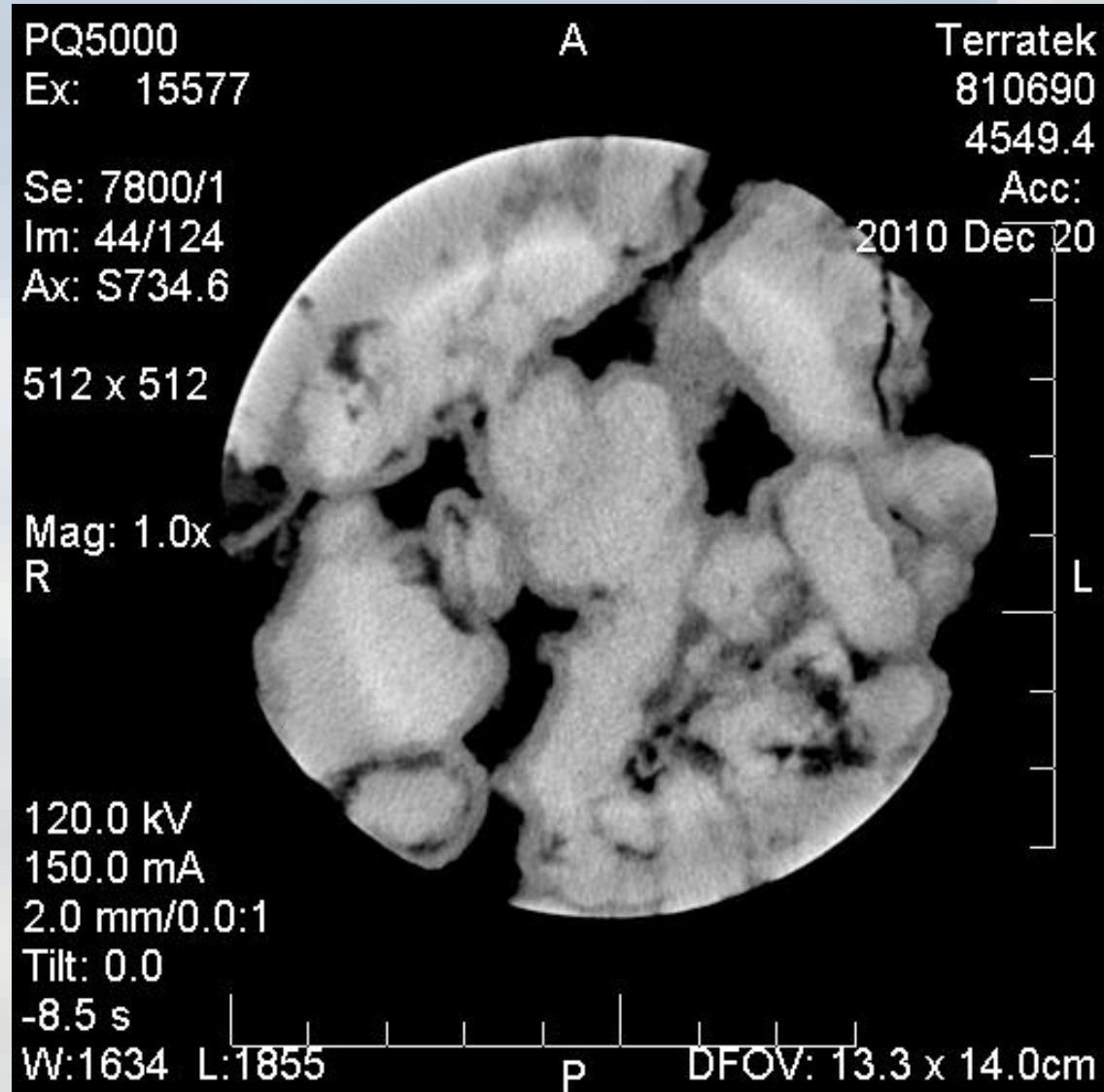
Collapse Breccia

- Sucrosic Dolomite Matrix

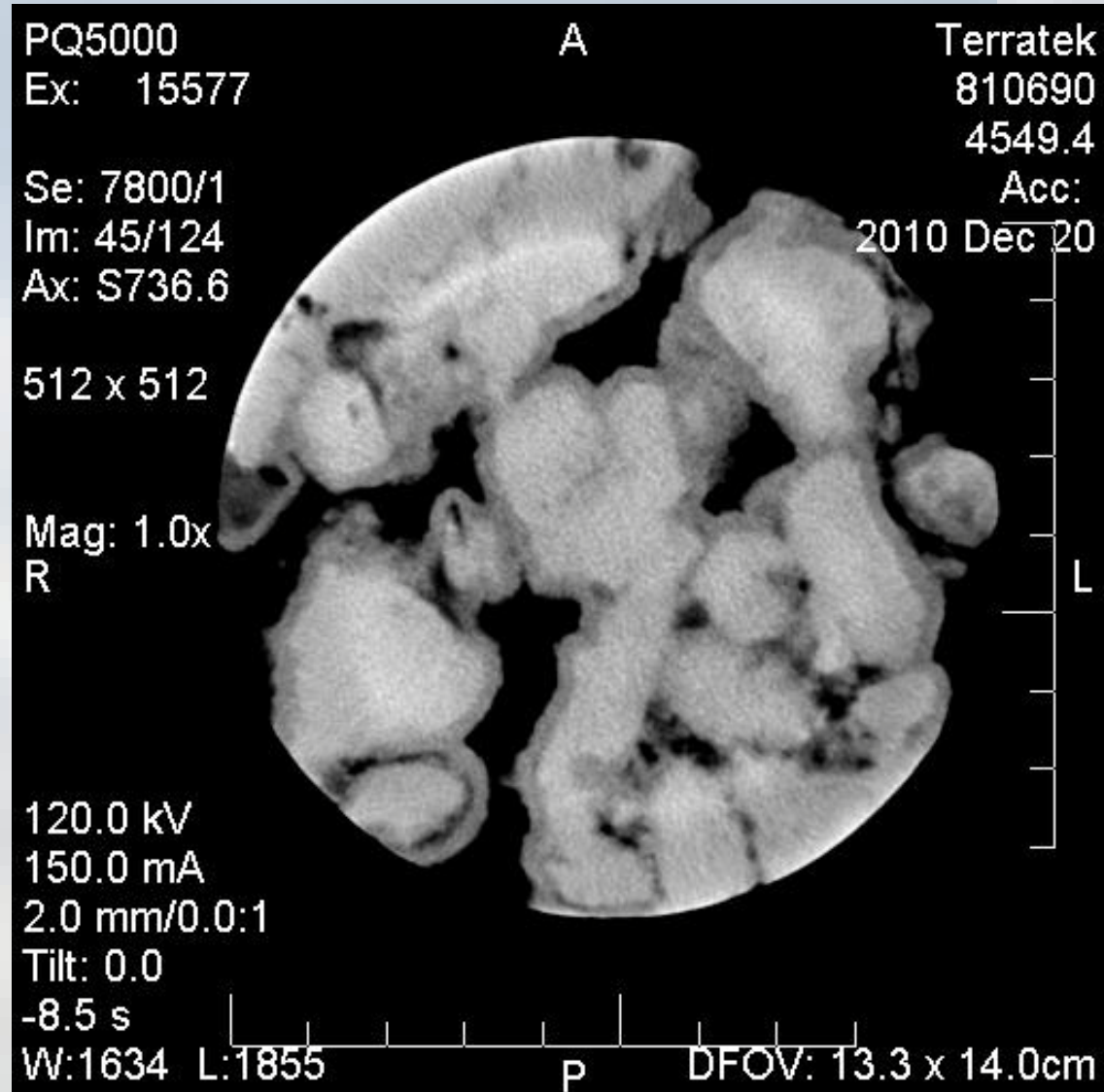


Plane-Light

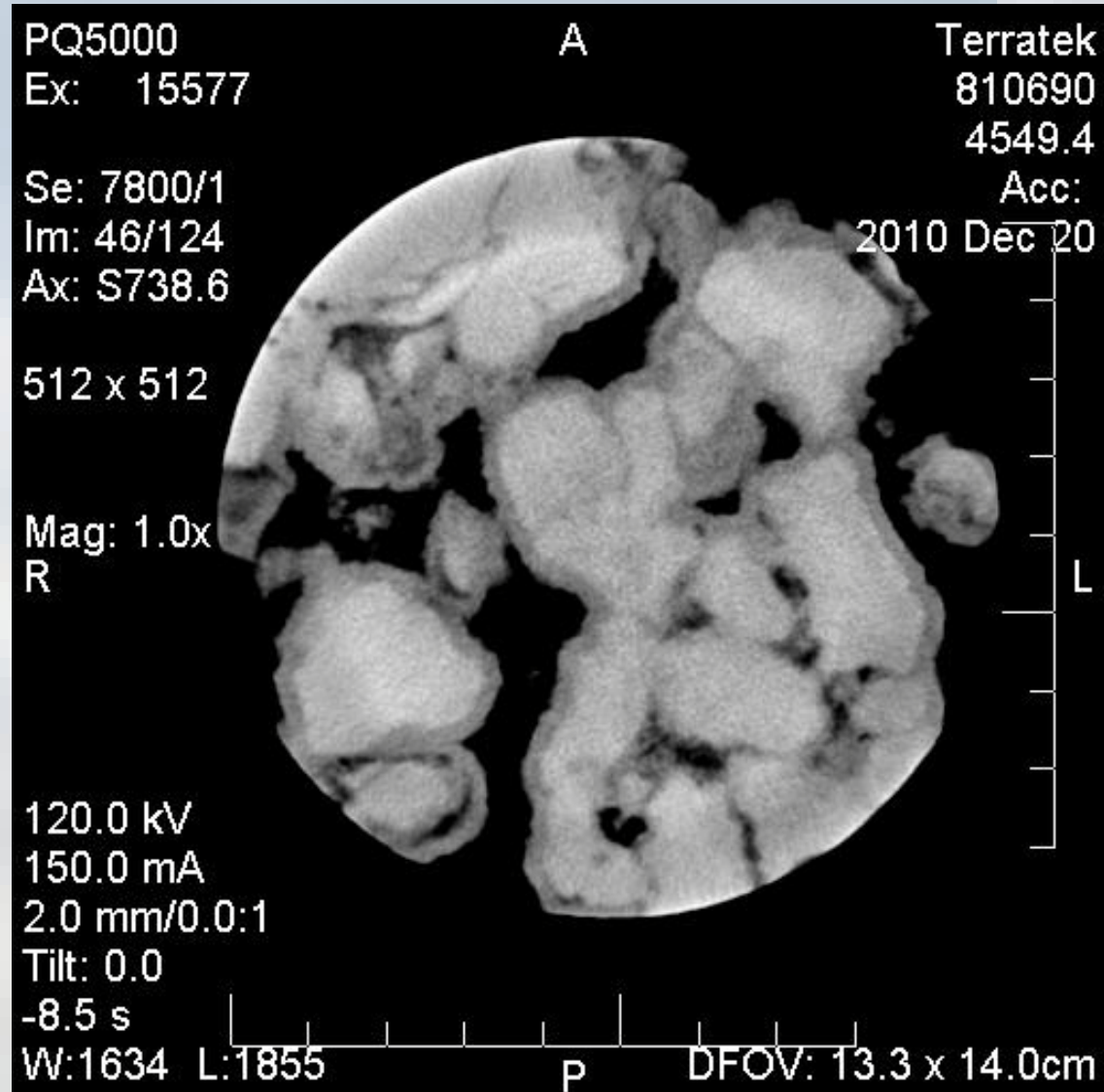
CT-Scan Collapse Breccia



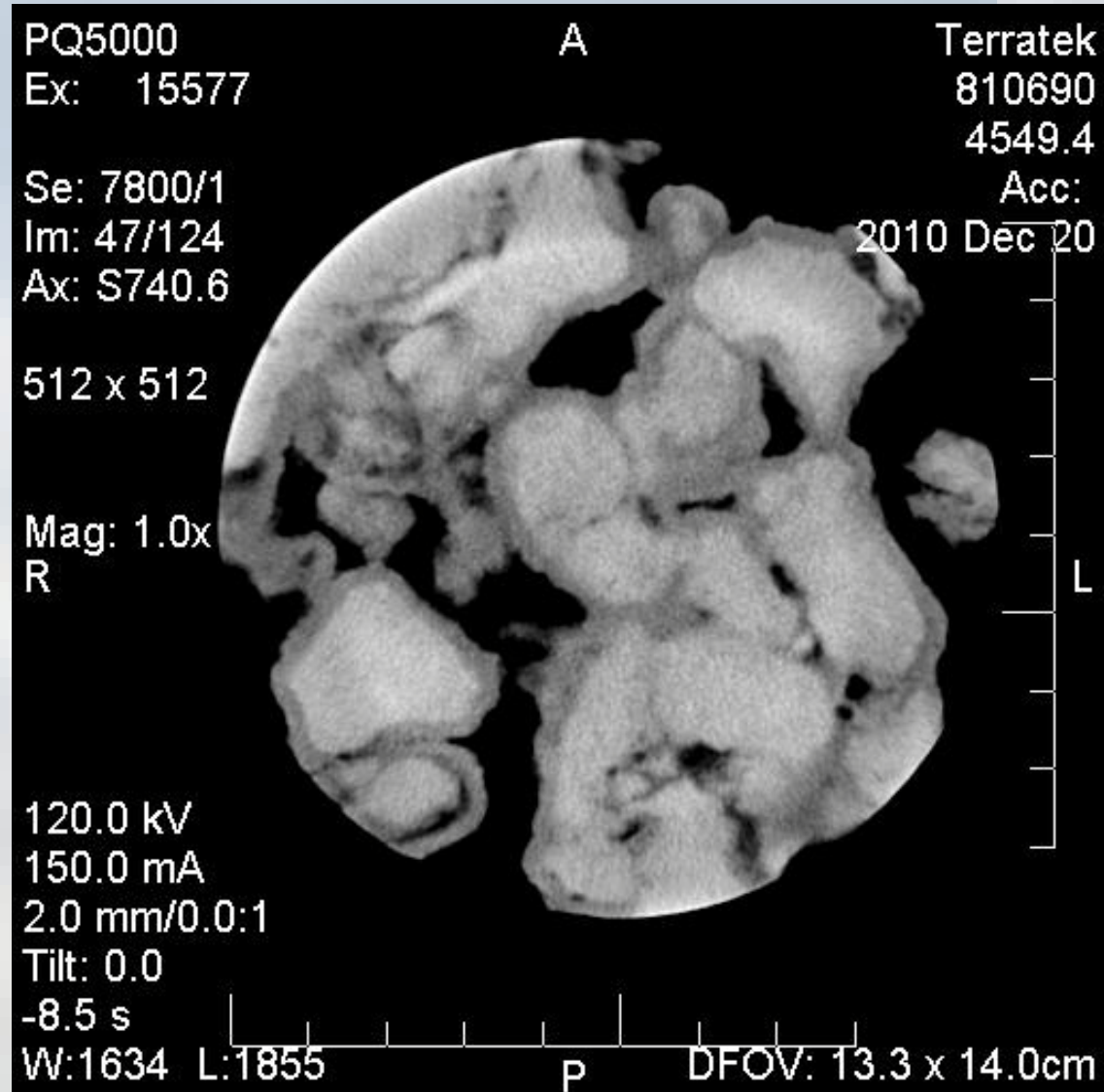
CT-Scan Collapse Breccia



