

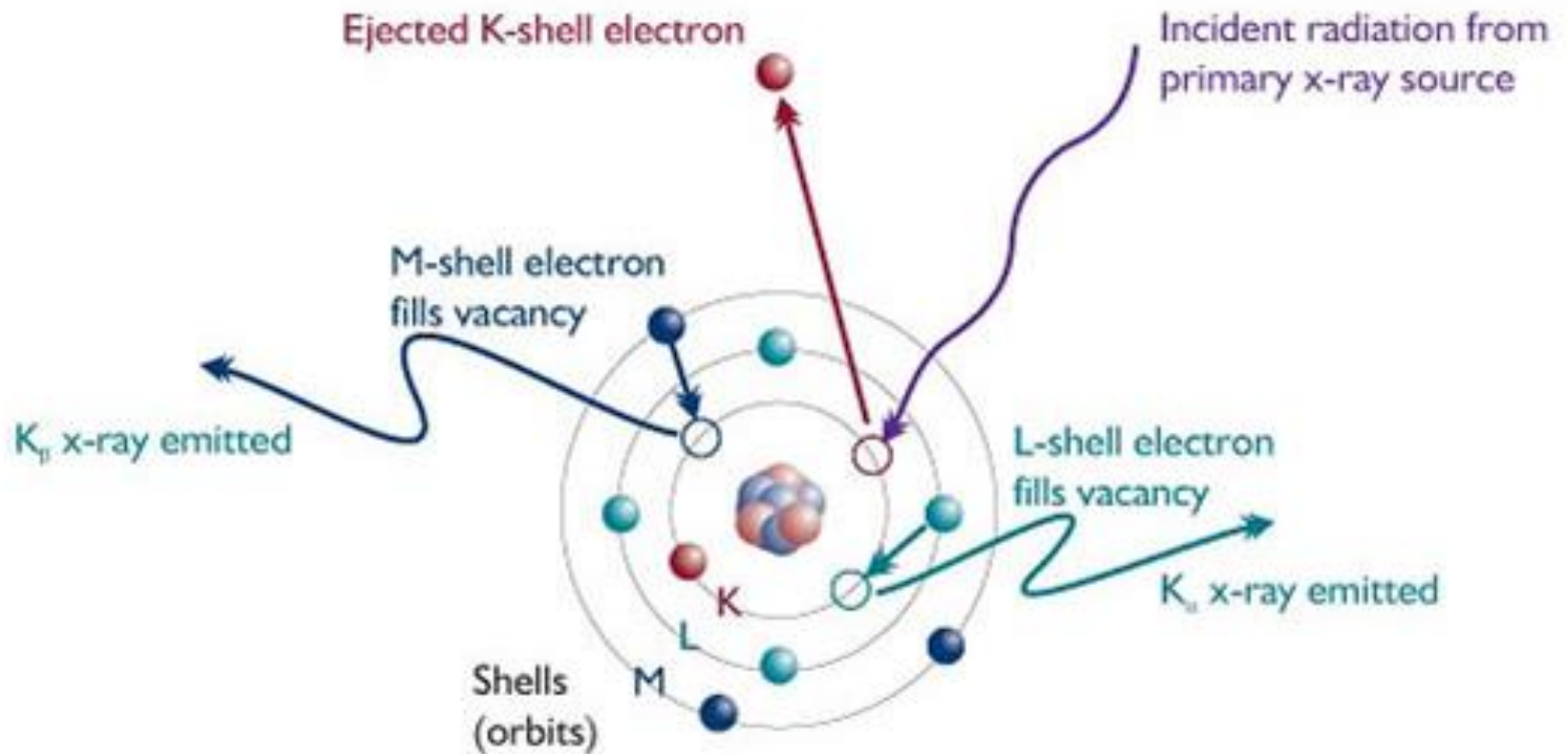
**Unlocking the Material Past through Material Science:
Preliminary Archaeometric Investigations of
Roman and Colonial Coins and the Weathering of
Historical Glasses**

**Comparison of Coins by X-ray Diffraction (XRD);
Preliminary Findings**



From left obverse (top) and reverse (bottom): Maxentius (Rome Mint), 1698 Half Penny, Greene Farm Unknown Coin, 1975 US Penny

