

PCA

Concrete Technology and Codes

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# The Petrographic Report



# Petrographic Examination

- What is it?
- How is it done?
- What can it do?
- What can't it do?
- What will the petrographic report say?
- How do I critically read a petrographic report?

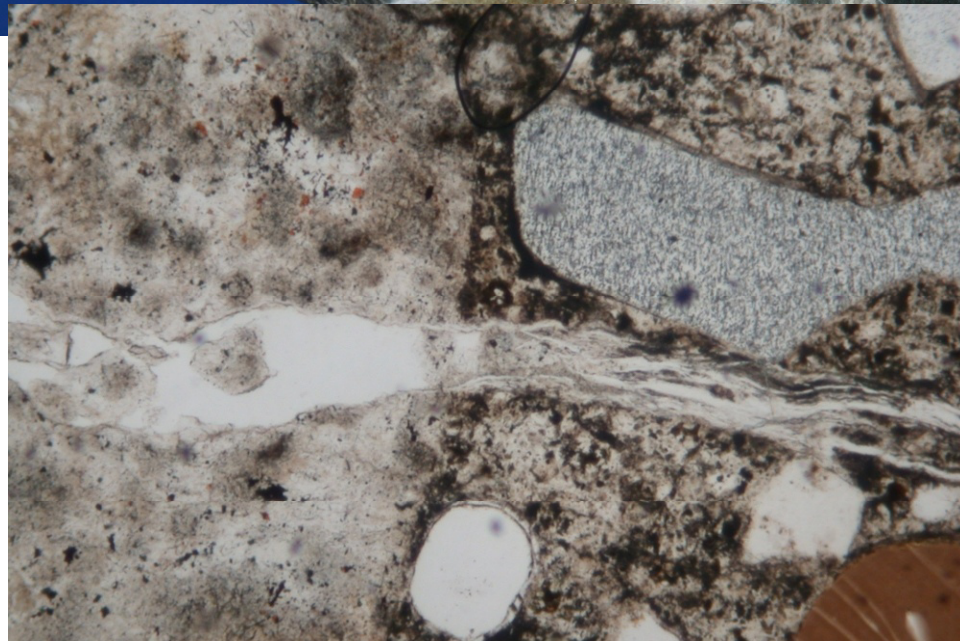
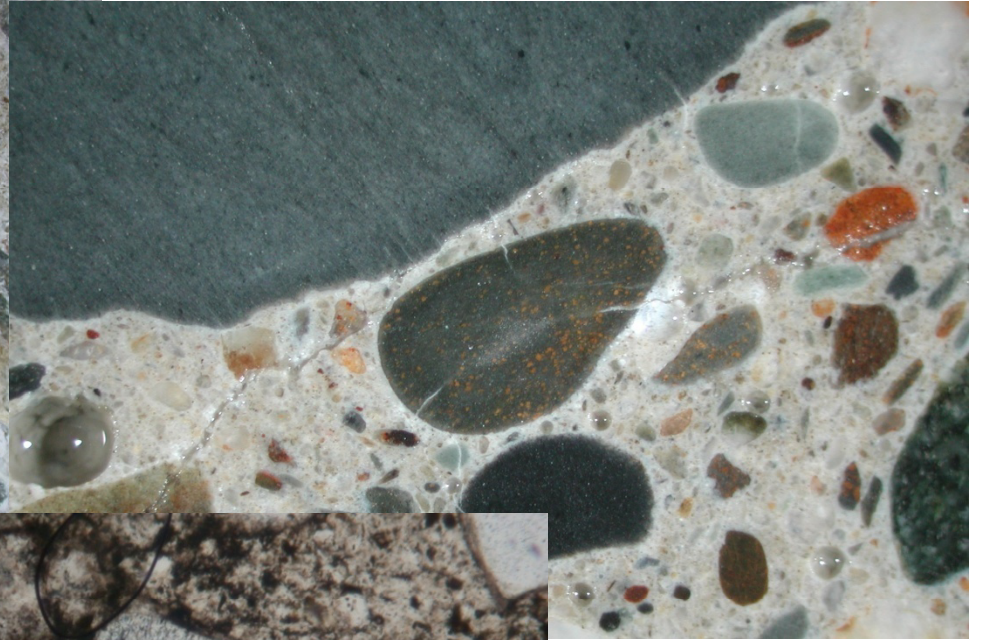
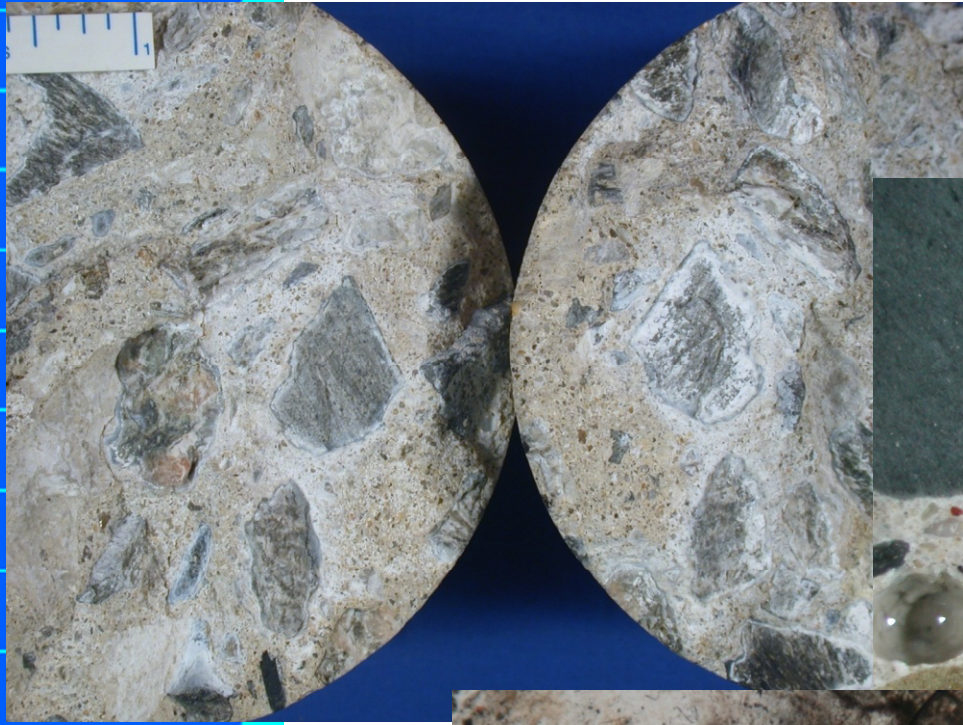


# Structural Evaluation

**LARGE** scale to small scale









# Structural Evaluation

- ACI 364.1R “Guide for Evaluation of Concrete Structures Prior to Rehabilitation”
  - ACI 349.3 “Evaluation of Existing Nuclear Safety-Related Concrete Structures”
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- document review
  - field inspection
  - condition survey
  - NDE
  - sampling
  - material testing (laboratory)

# Structural Evaluation

ACI 364.1 Table 6.1(a)

Evaluation of Properties of Concrete

CHEMICAL AND PHYSICAL PROPERTIES	EVALUATION PROCEDURE																
	ACOUSTIC IMPACT (Table 6.3)	AIR CONTENT TEST (ASTM C457)	CEMENT CONTENT TEST (ASTM C1084)	CHEMICAL TESTS	CORE TESTING (ASTM C42)	ELECTRICAL POTENTIAL MEASUREMENTS (Table 6.3)	ELECTRICAL RESISTANCE MEASUREMENTS (Table 6.3)	FLEXURAL TESTS (ASTM C42)	FREEZE-THAW TEST (ASTM C666)	GAMMA RADIOGRAPHY (Table 6.3)	NUCLEAR MOISTURE METER (Table 6.3)	PERMEABILITY TEST (CRD C48)	PETROGRAPHIC ANALYSIS (ASTM C856)	PULLOUT TESTING (ASTM C900)	REBOUND HAMMER (ASTM C805)	UNTRASONIC PULSE (ASTM C597)	WINDSOR PROBE (ASTM C803)
ACIDITY				●									●				
AIR CONTENT		●											●				
ALKALI-CARBONATE REACTION													●				
ALKALI-SILICA REACTION													●				
CEMENT CONTENT			●	●									●				
CHEMICAL COMPOSITION				●									●				

# Structural Evaluation

ACI 364.1 Table 6.1(b)

Evaluation of Physical Conditions of Concrete

PHYSICAL CONDITION	EVALUATION PROCEDURE															
	ACOUSTIC EMISSIONS (Table 6.3)	ACOUSTIC IMPACT (Table 6.3)	CHEMICAL TESTS	CORE TESTING (ASTM C42)	FIBER OPTICS (Table 6.3)	GAMMA RADIOGRAPHY (Table 6.3)	INFRARED THERMOGRAPHY (Table 6.3)	LOAD TESTING (ACI 437R)	PETROGRAPHIC ANALYSIS (ASTM C856)	PHYSICAL MEASUREMENT	RADAR (Table 6.3)	REBOUND HAMMER (ASTM C805)	UNTRASONIC PULSE (ASTM C597)	UNTRASONIC PULSE-ECHO (ASTM C597)	VISUAL EXAMINATION (ACI 201.1R, ASTM C823)	WINDSOR PROBE (ASTM C803)
BLEEDING CHANNELS									●						●	
CHEMICAL DETERIORATION			●						●						●	
CORROSION OF STEEL			●	●					●						●	
CRACKING	●	●		●	●		●		●	●	●		●	●	●	
CROSS SECT PROPERTIES AND THICKNESS				●		●				●			●			



# Structural Evaluation

Importance of Appropriate Samples





# Petrography

- Defined as the systematic description and classification of rocks (or concrete), especially through microscopical examination
- Methods and techniques for concrete petrography derived from geology, metallurgy, and ceramics



# Petrographic Examination

ASTM C 856-04 – Standard Practice for Petrographic Examination of Hardened Concrete

- ◆ “Guideline” for microscopical analysis of concrete and related materials
- ◆ Methods and techniques may vary with scope of investigation



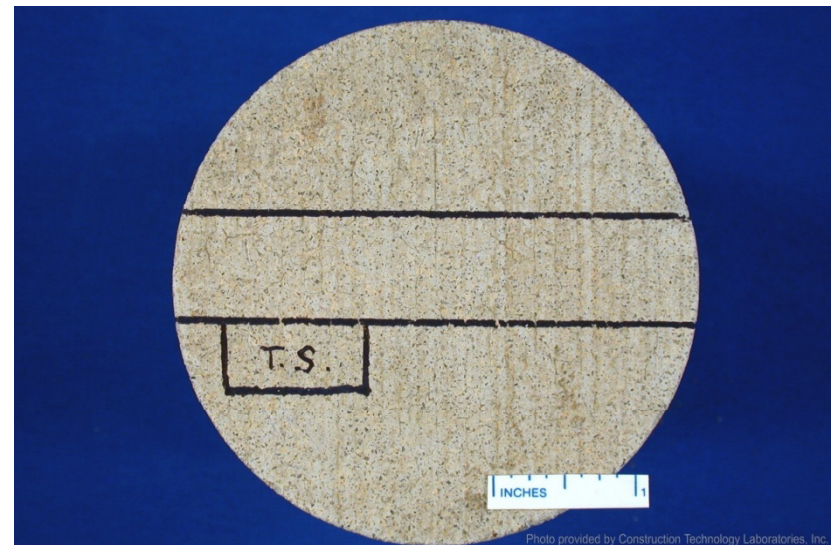
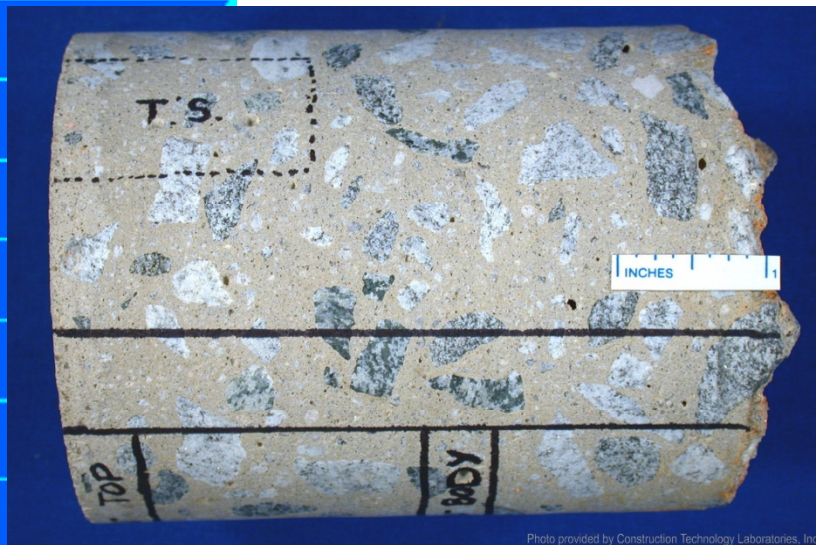
# Petrographic Examination