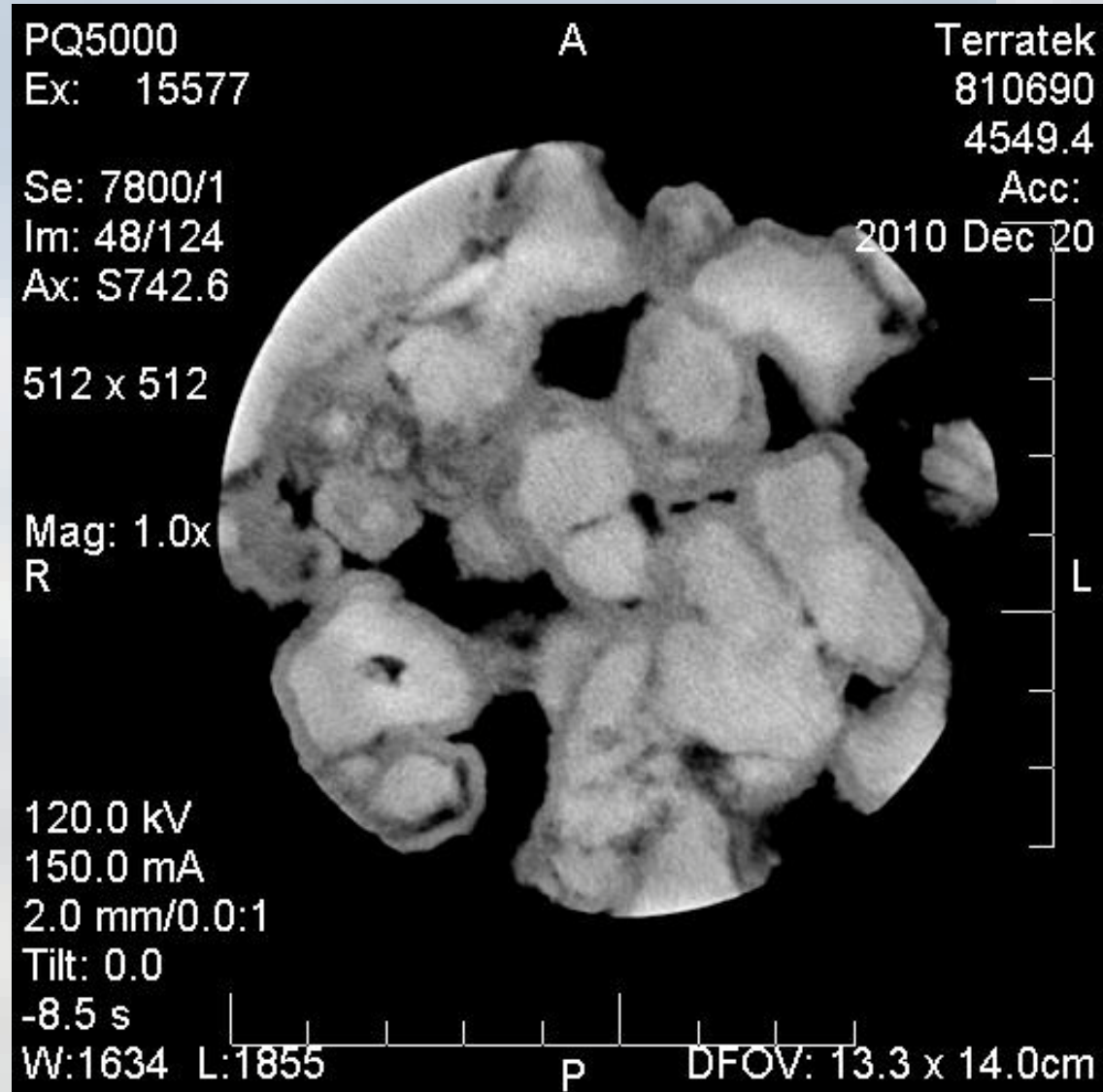
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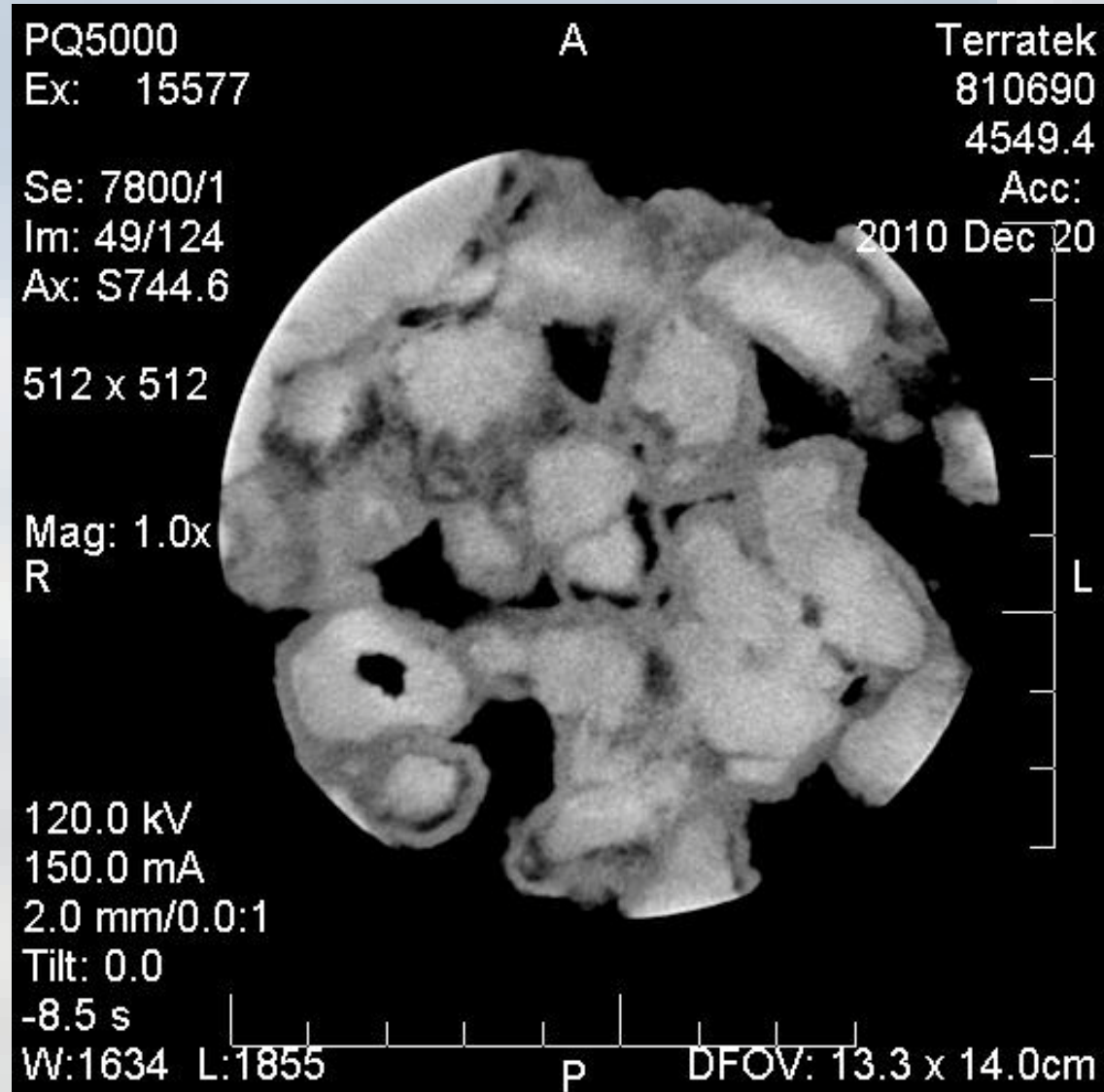
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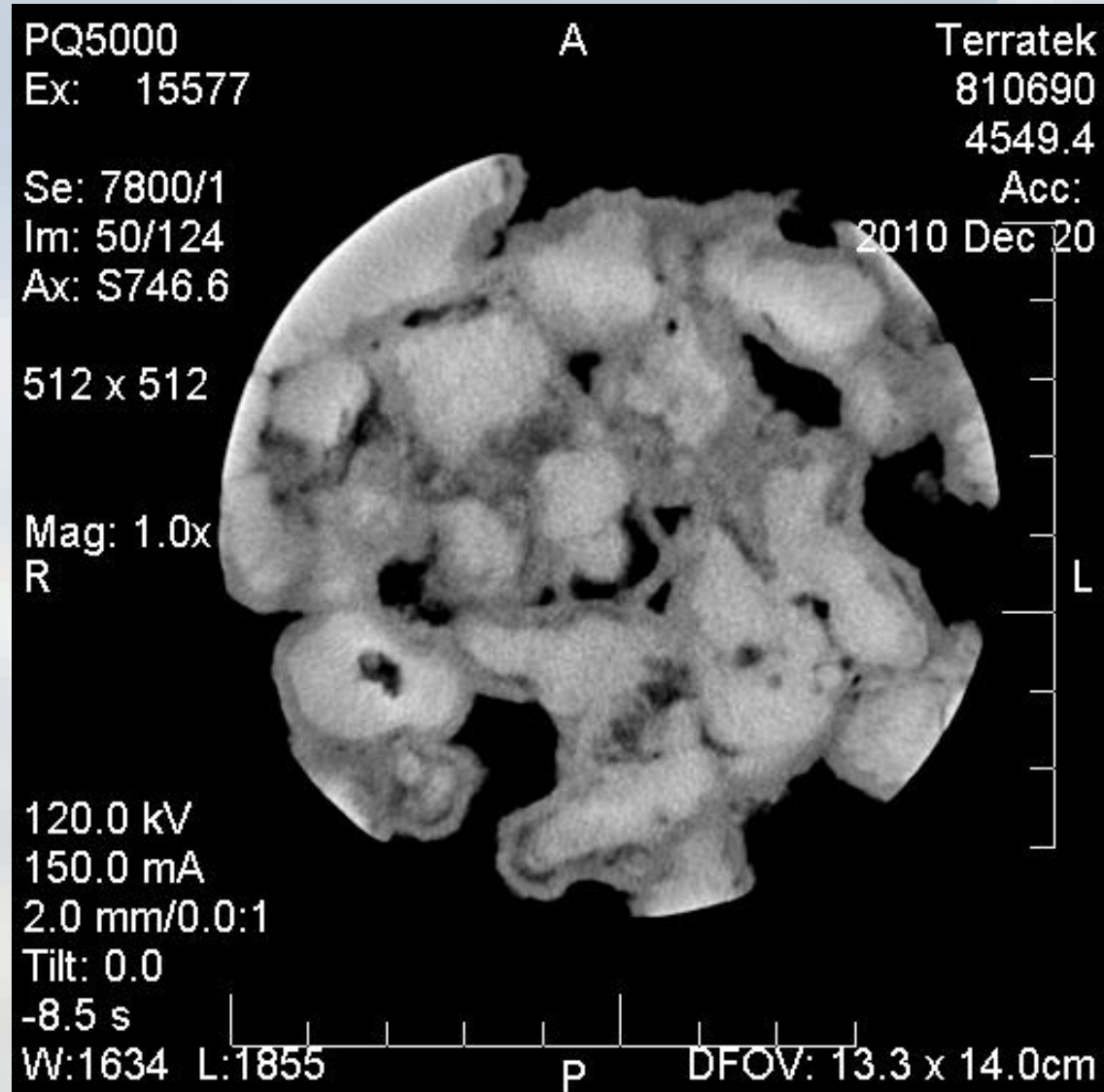
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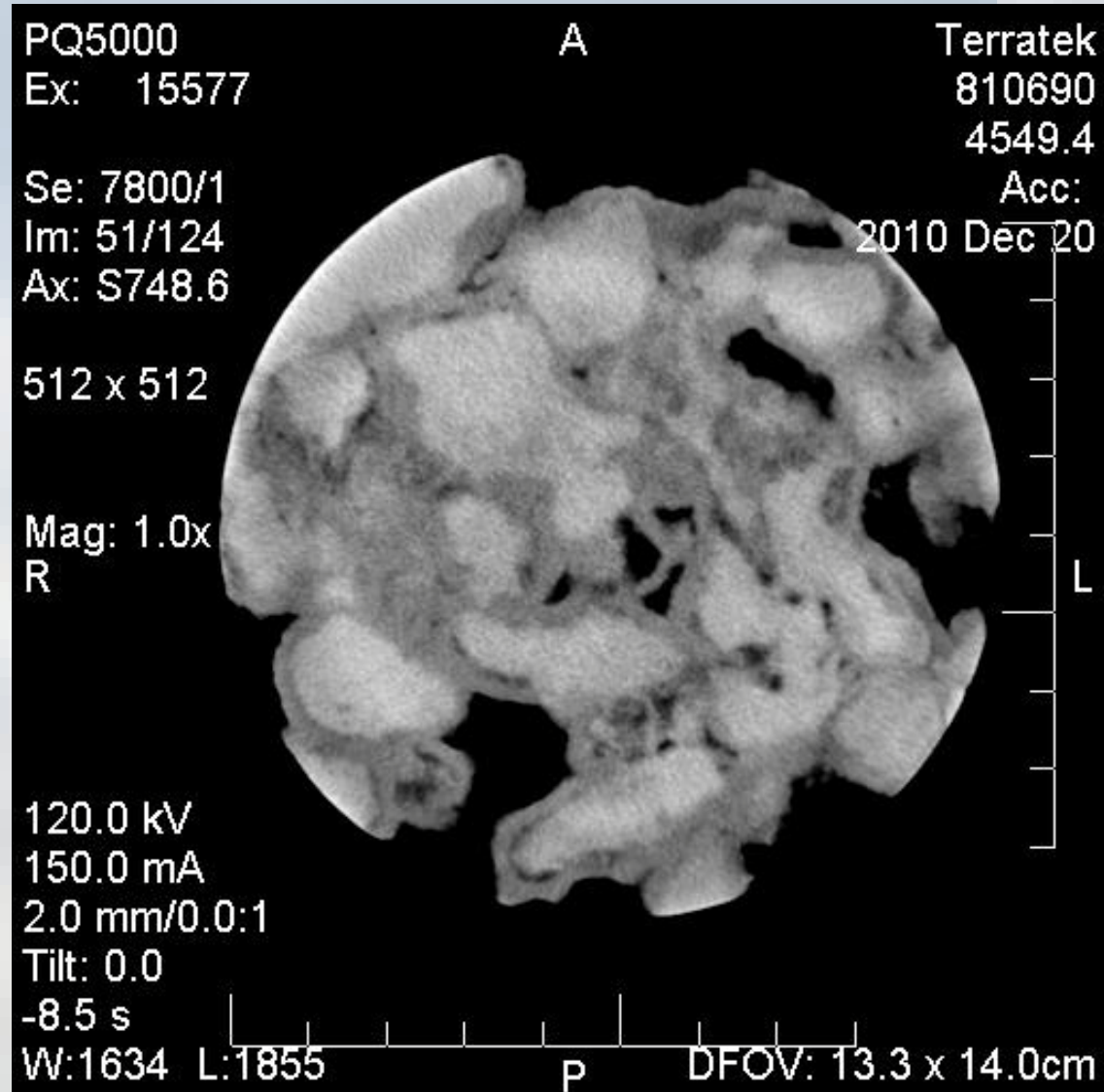
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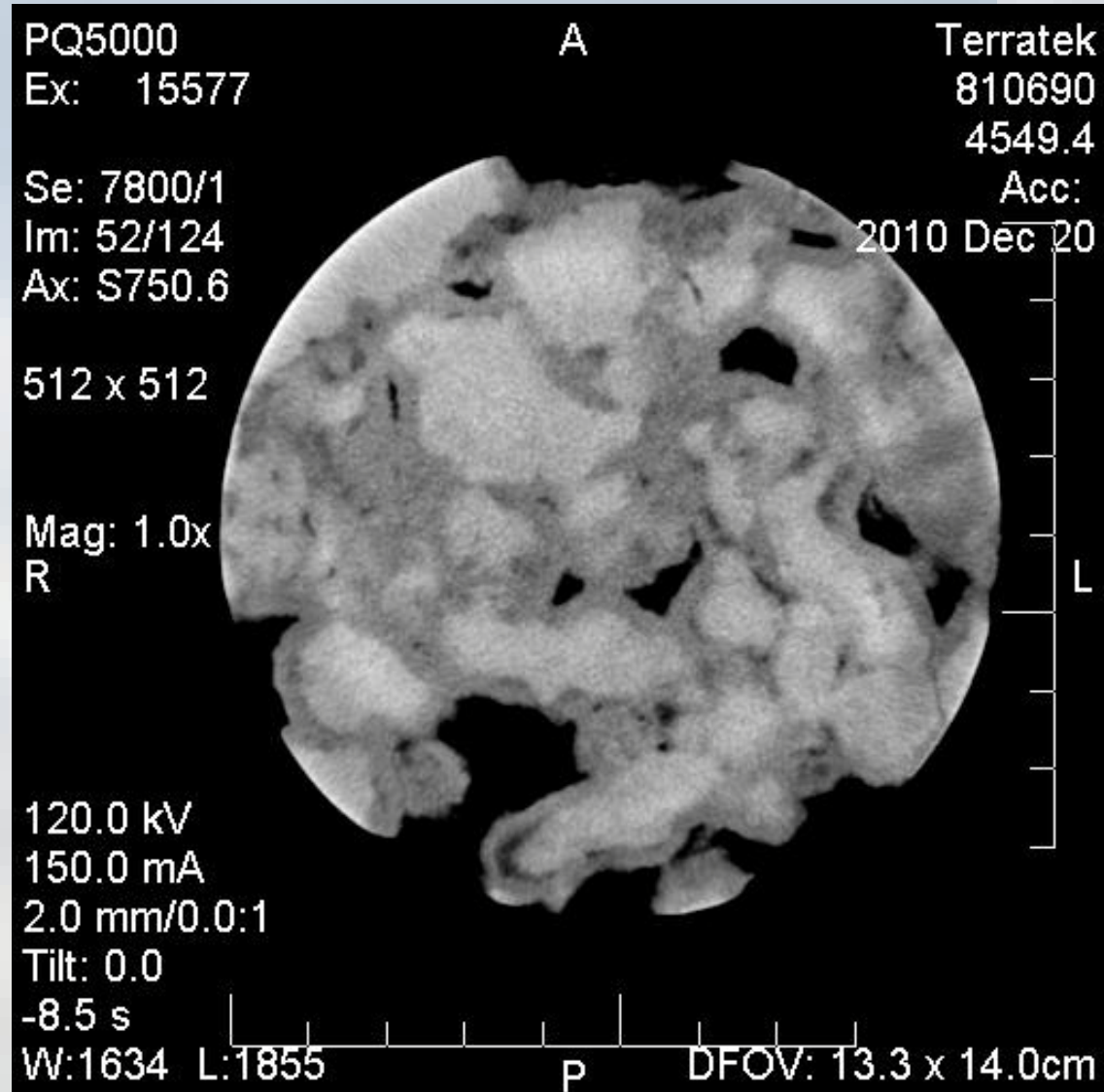
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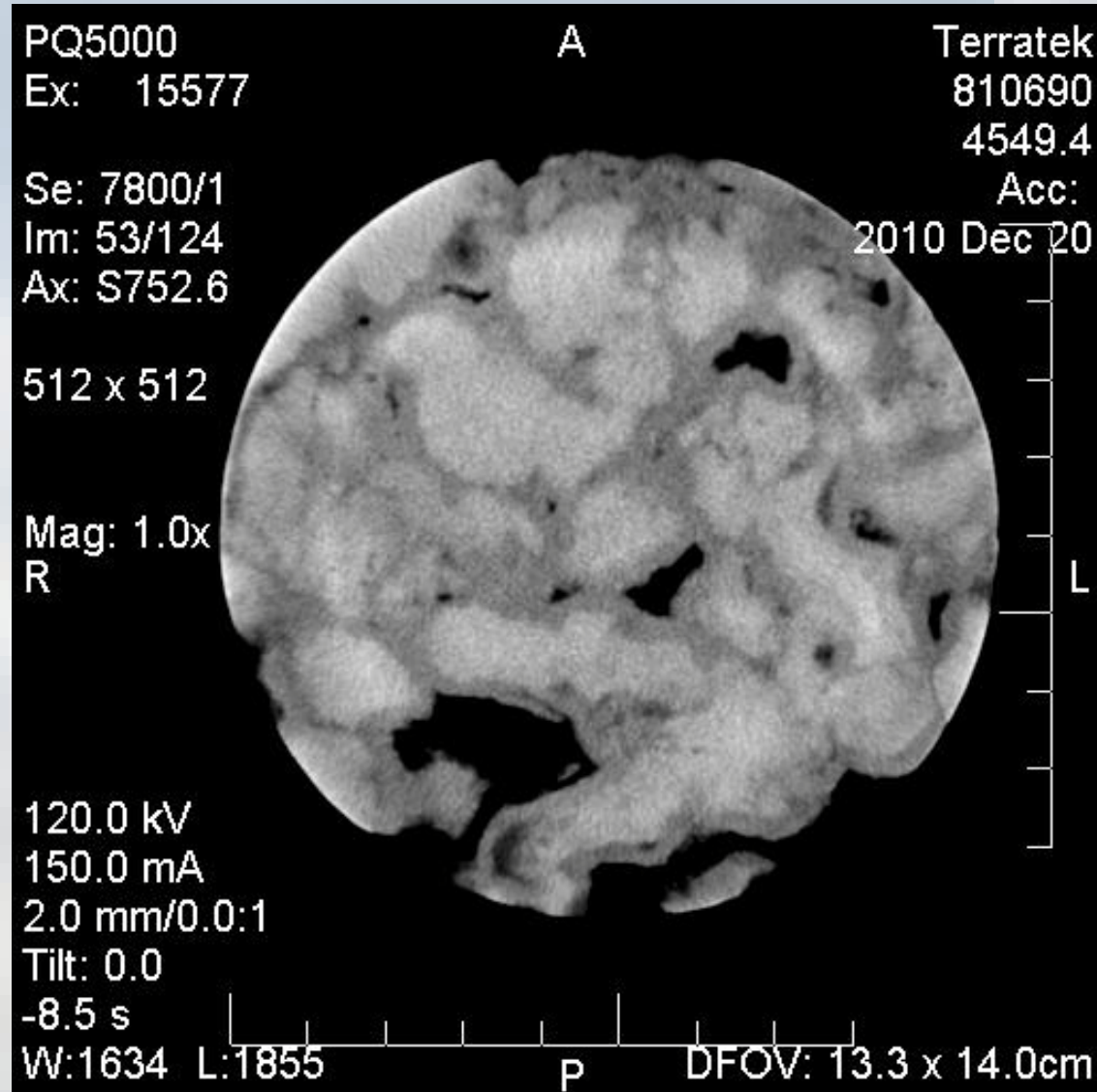