- Examine sample as-received



# Petrographic Examination

- Select areas for sub-sampling





# Petrographic Examination

- Lapped surface



# Petrographic Examination

- Stereomicroscope



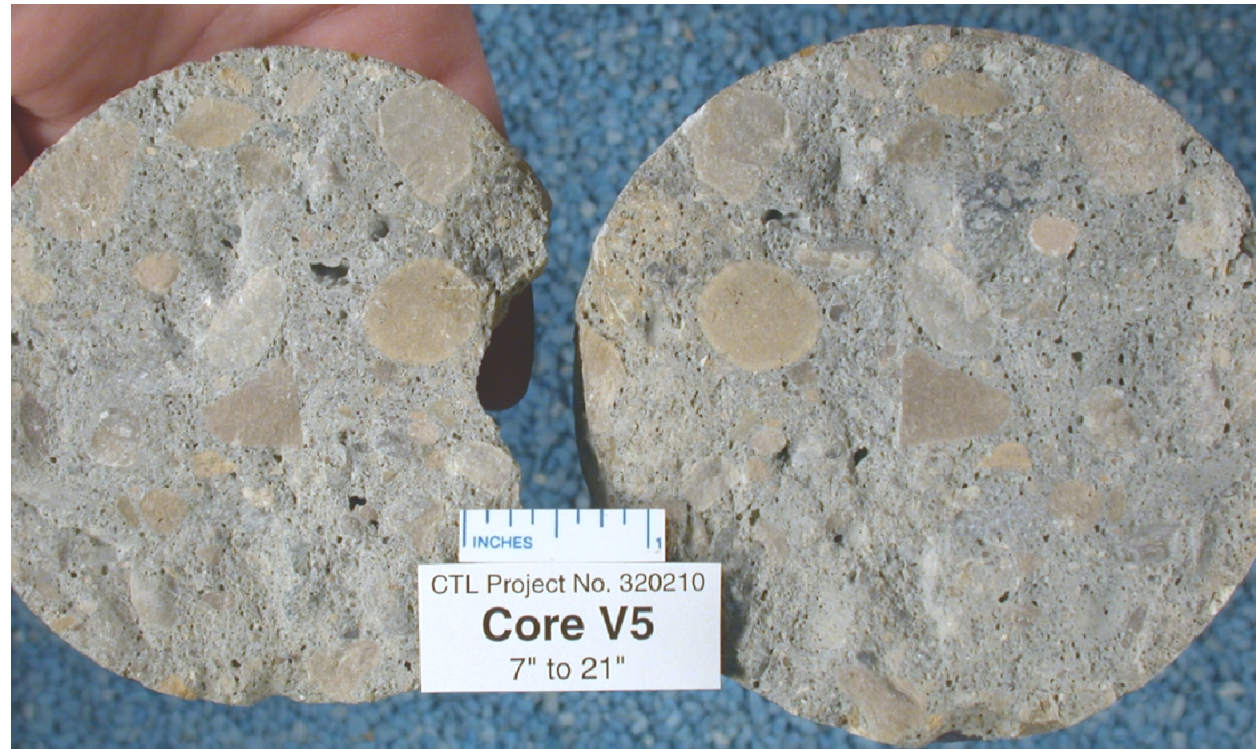


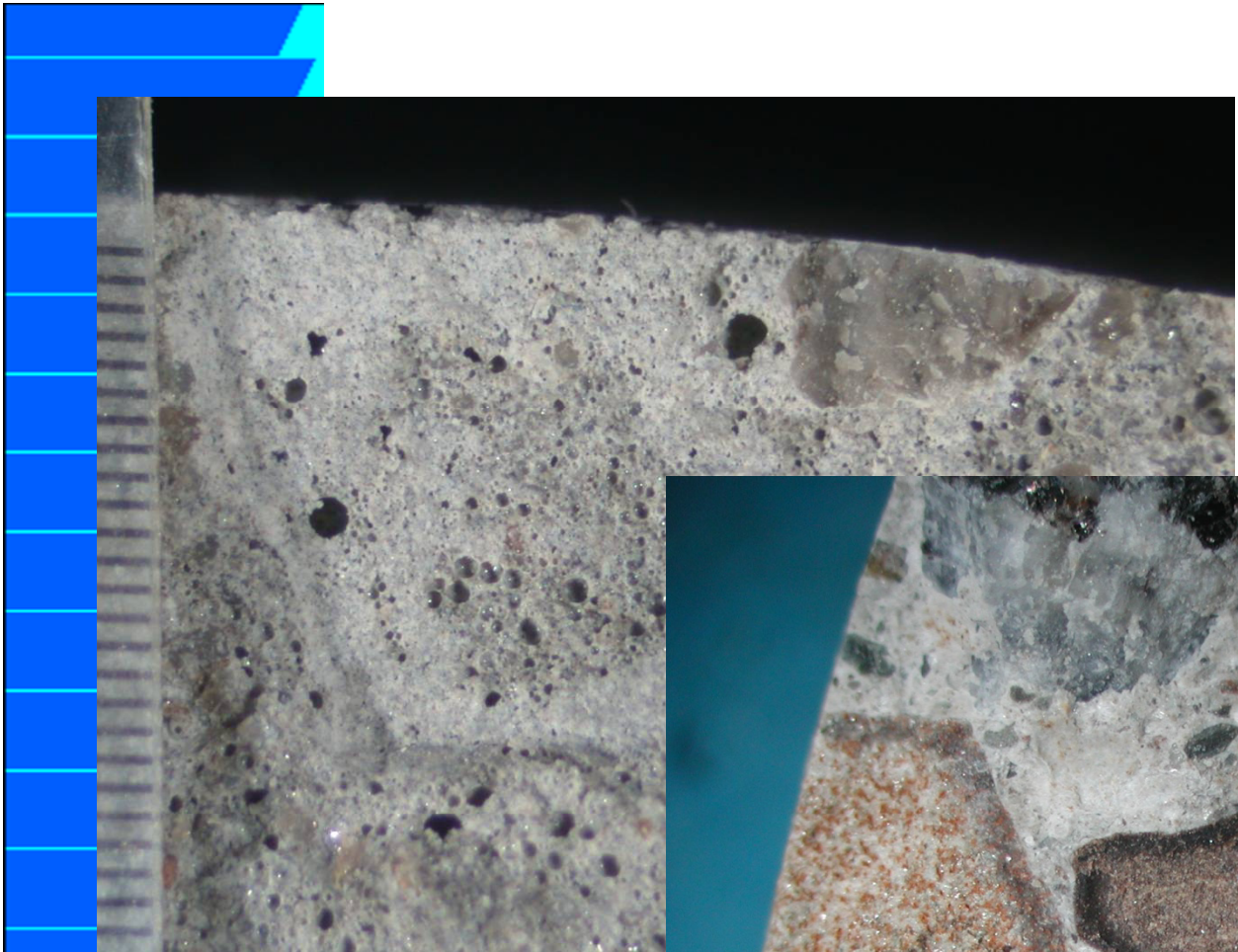




# Petrographic Examination

- Fresh fracture

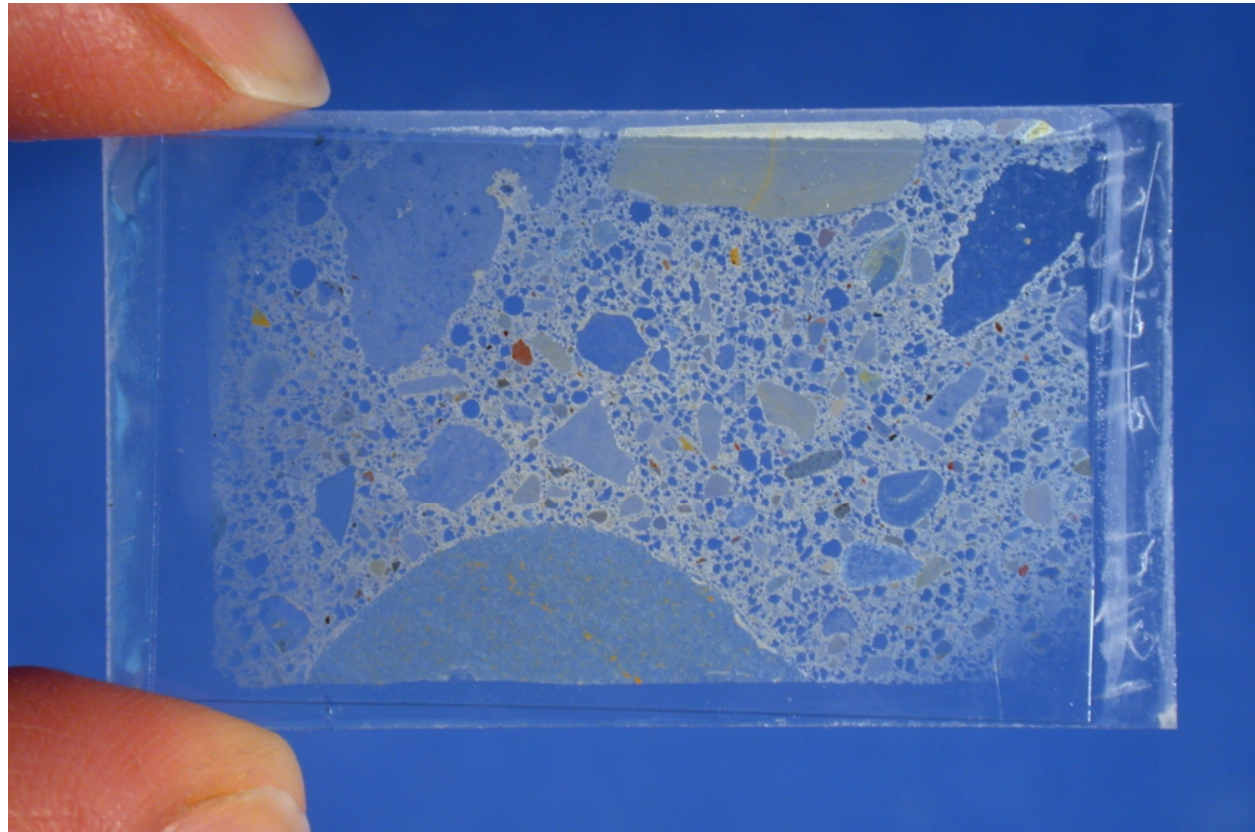






# Petrographic Examination

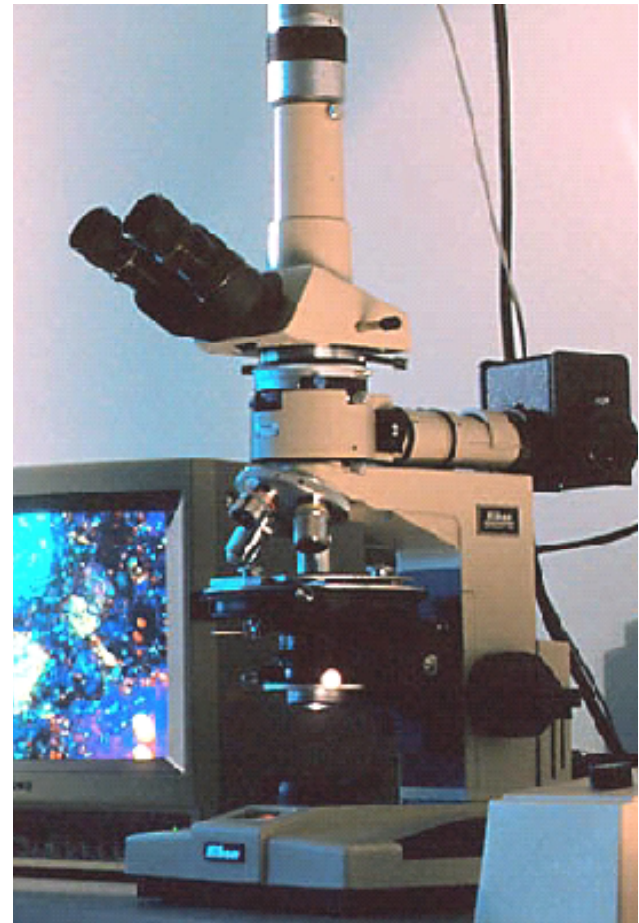
- Thin section



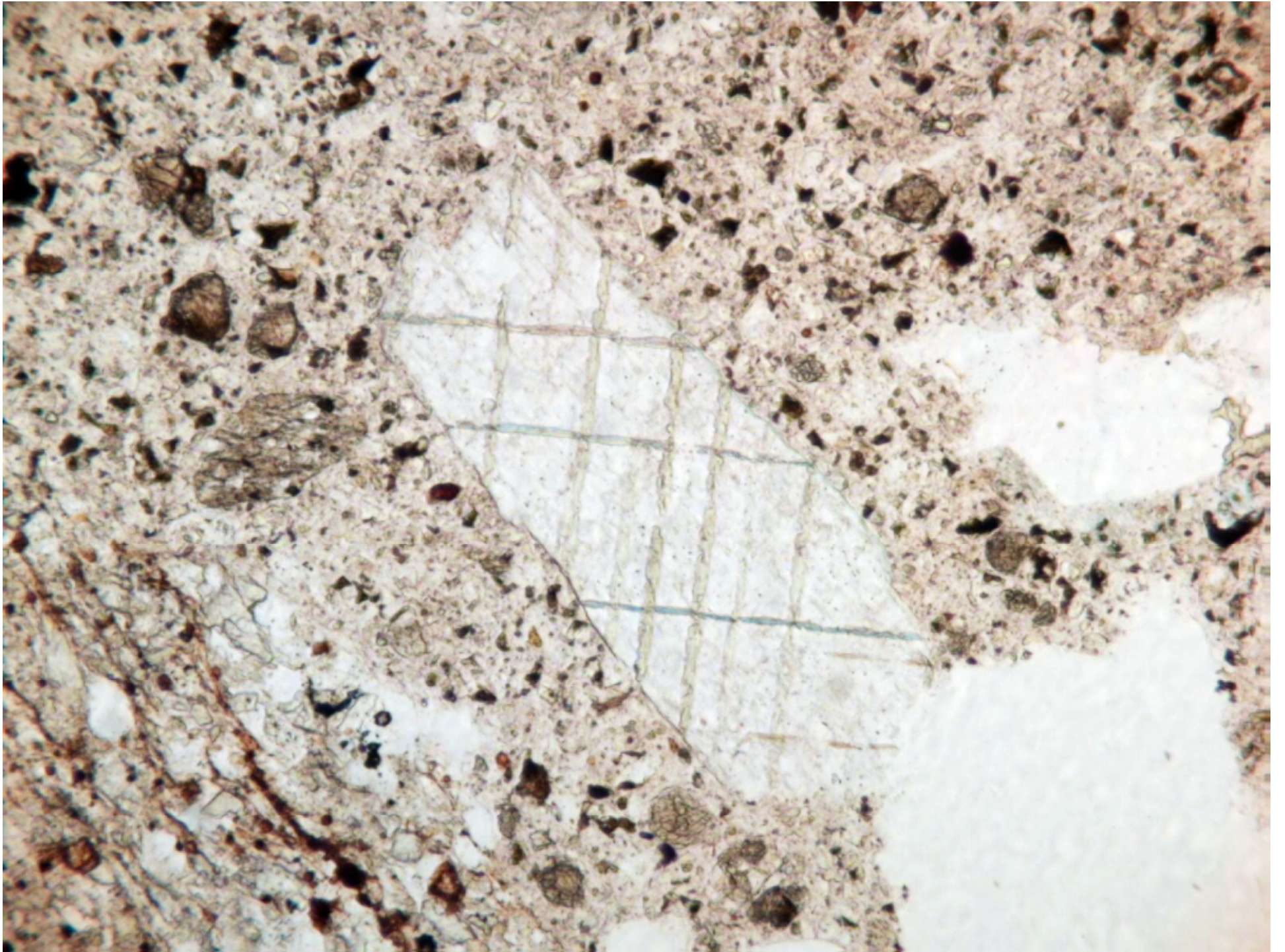


# Petrographic Examination

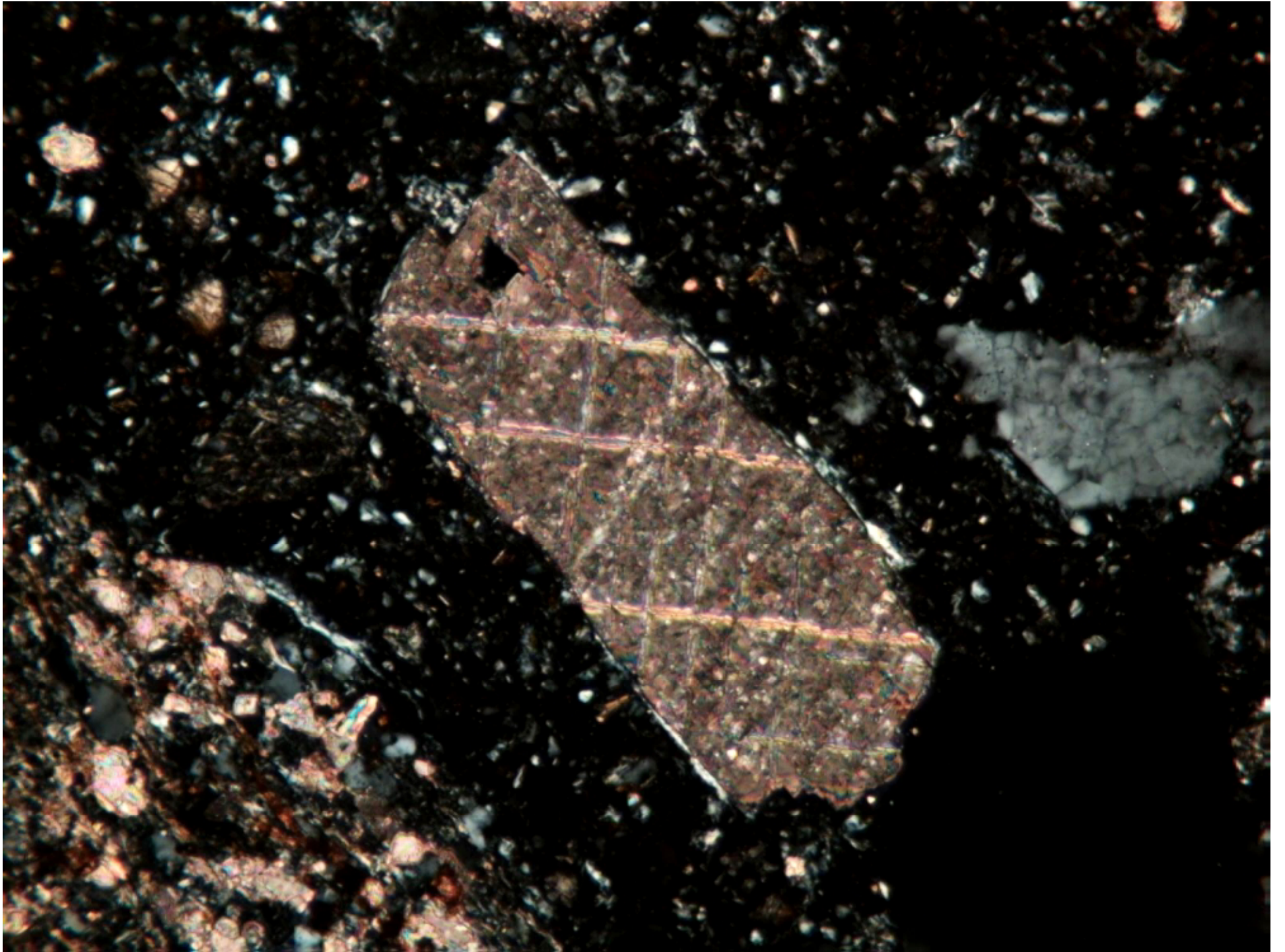
- Polarized light (petrographic) microscope