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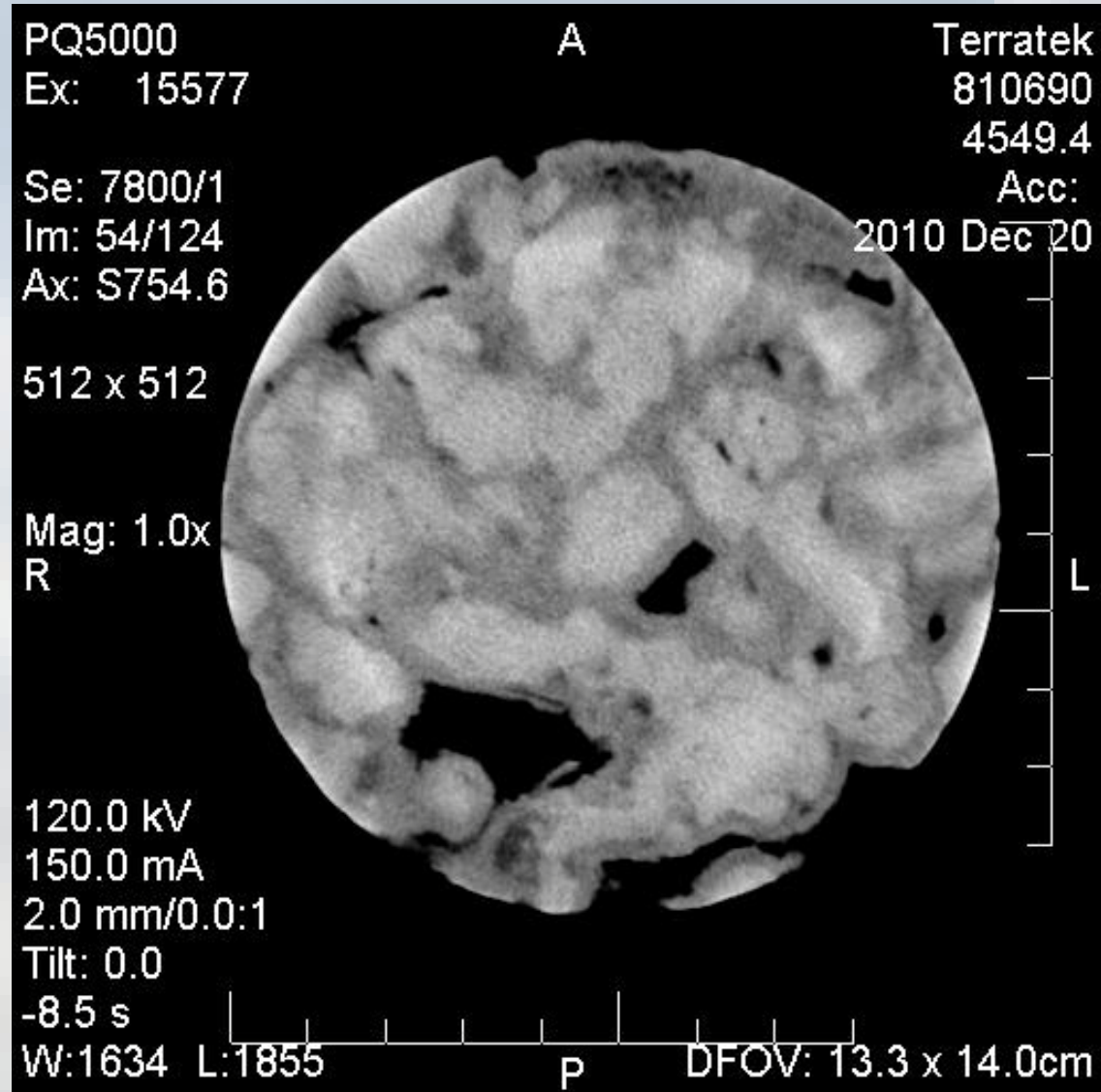
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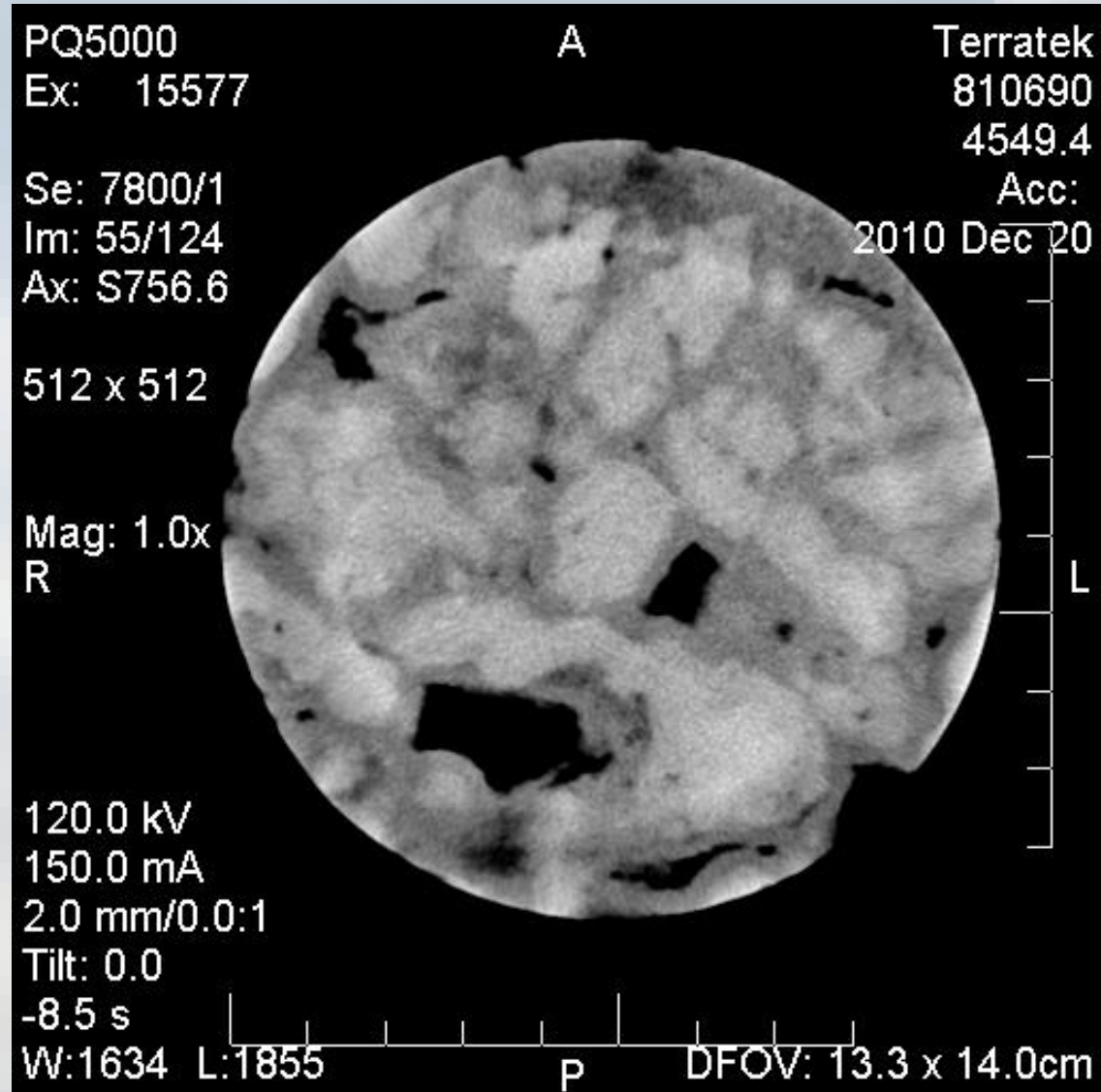
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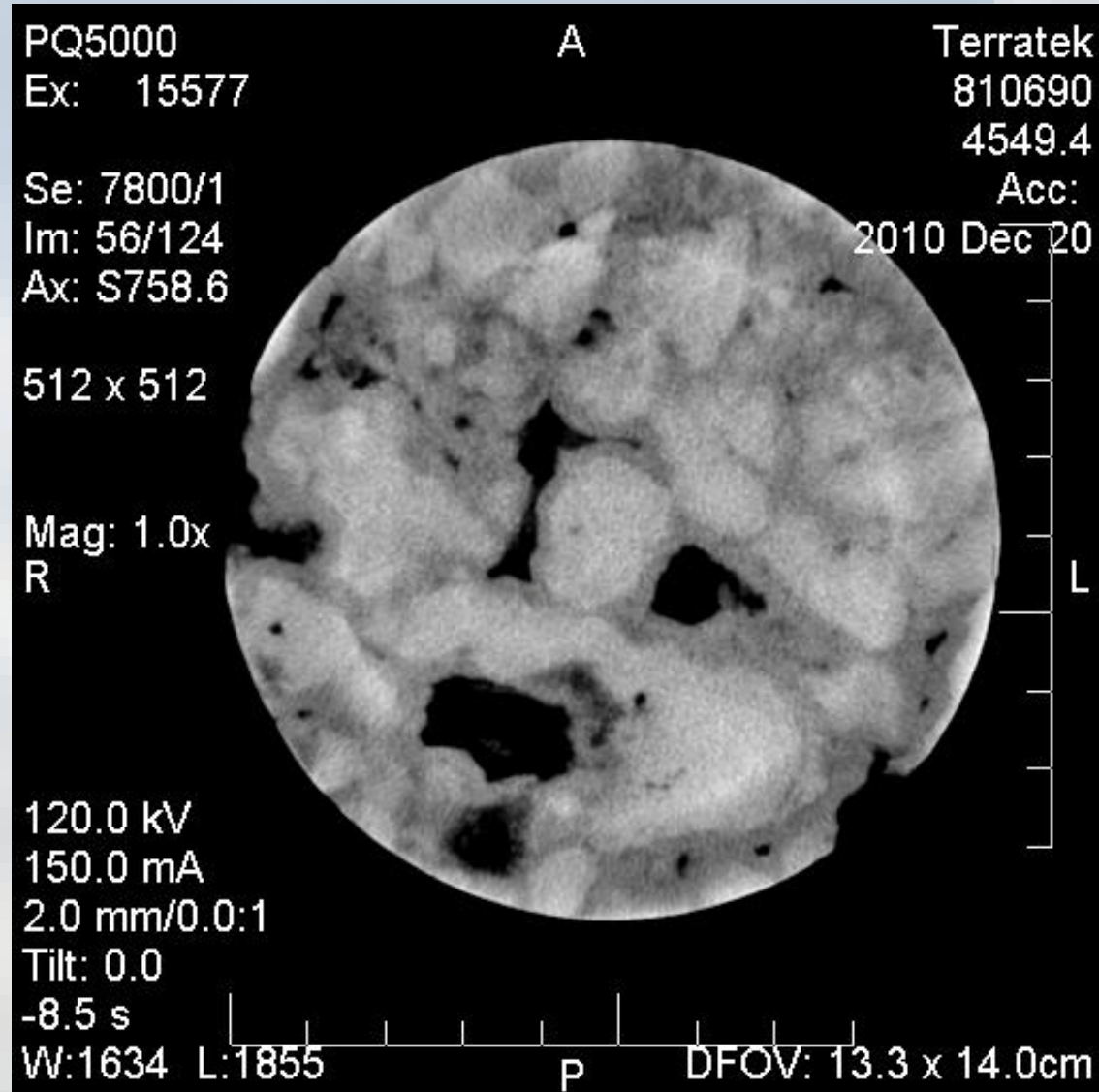
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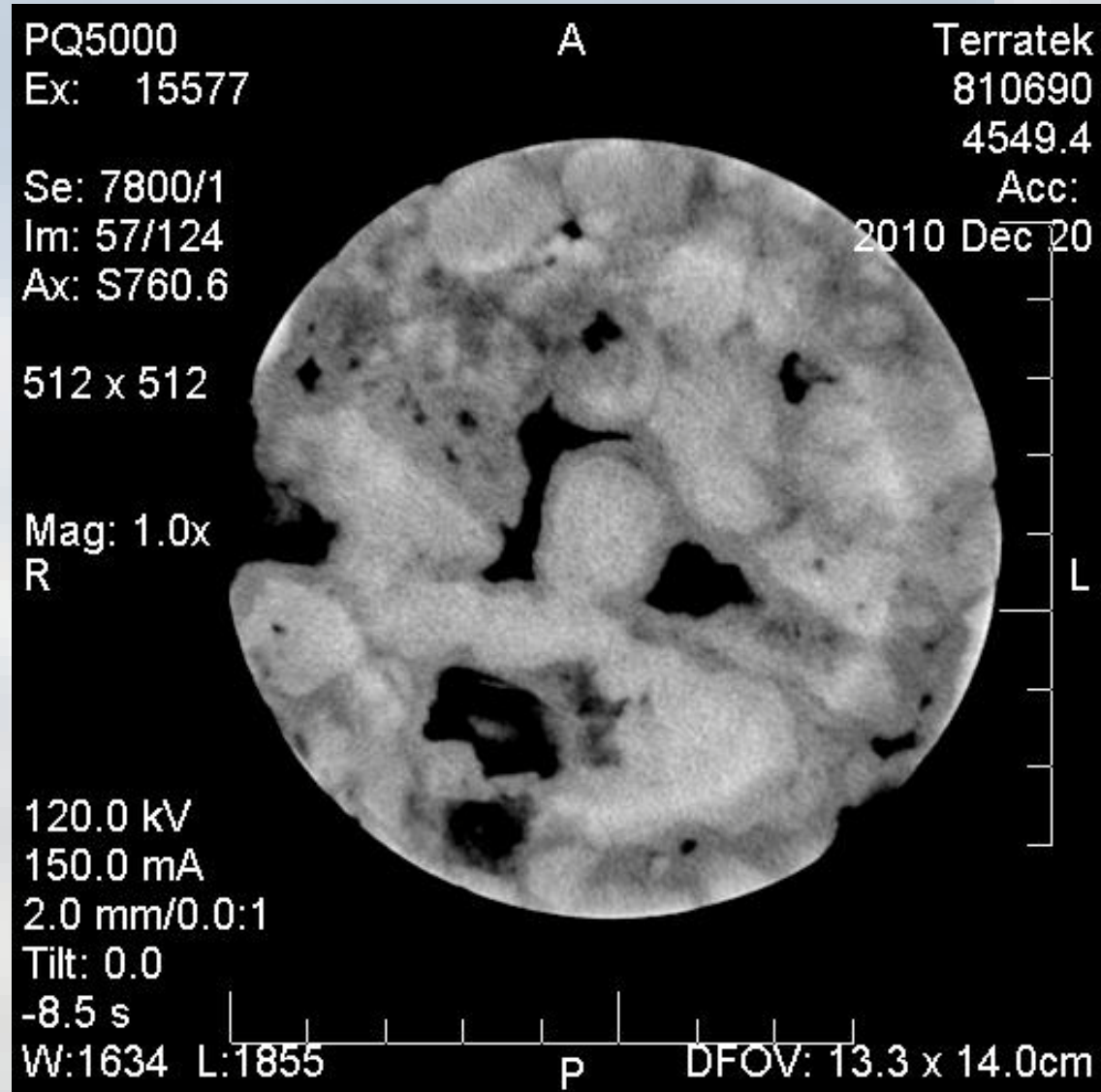
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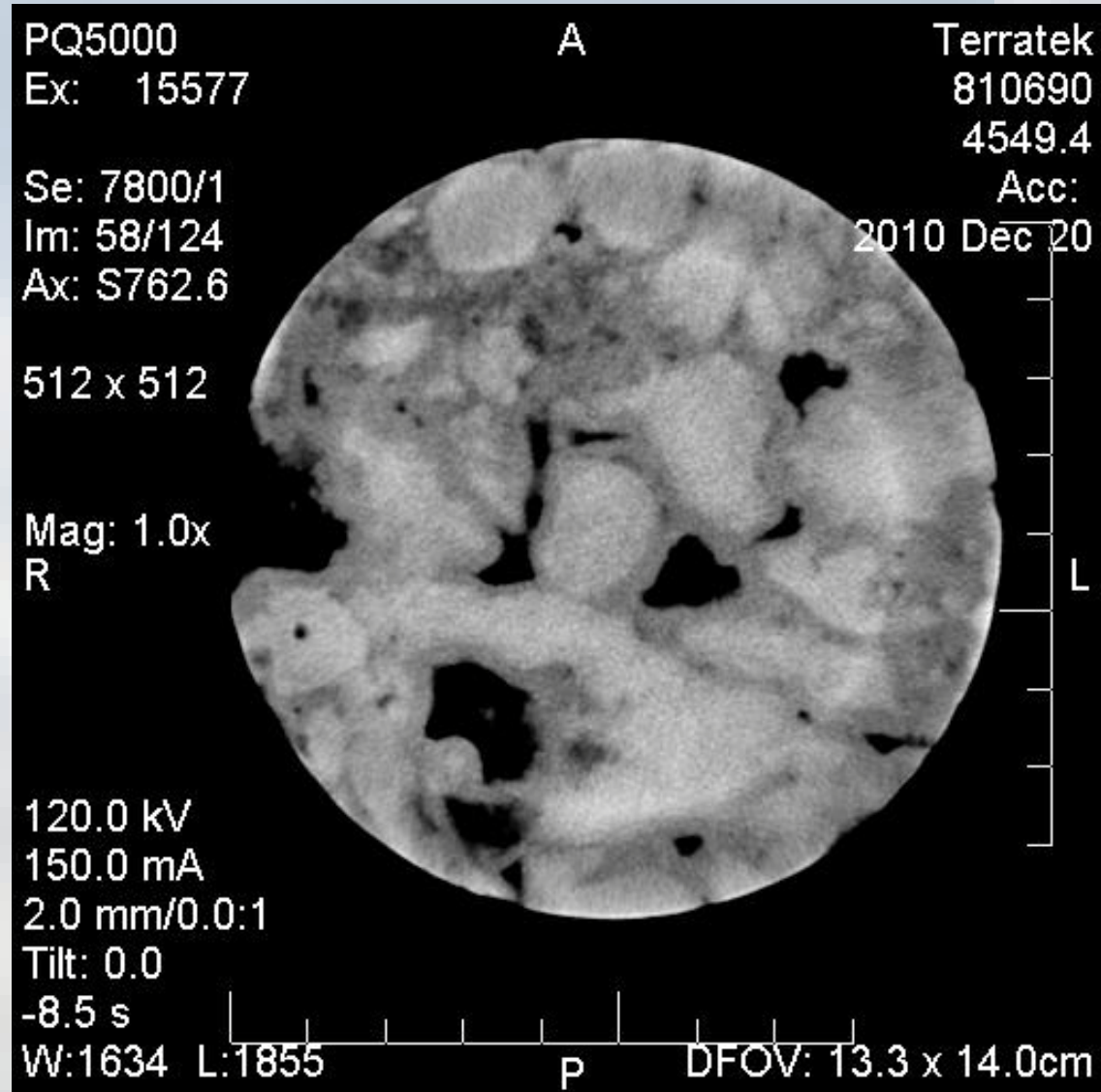
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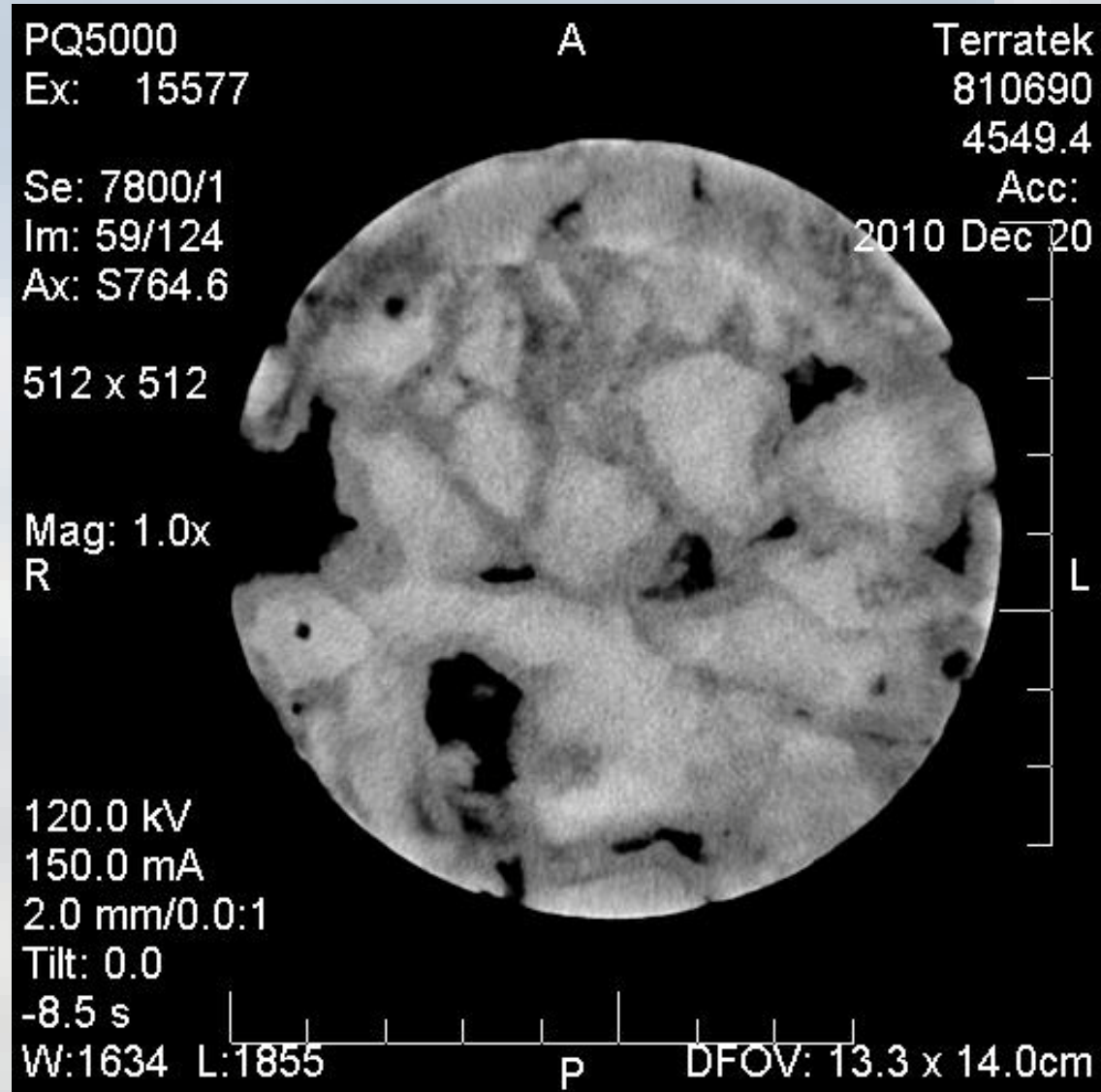