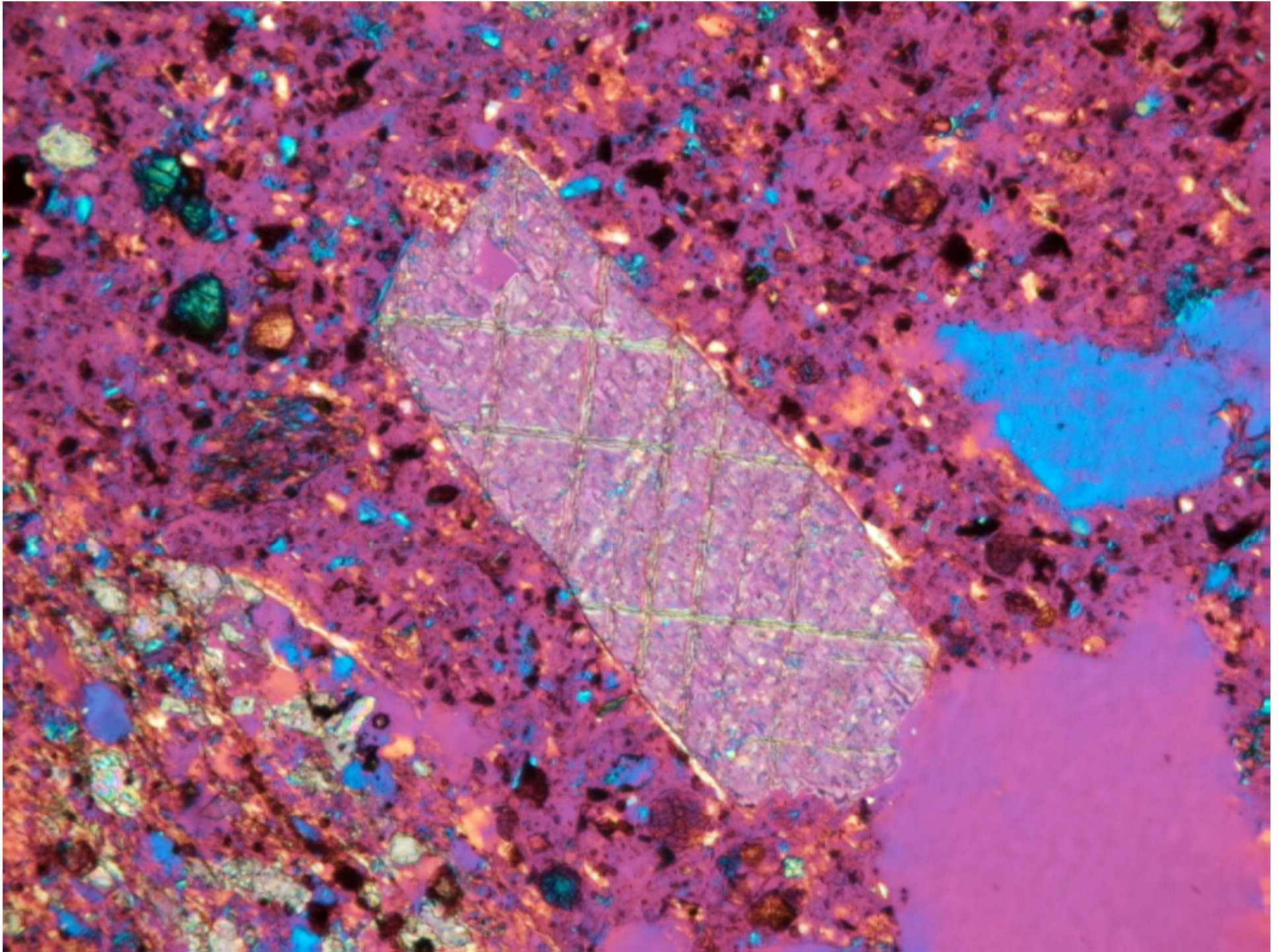








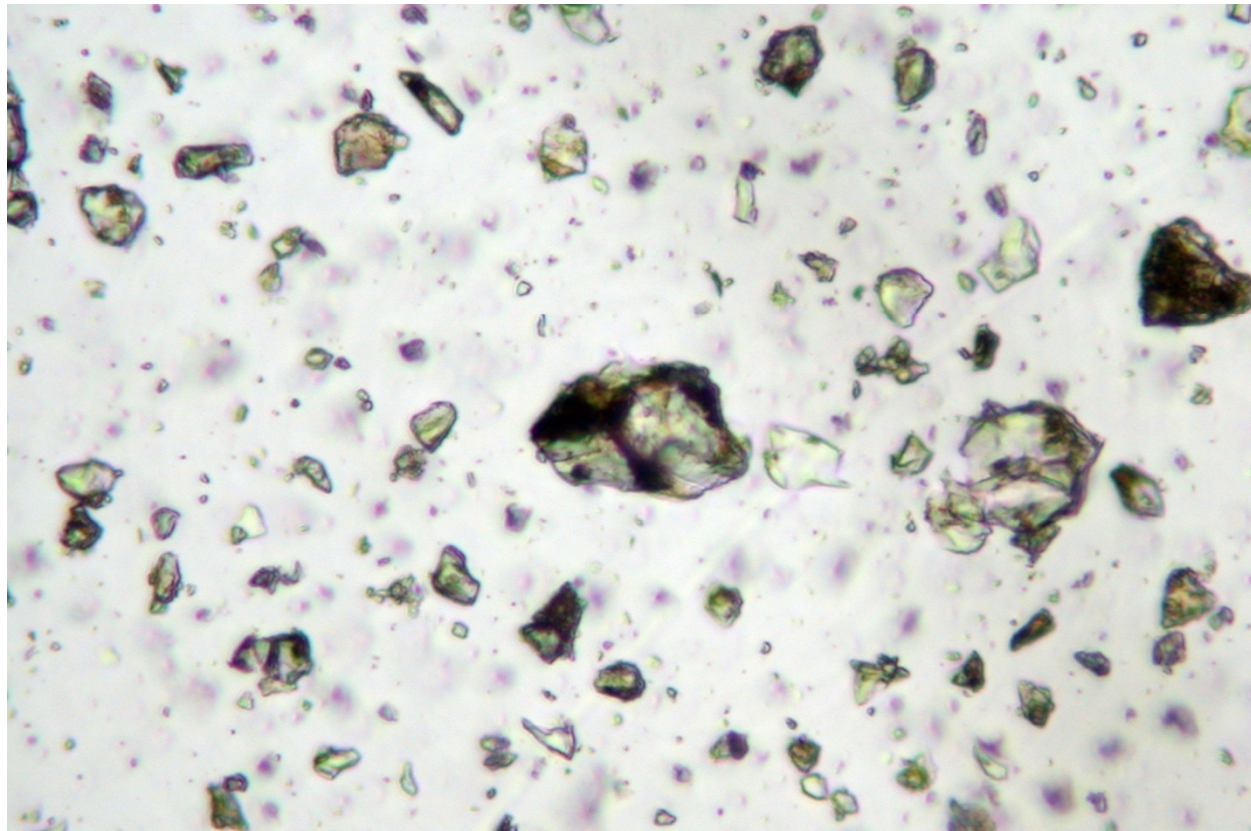






# Petrographic Examination

- Powder mount



# Petrographic Examination CAN...

- Describe the general composition, quality, and condition of the concrete and its constituents