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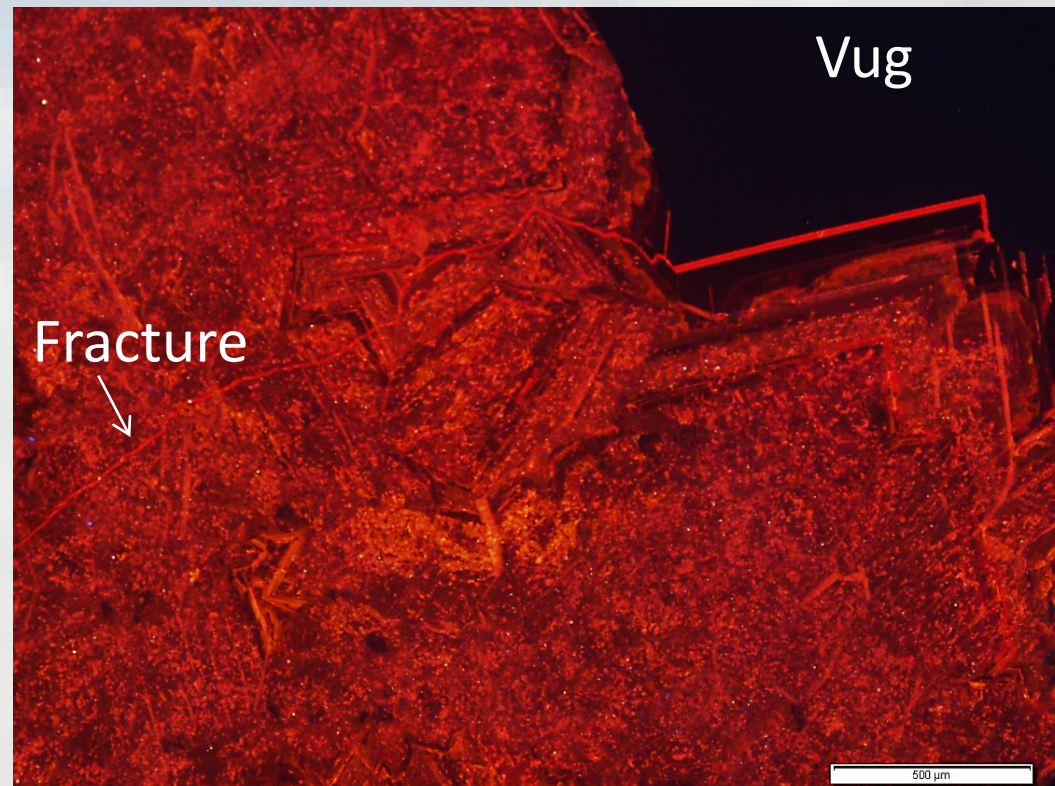
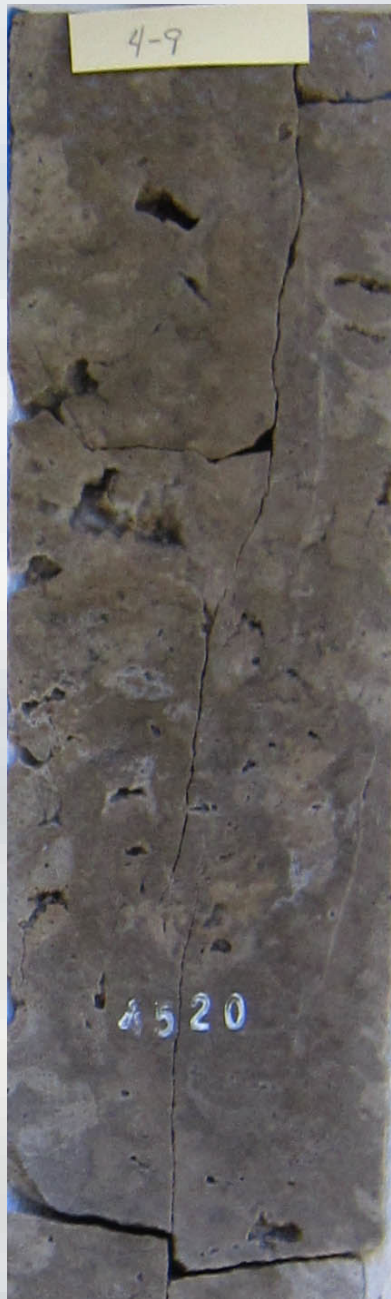
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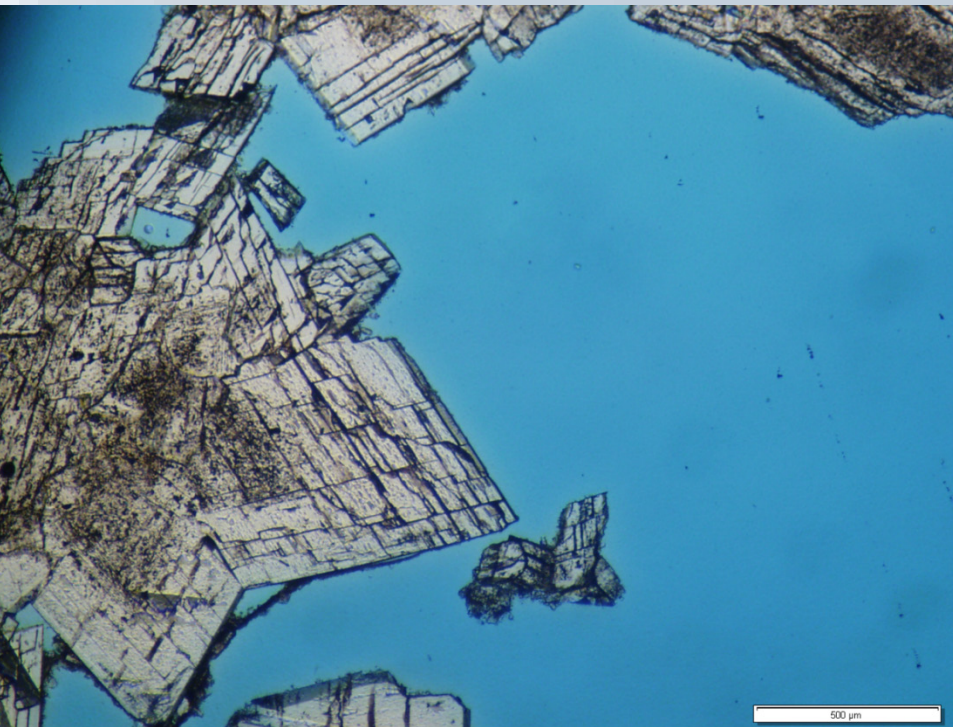
Fractures and Vugs w/ Late Dolomite Cements



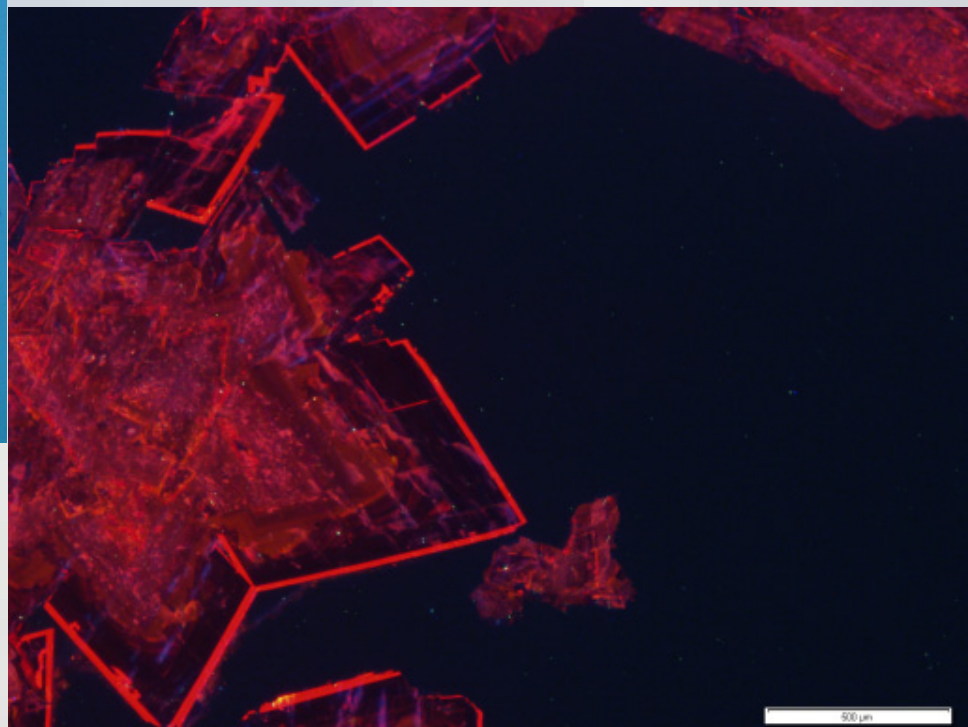
4 "