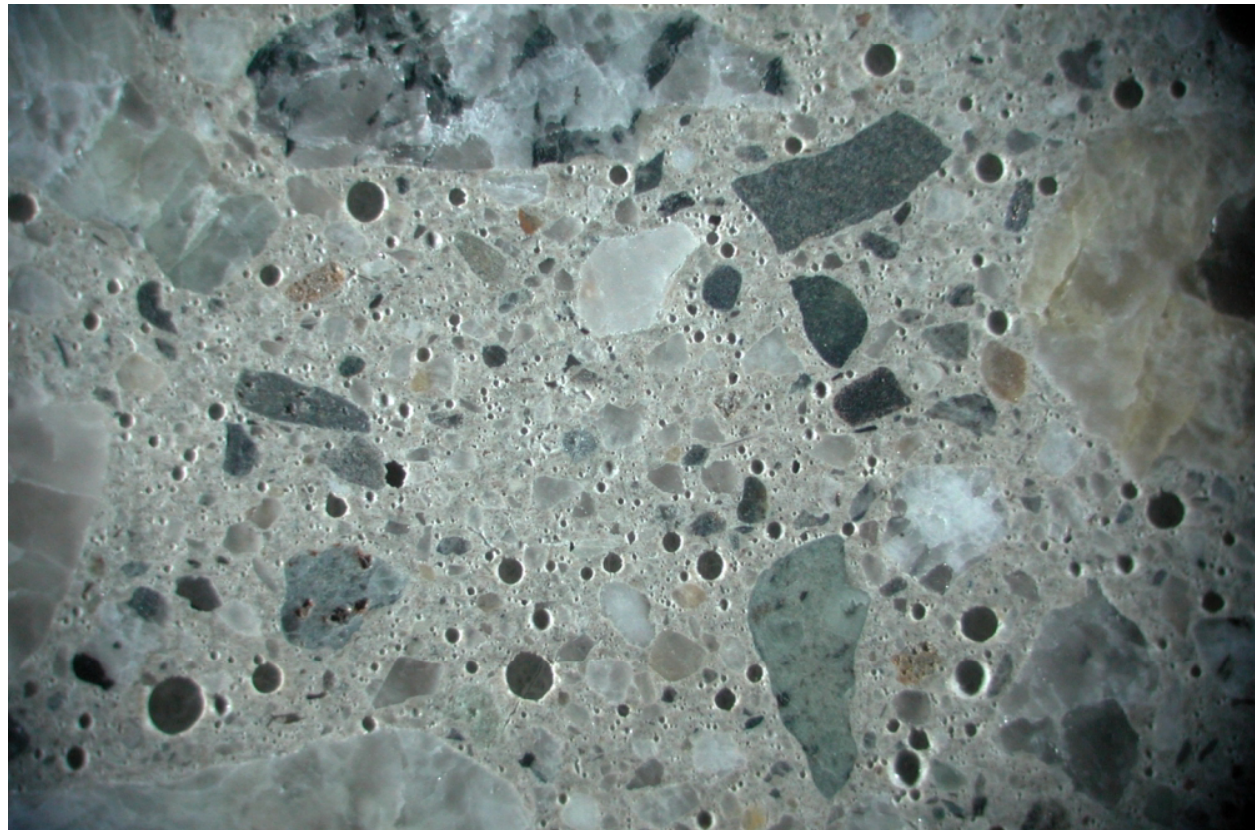




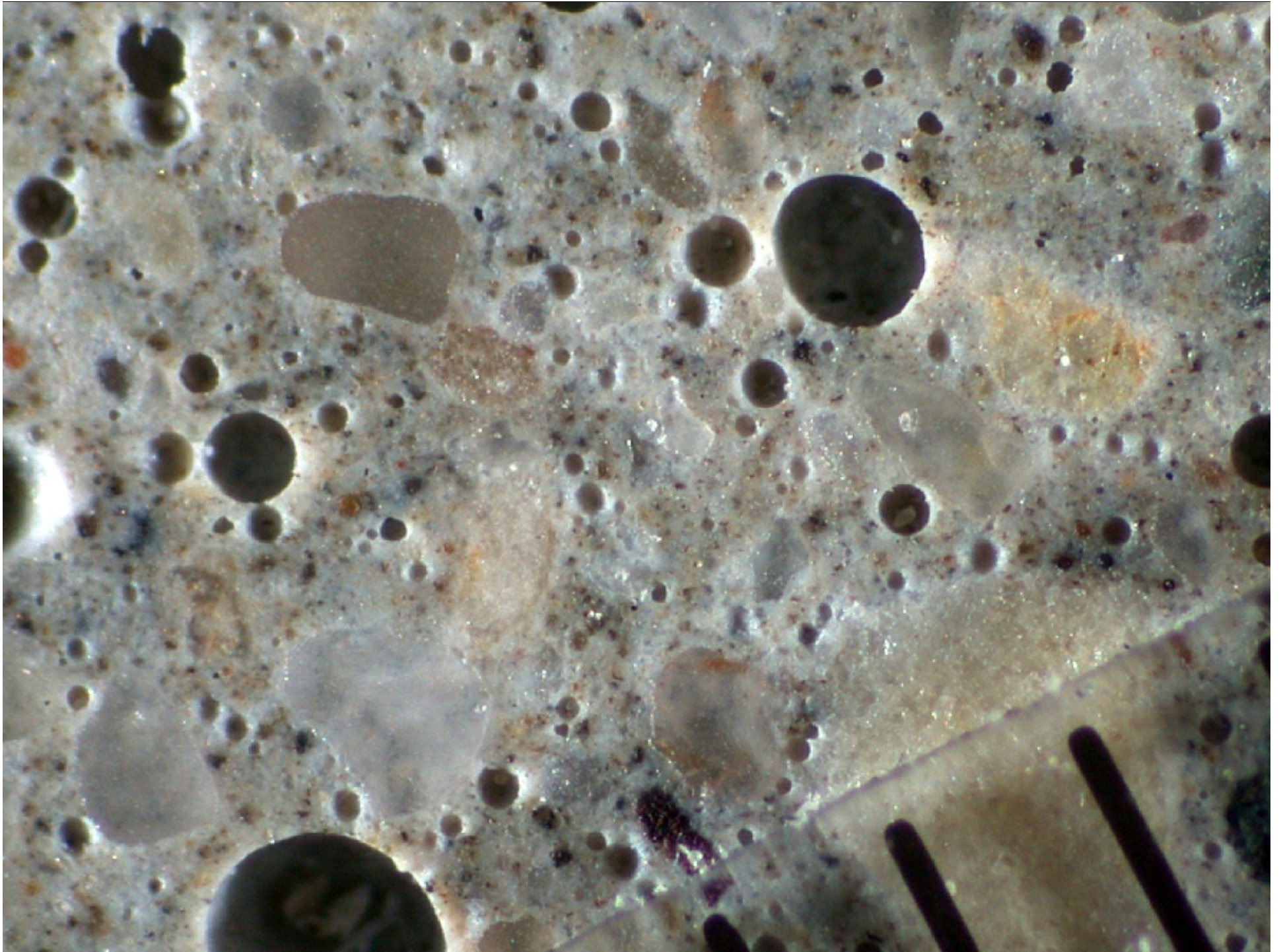


# Petrographic Examination CAN...

- Estimate air content and adequacy of air-void system



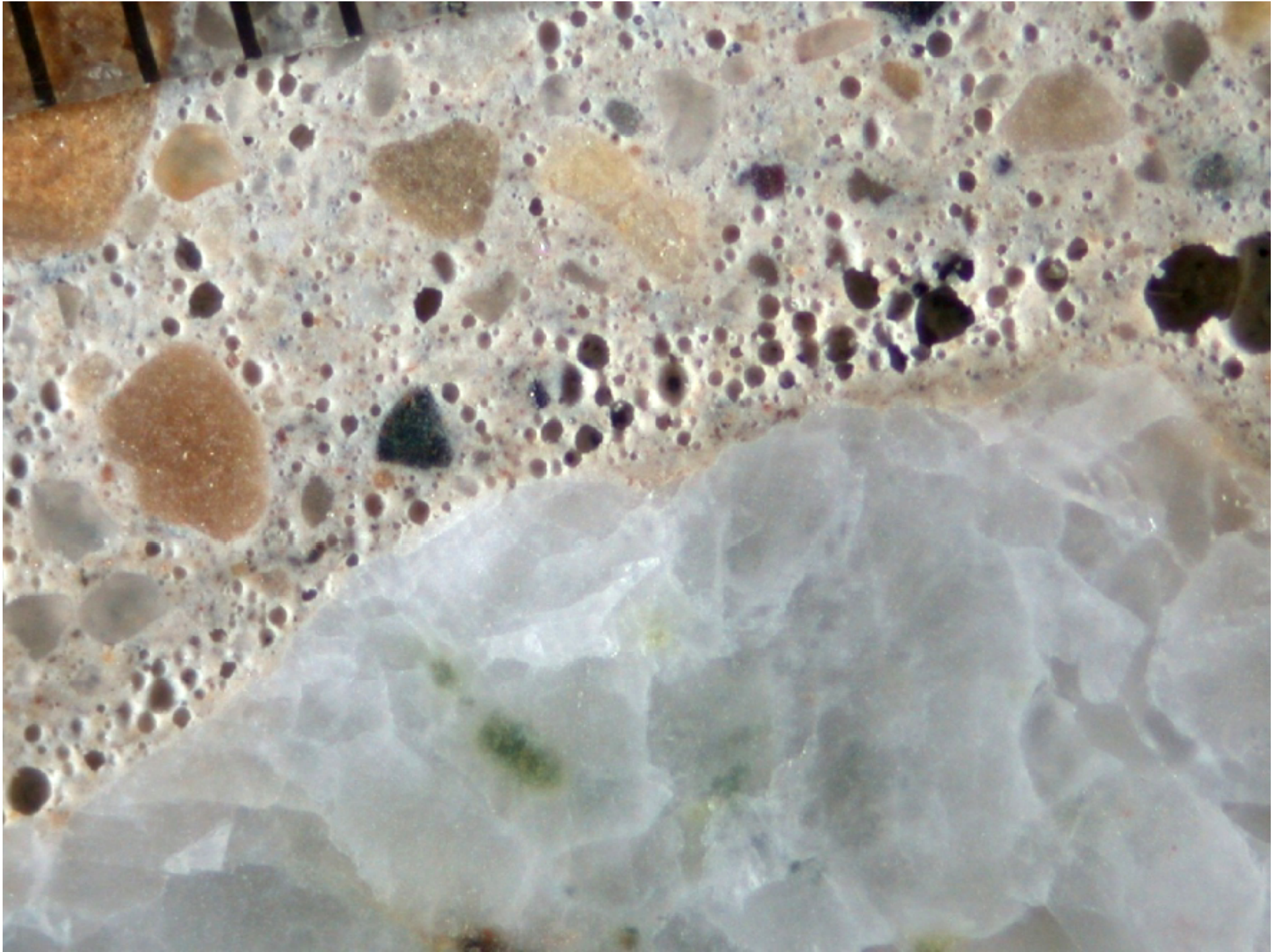






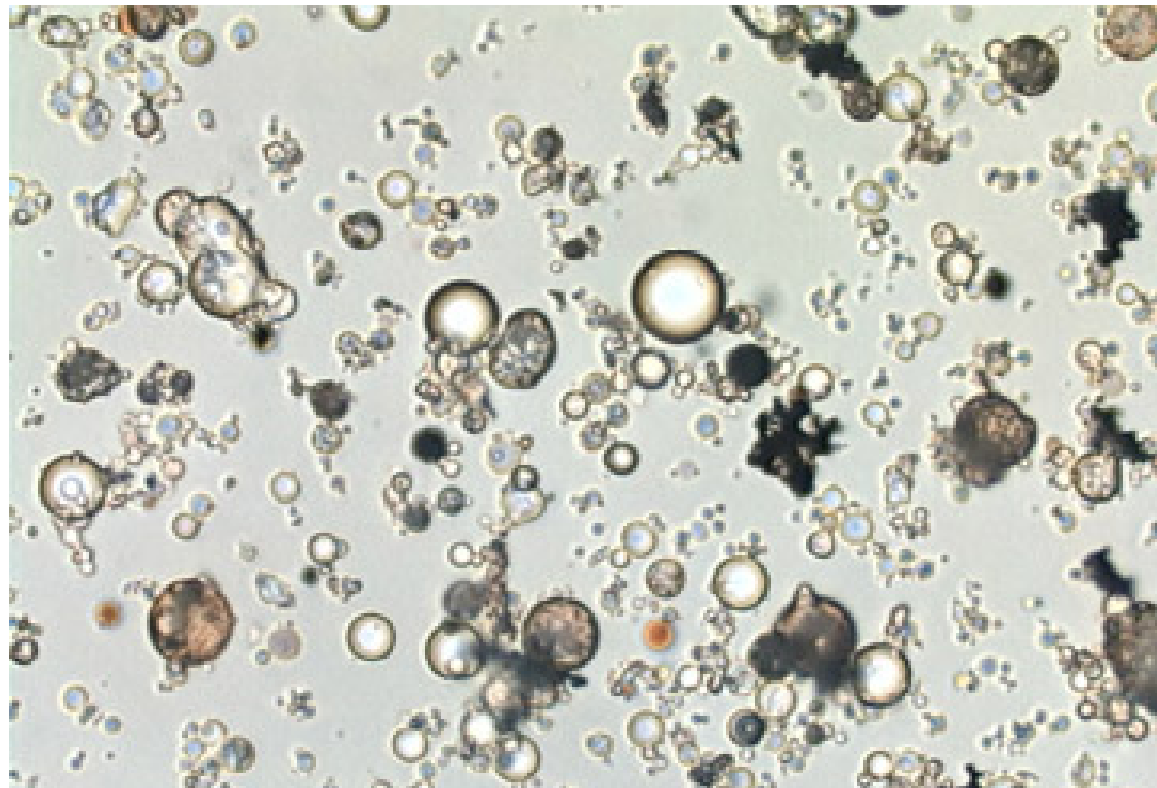




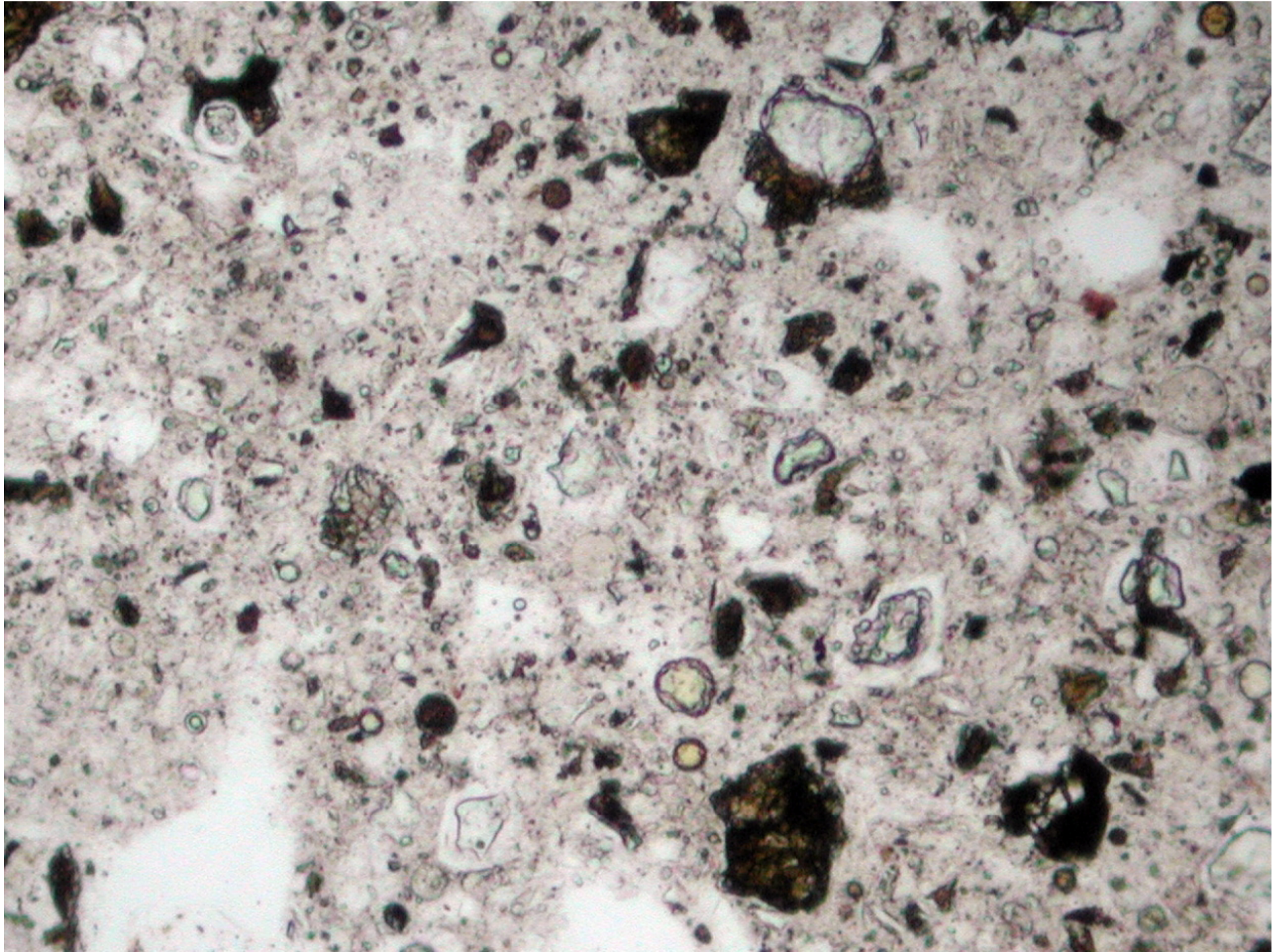


# Petrographic Examination CAN...

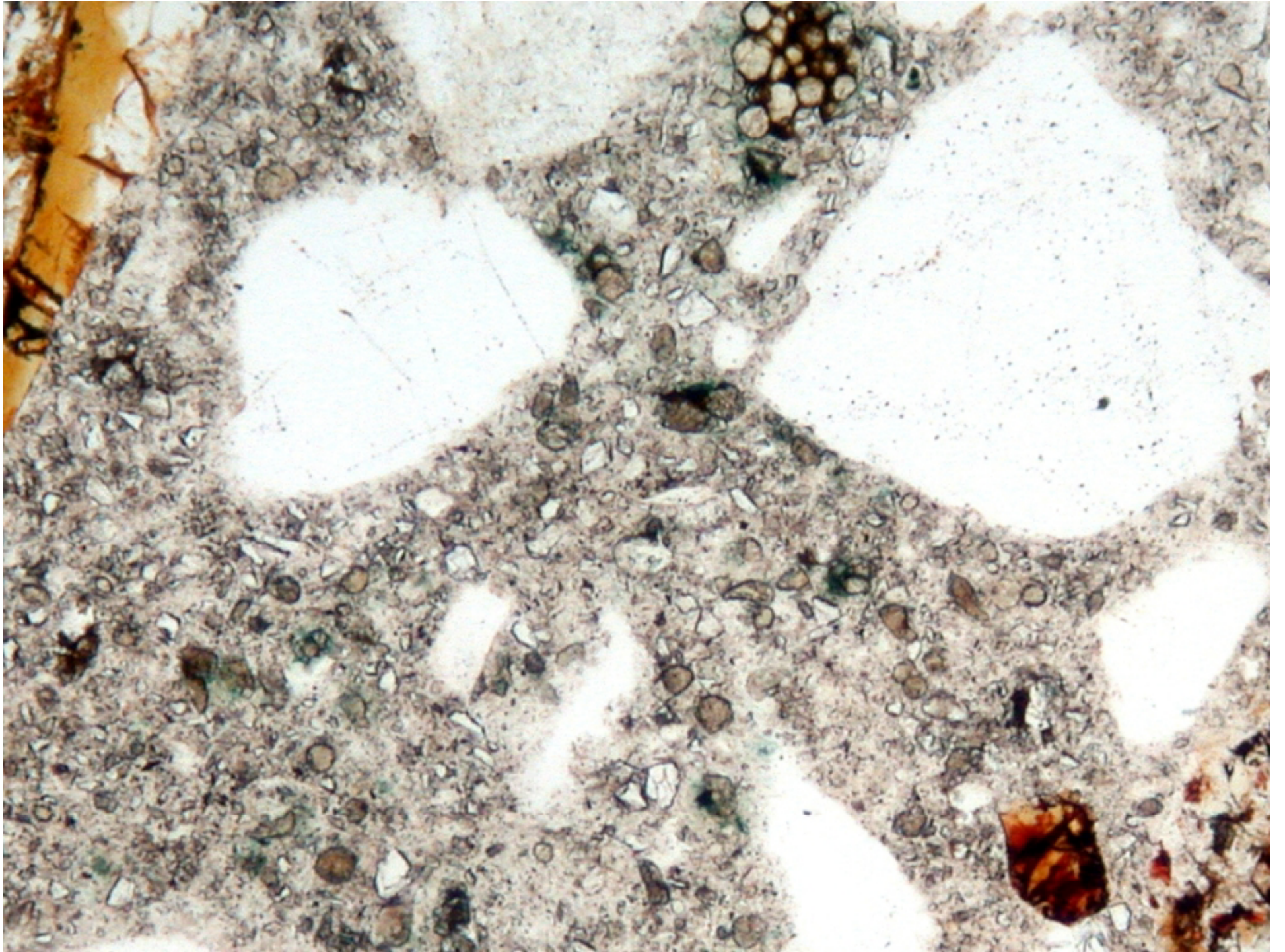
- Identify supplementary cementing materials



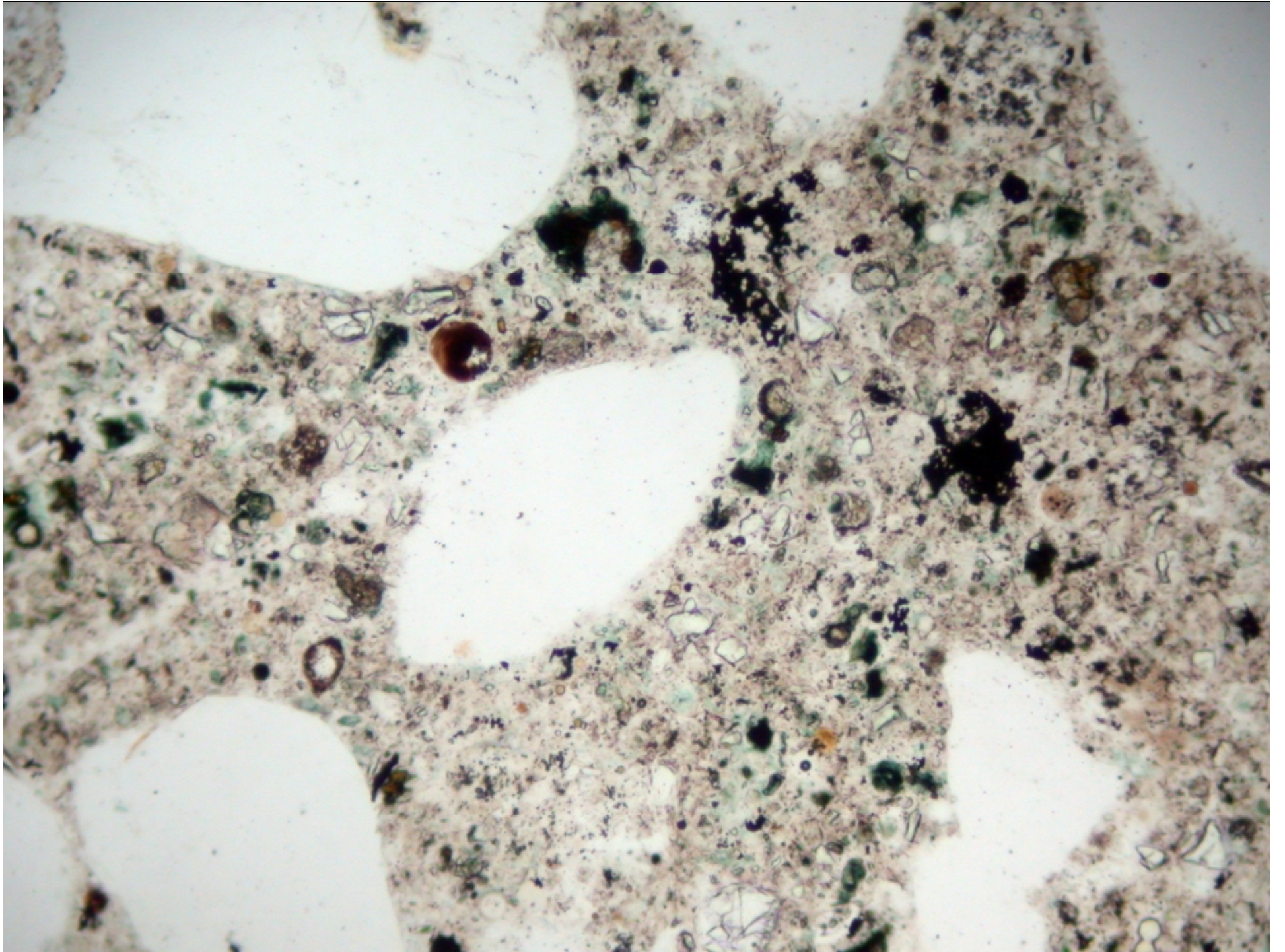




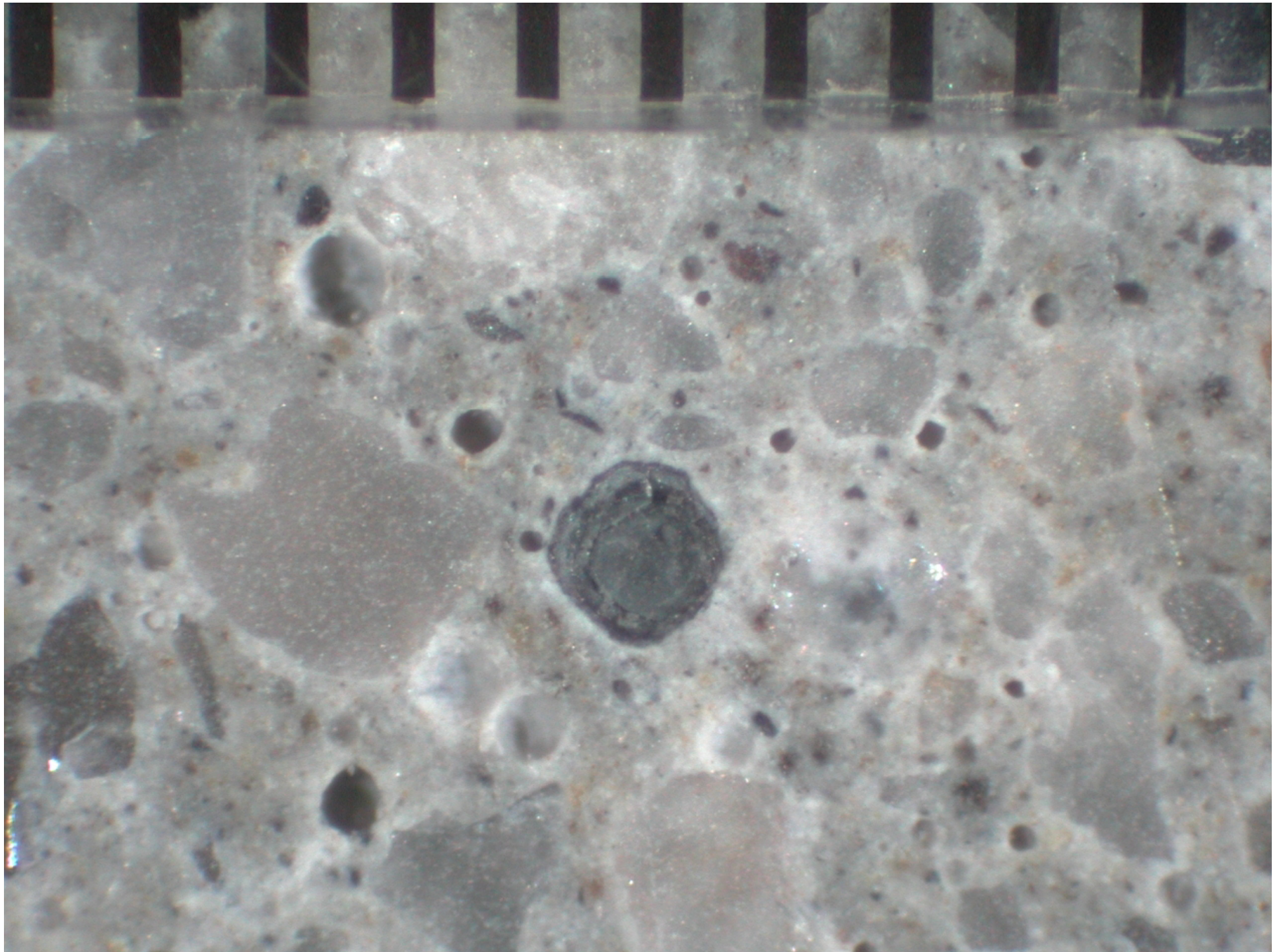




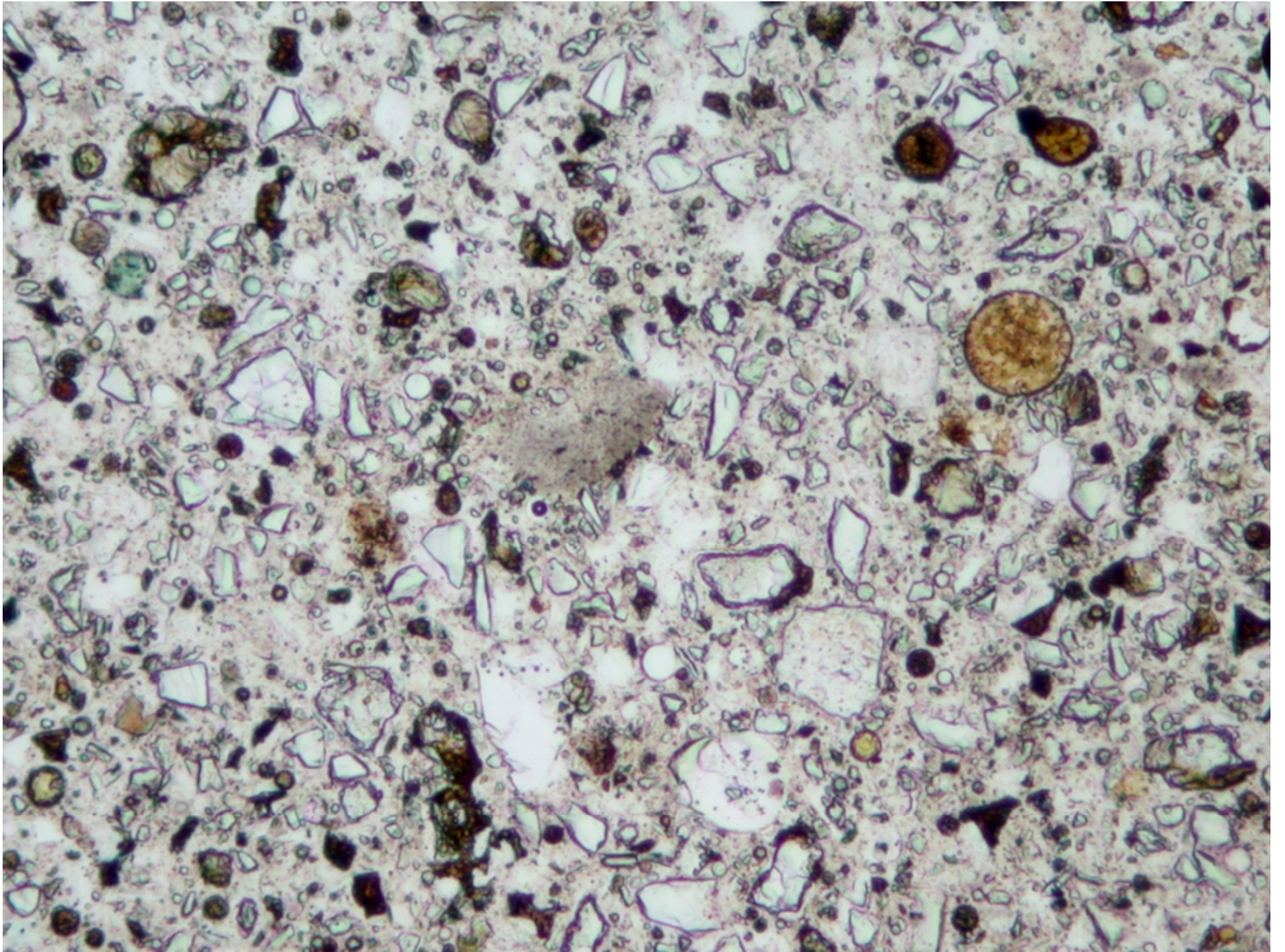








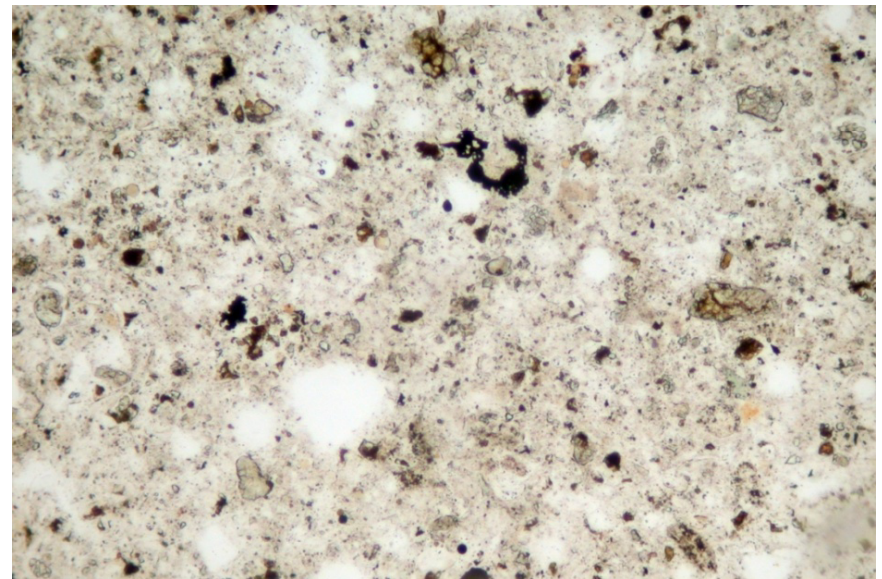
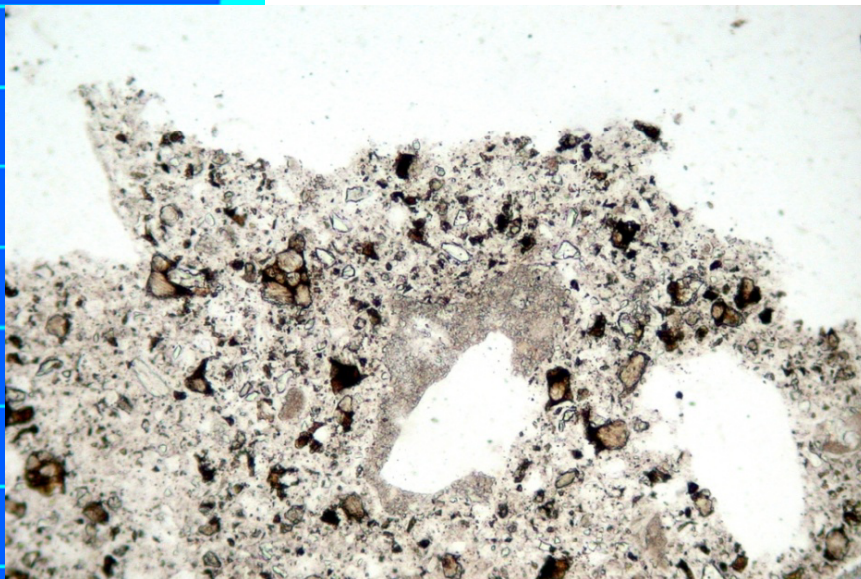