Cathodoluminescence

Dolomite-lined Vugs

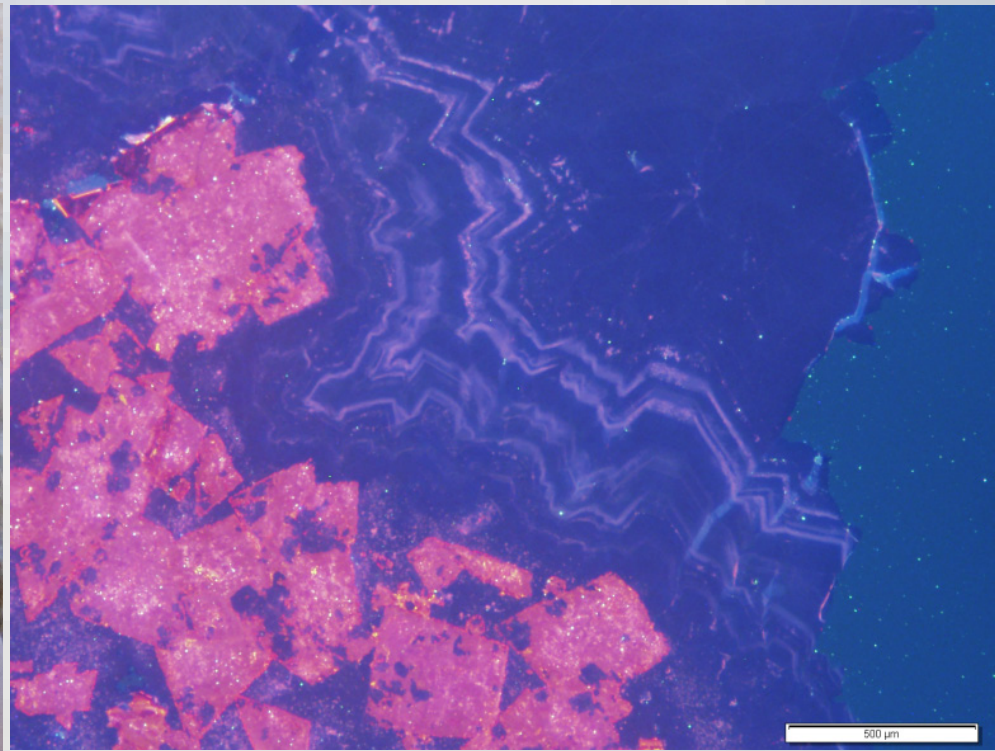


Plane-Light



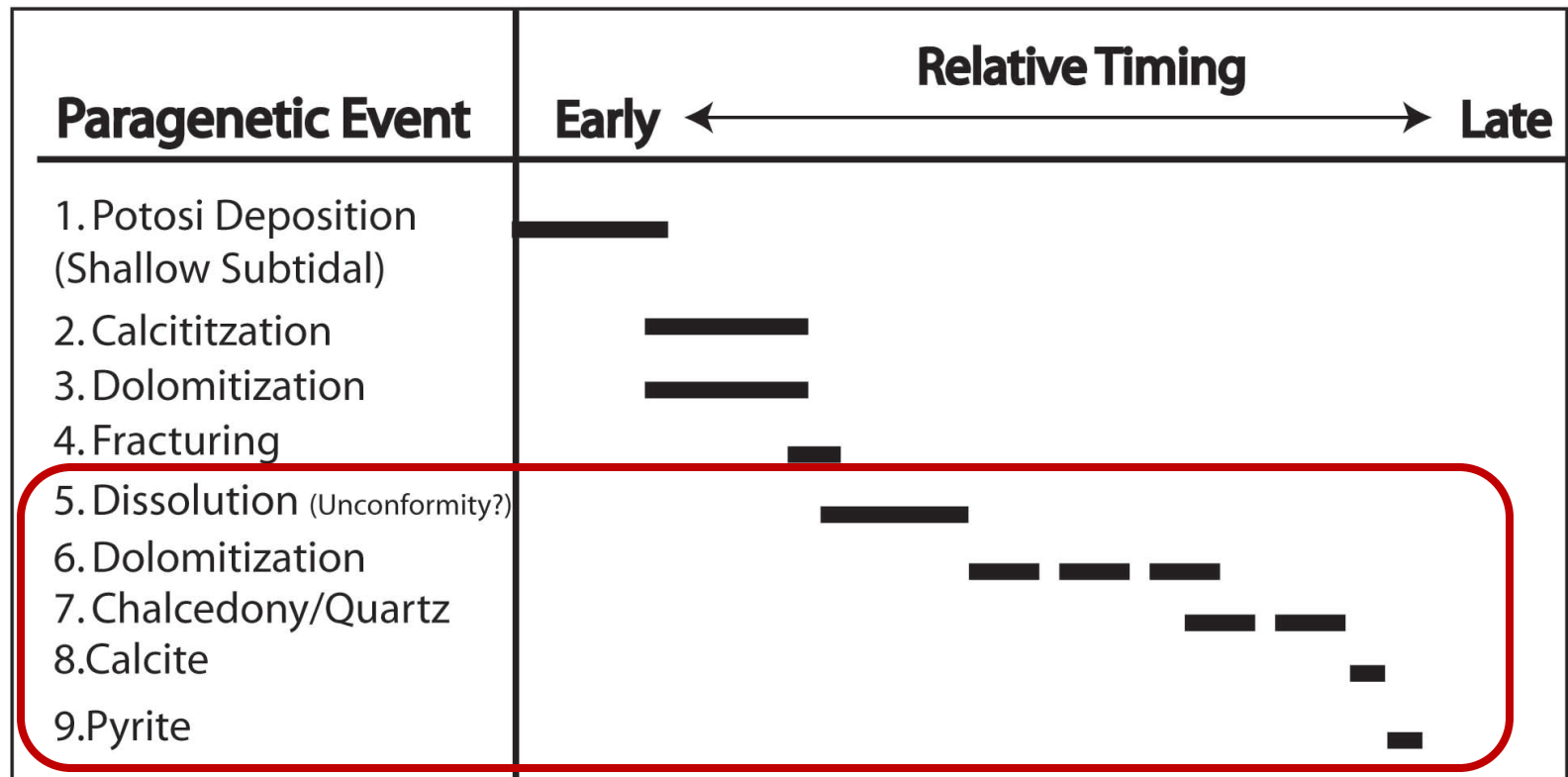
Cathodoluminescence

Quartz-Lined Solution Enhanced Vugs



Cathodoluminescence

Potosi Paragenetic Sequence



**Late Stage Hydrothermal Diagenesis or
Unconformity?**



Arcadia, WI

Widespread Diagenetic Chalcedony and Quartz in the Potosi

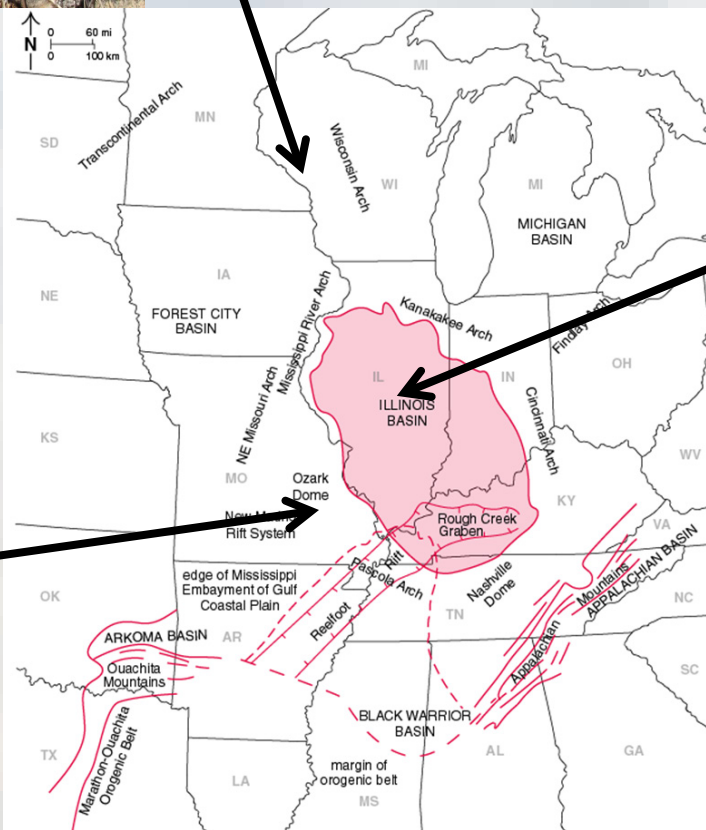
Unconformity...



Decatur, IL



Old Mines, MO



Conclusions

- Cavernous porosity appears to be a common porosity within the Potosi Dolomite in the Illinois Basin suggesting a relationship to karst processes during an unconformity.
- Algal beds are diagenetically altered via partial or complete dissolution of digitate stromatolites offering vuggy or fenestral porosity.
- Fractures and collapse breccias are common with typical late-stage dolomite cements and sometimes sucrosic dolomite matrixes.
- Chalcedony and mega-quartz line vugs and cavities and are a common diagenetic event in the Potosi across the Illinois Basin and onto the Ozark Uplift and Wisconsin Arch further suggesting a relationship to unconformity.

Thank You!

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