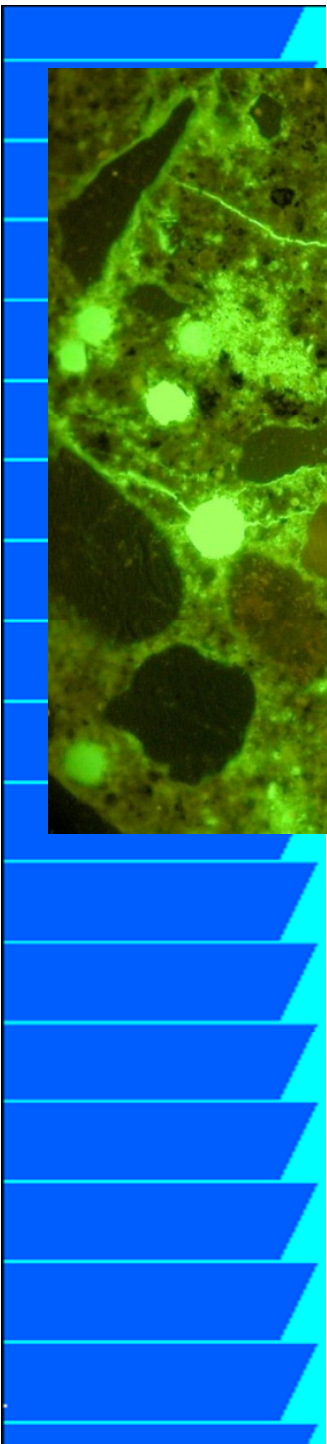
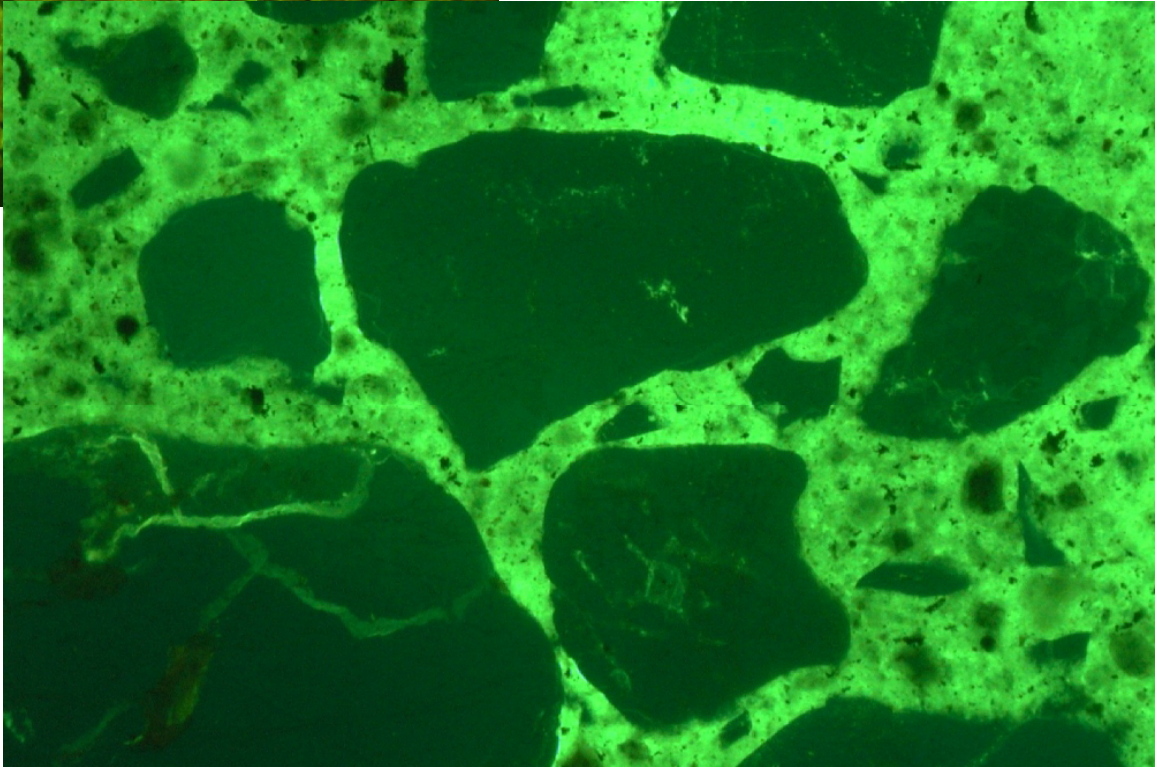
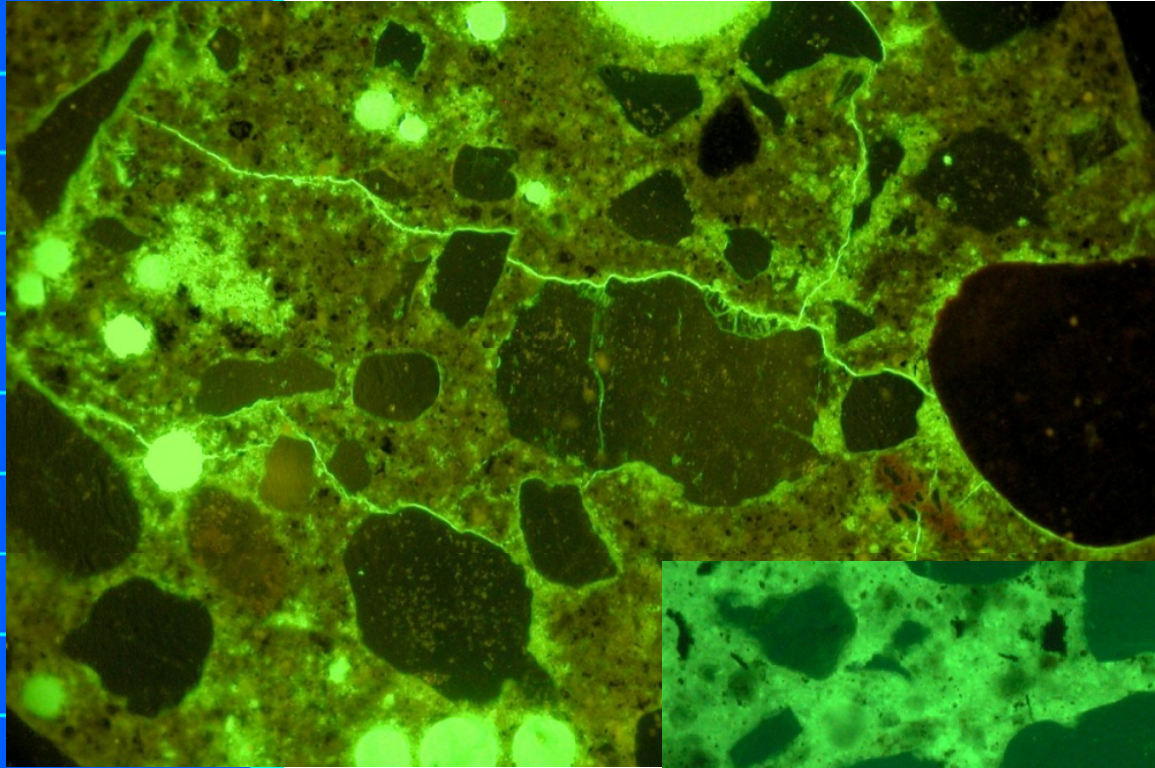


# Petrographic Examination CAN...

- Determine general compliance with mix design (aggregates, air content, SCMs, w/c)



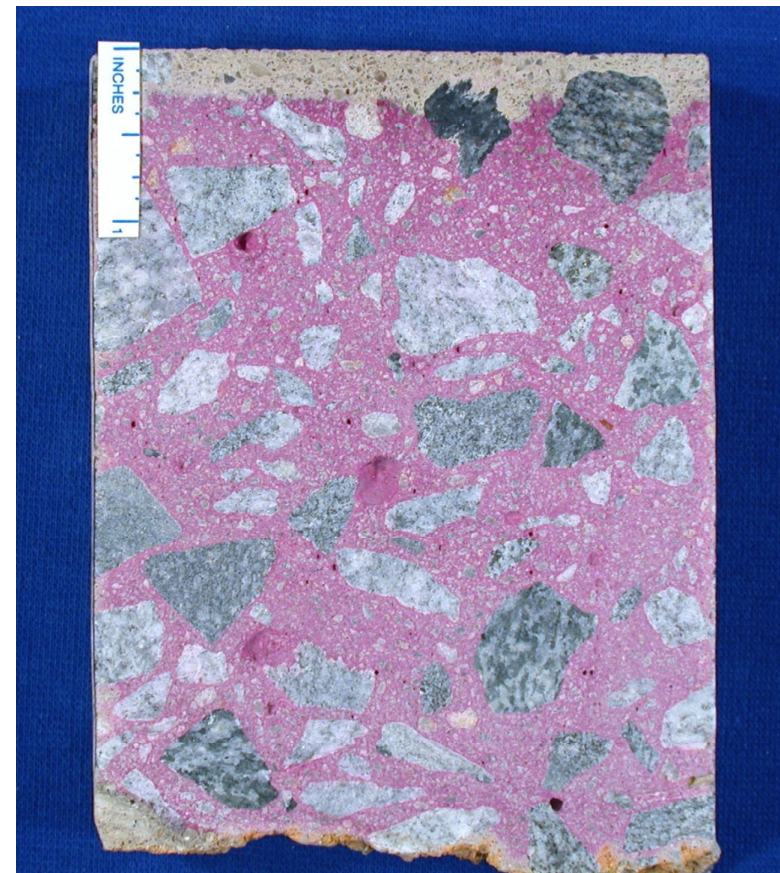
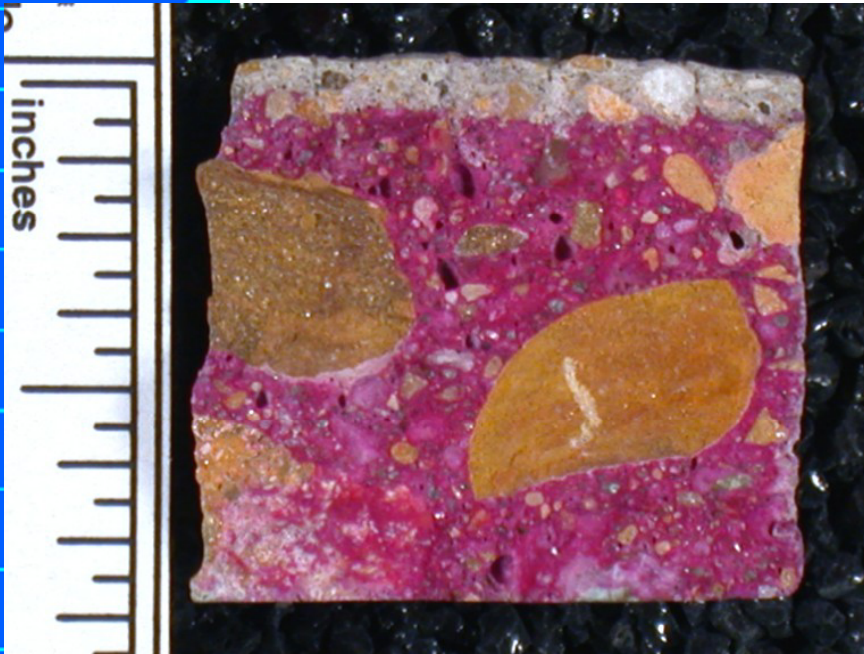






# Petrographic Examination CAN...

- Determine depth of paste carbonation





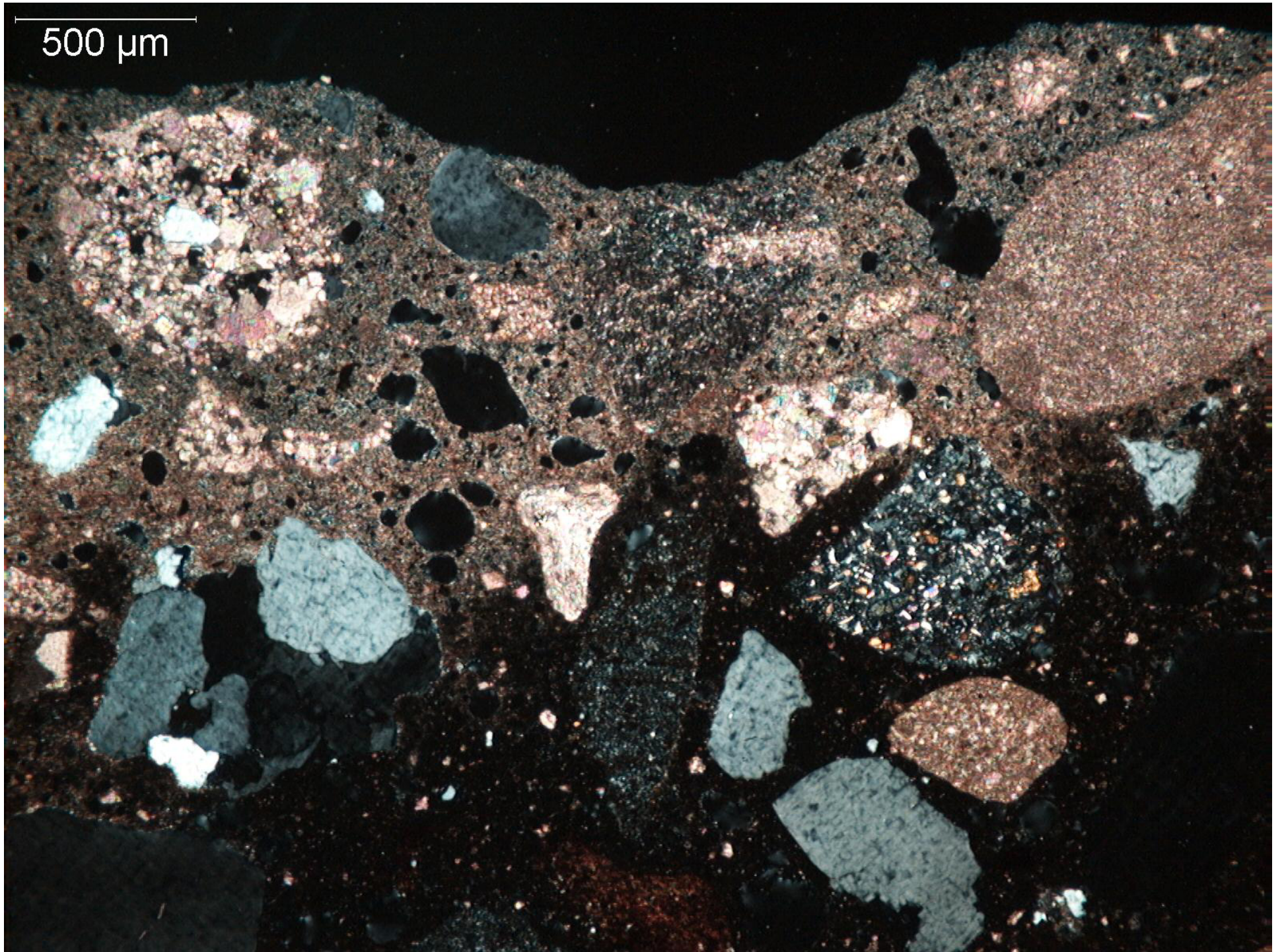


INCHES 1

CTL Project No. 230843  
**Core BM2CR-A**



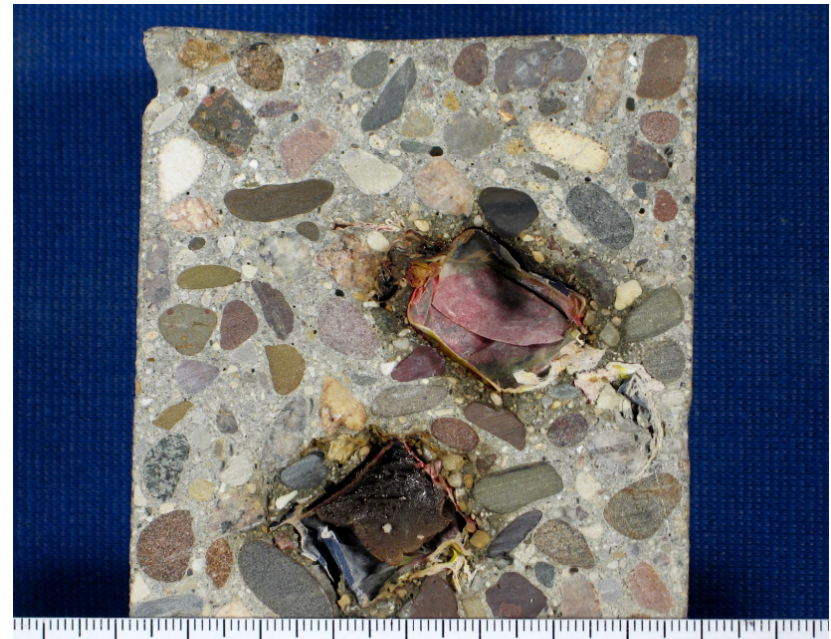
500  $\mu\text{m}$



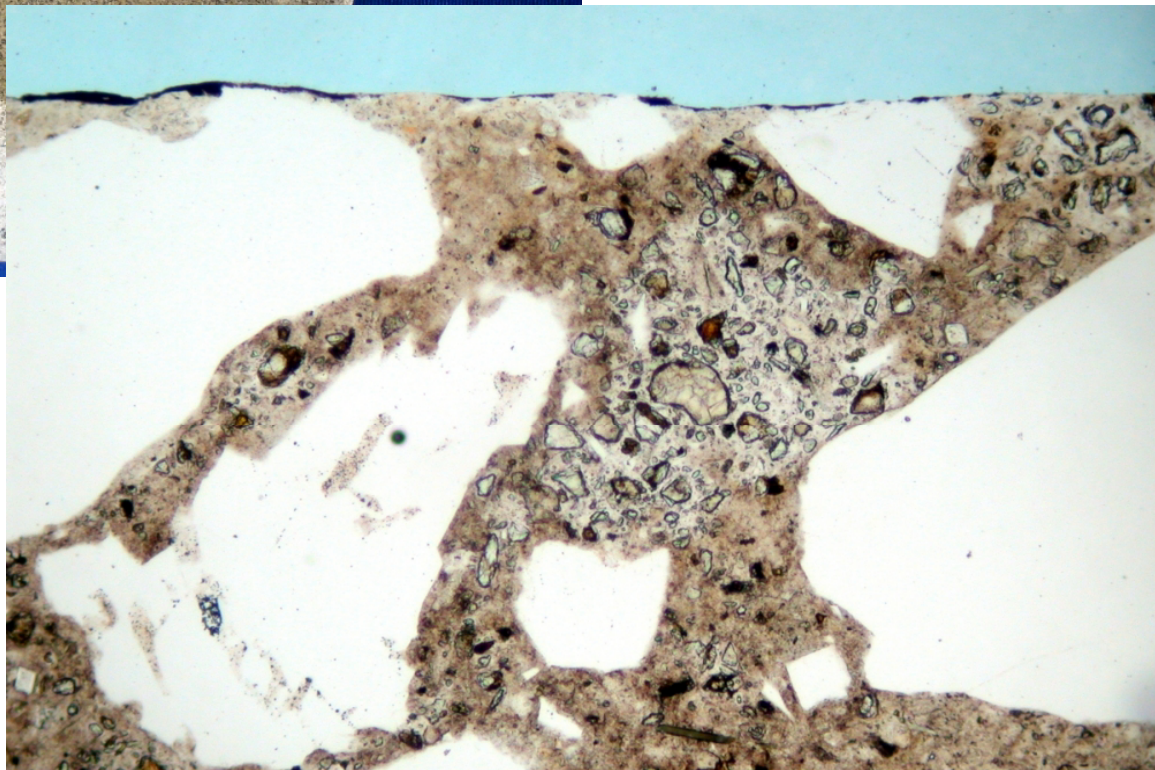
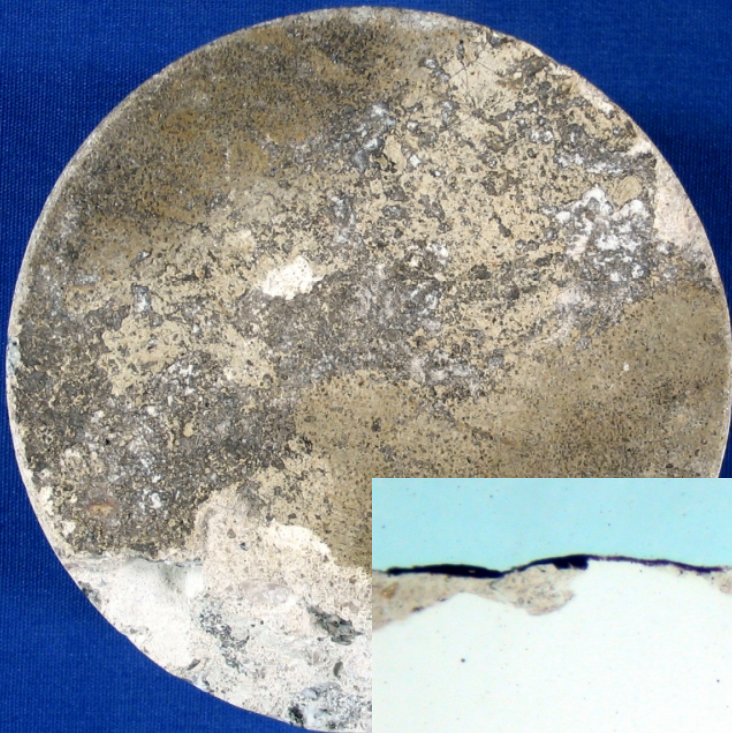


# Petrographic Examination CAN...

- Evaluate workmanship (consolidation, finishing, curing)



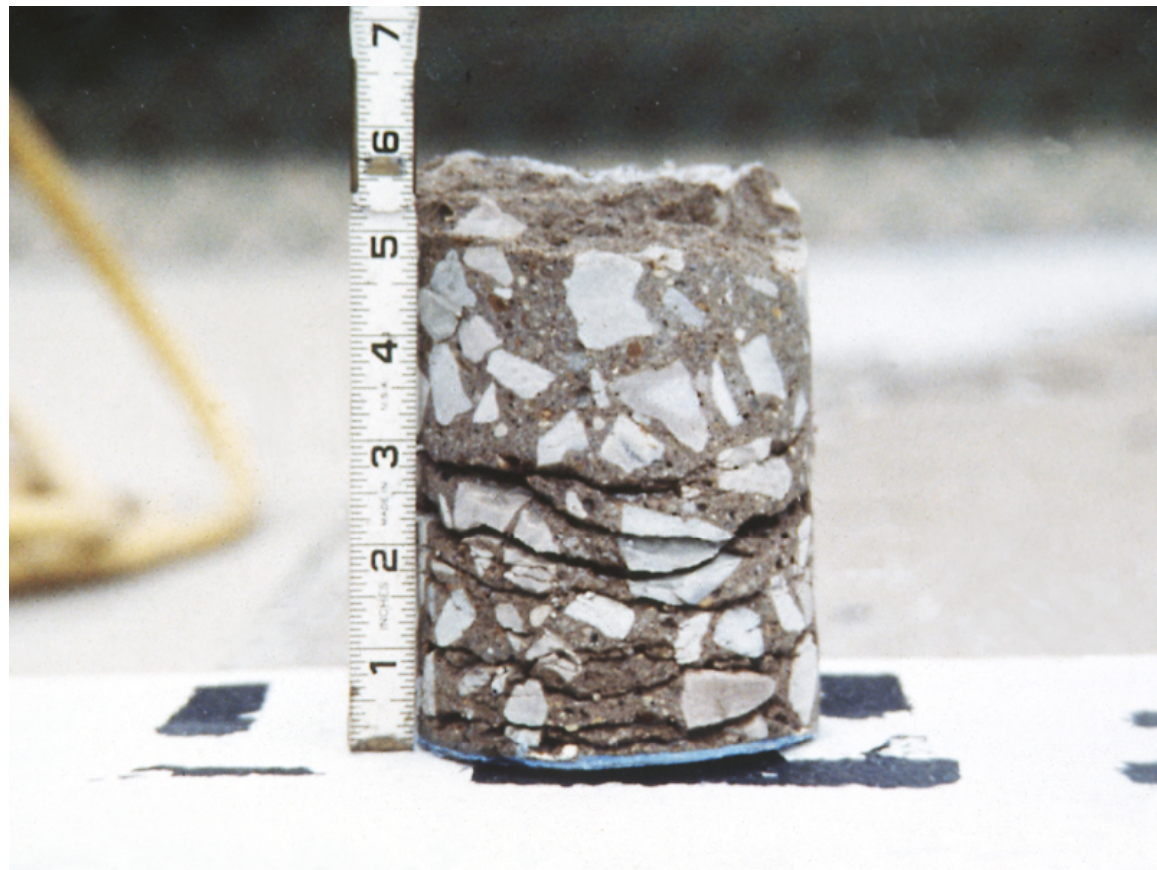




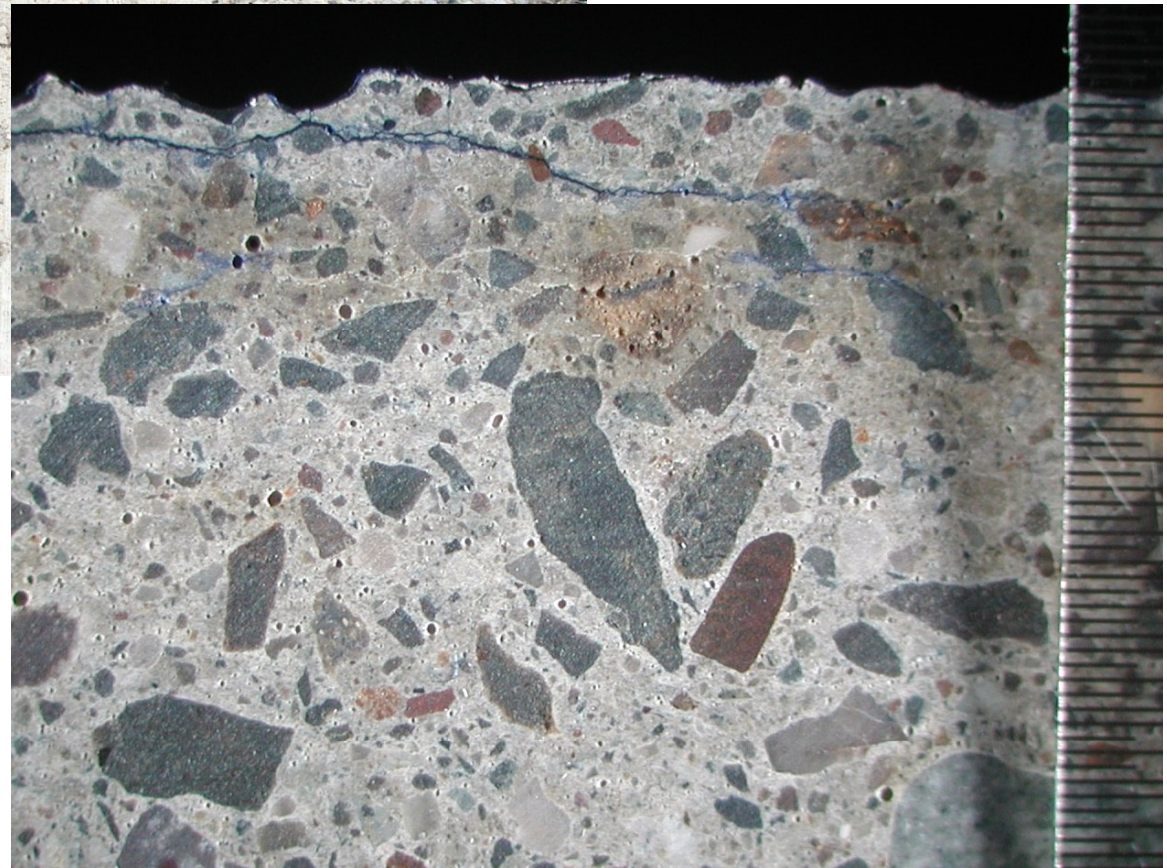


# Petrographic Examination CAN...

- Evaluate possible causes of distress



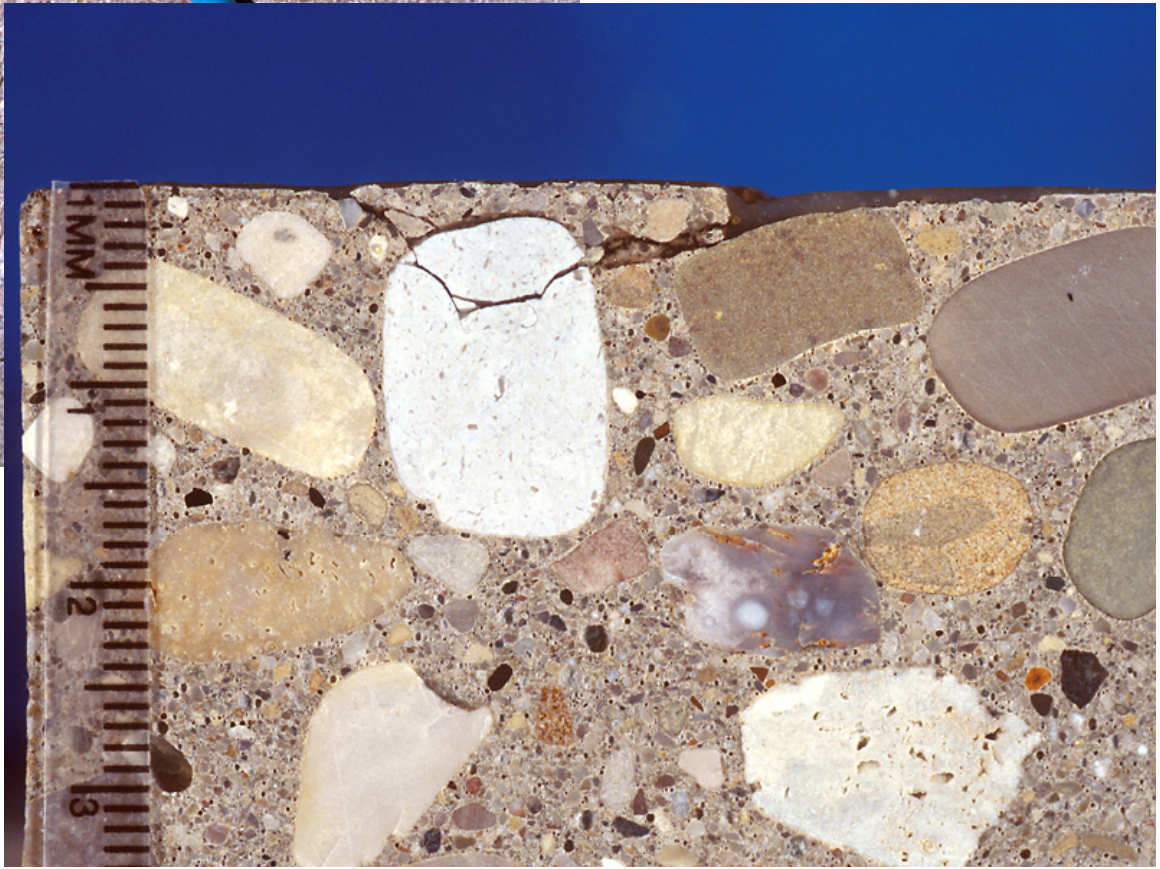
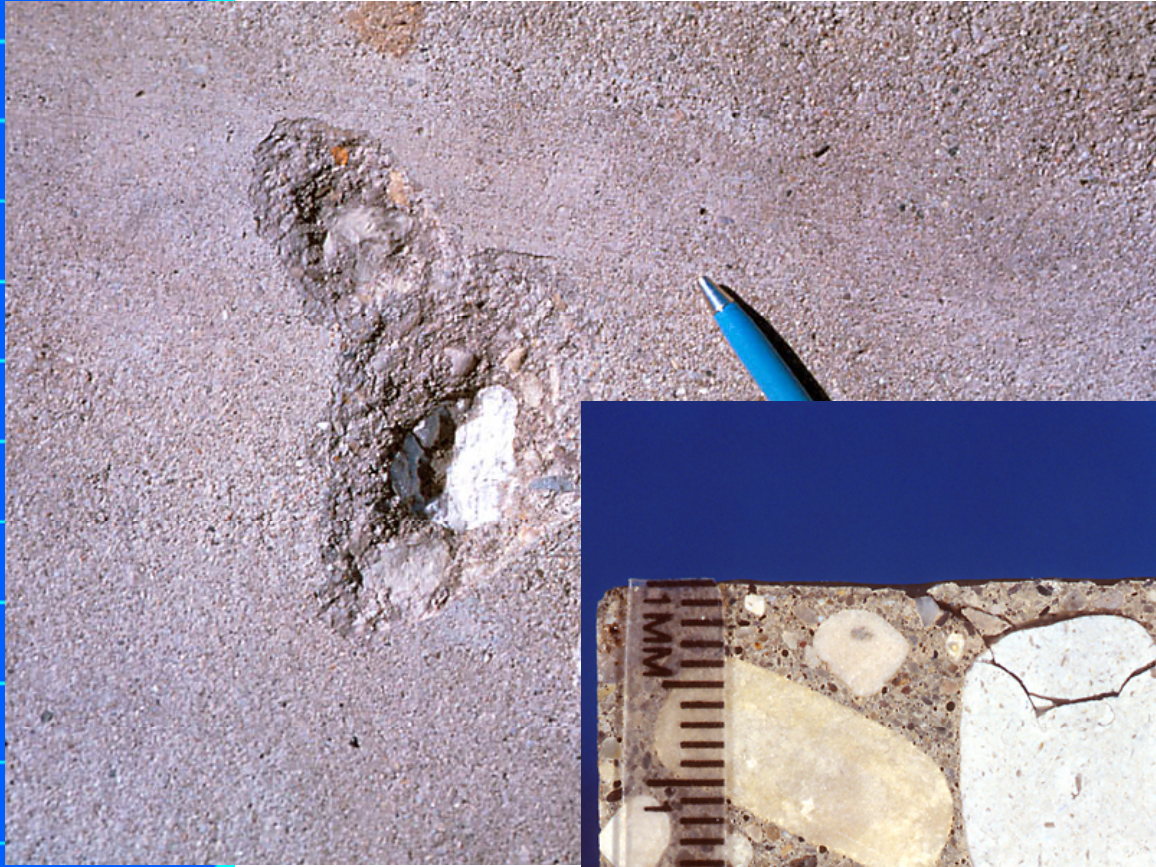








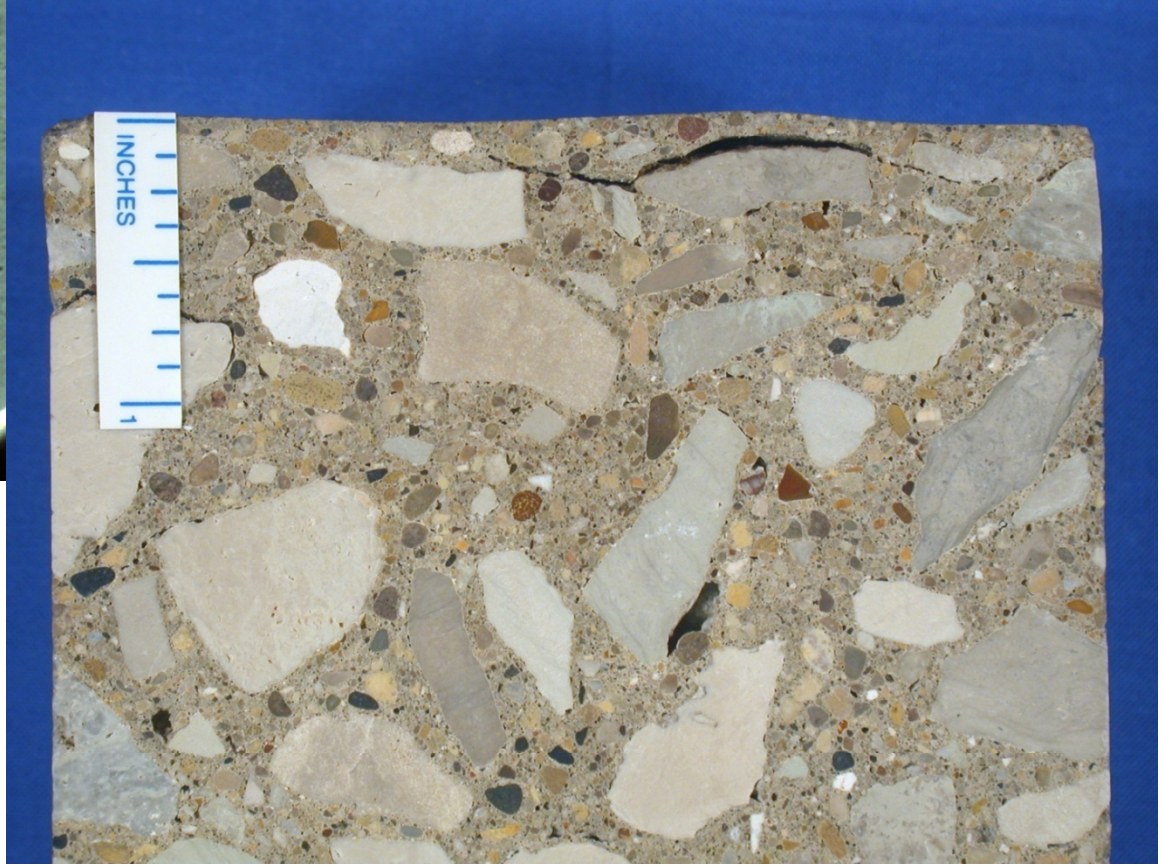
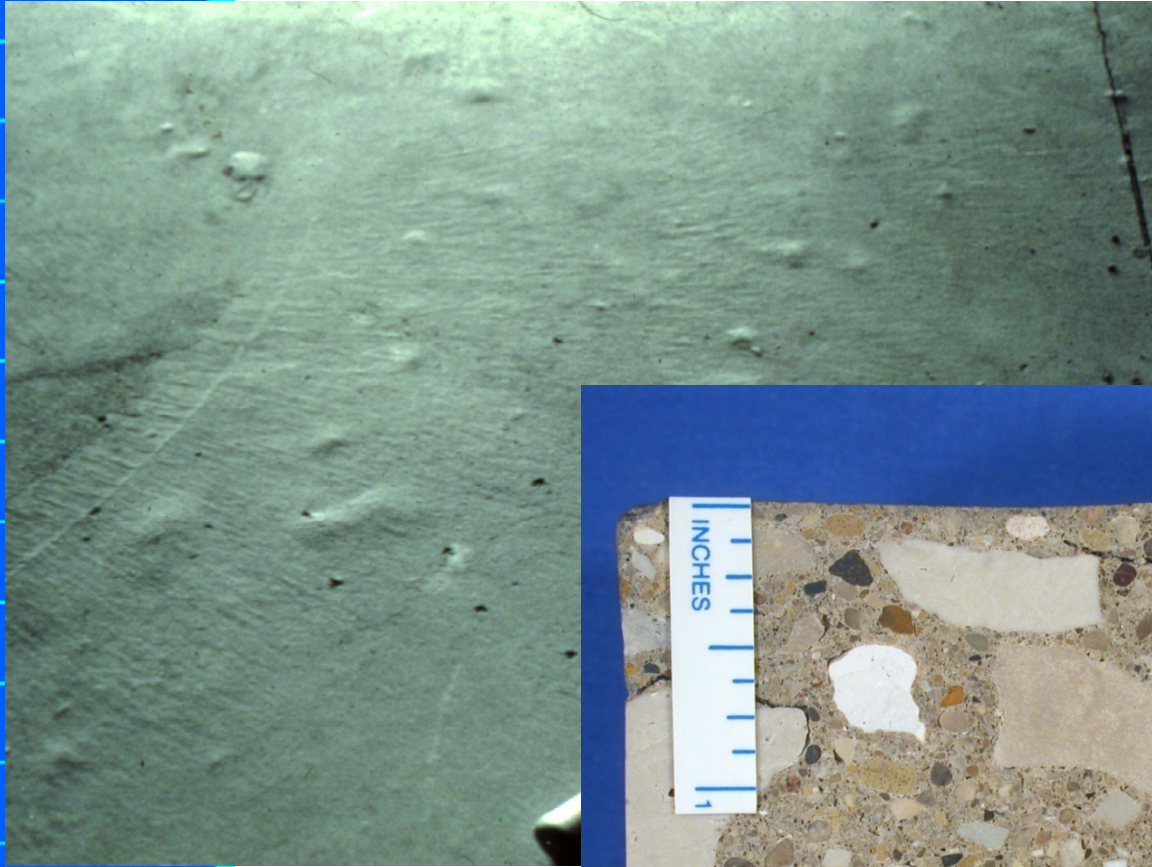
















# Petrographic Examination CAN...

- Recommend additional tests to investigate the problem
  - ◆ Air void system analysis (ASTM C457)
  - ◆ Scanning electron microscopy (SEM-EDX)
  - ◆ Cement content analysis (ASTM C1084)
  - ◆ Compressive strength testing (ASTM C42)
  - ◆ X-ray diffraction
  - ◆ X-ray fluorescence
  - ◆ Chemical tests





# Petrographic Examination CAN'T...

- Determine cement content
- Determine cement type
- Confirm presence, type, or quantity of chemical admixtures
- Determine timing of water additions
- Determine precise proportions of mix
- Determine concrete strength





# Petrographic Report

- Background information/ reason for testing
- Conclusions
- Summary of observations
- Discussion
- Methodology of examination
- Photographs
- Data pages

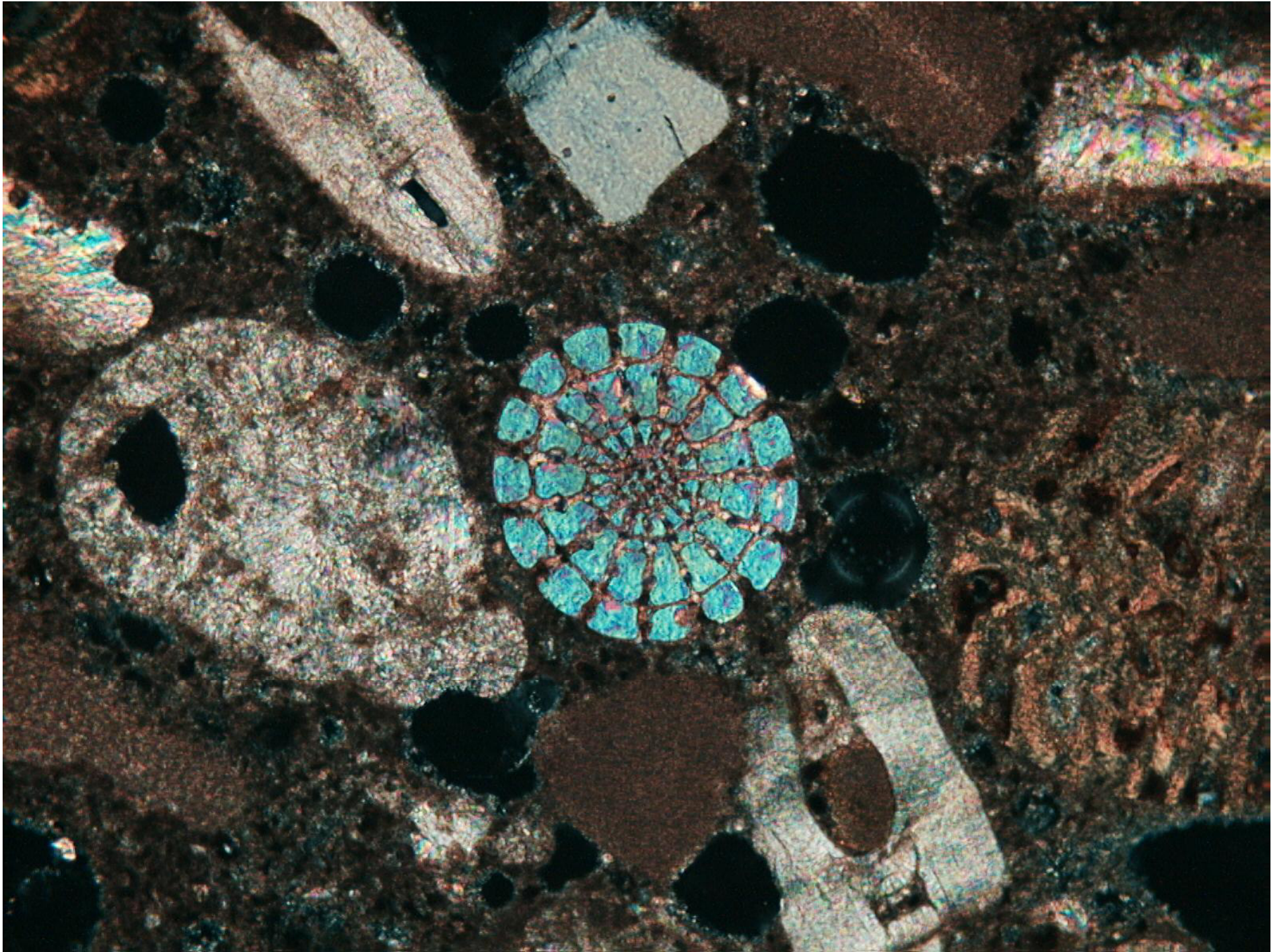


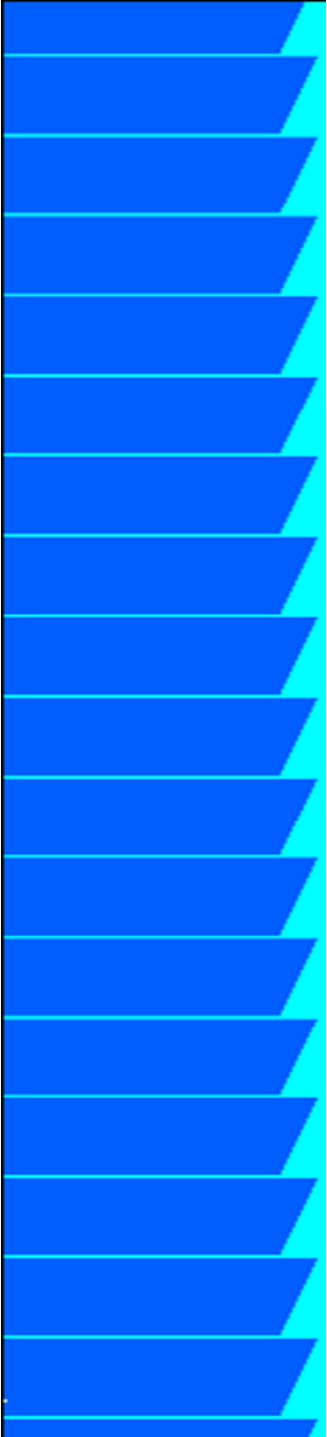
# Evaluating a Report

- Were samples representative?
- Do observations/data agree and seem plausible?
- Do photographs illustrate observations?
- Do conclusions drawn from observations seem logical?
- Is original question addressed?

**NEVER BE AFRAID TO QUESTION THE  
PETROGRAPHER!**







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