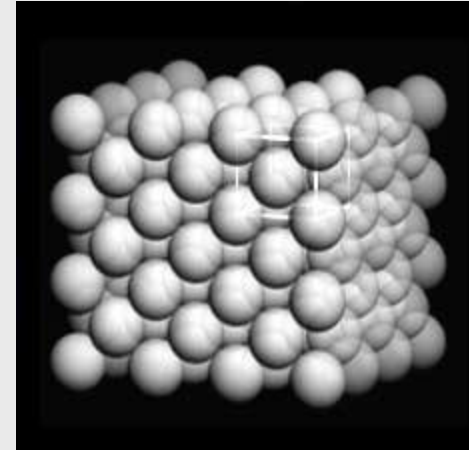
X-ray Fluorescence (XRF)



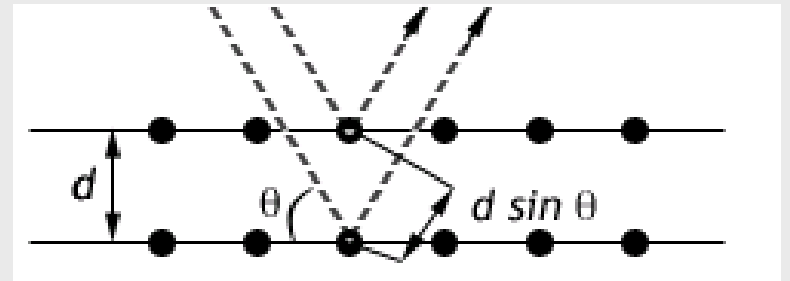
Relative Composition (%)	Cu	Zn	Pb	Ag	Sn	Fe
Penny, 2005	47.15	52.68	0.01			0.17
Penny, 1975	96.57	3.26				0.17
Half-Penny, 1698	99.25		0.49		0.02	0.24
Maxentius, Mint	88.72	0.27	6.83	1.04	2.81	0.32
GFAP Unknown	0.20	4.99	1.95			92.87

X-ray Diffraction (XRD)

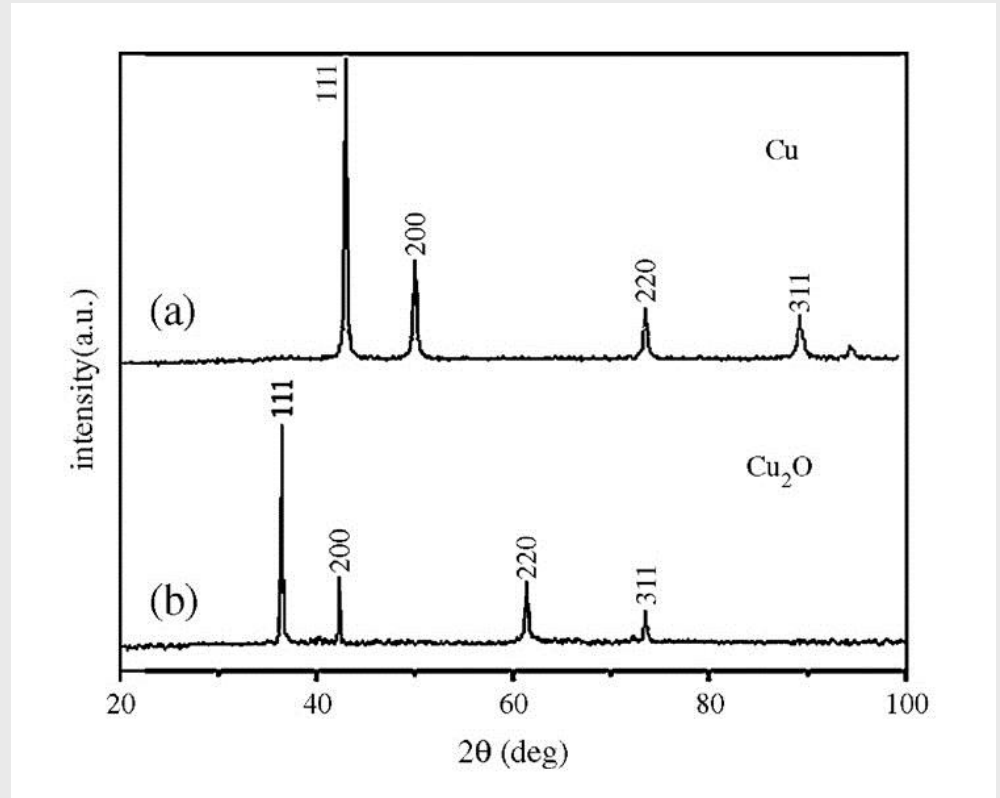
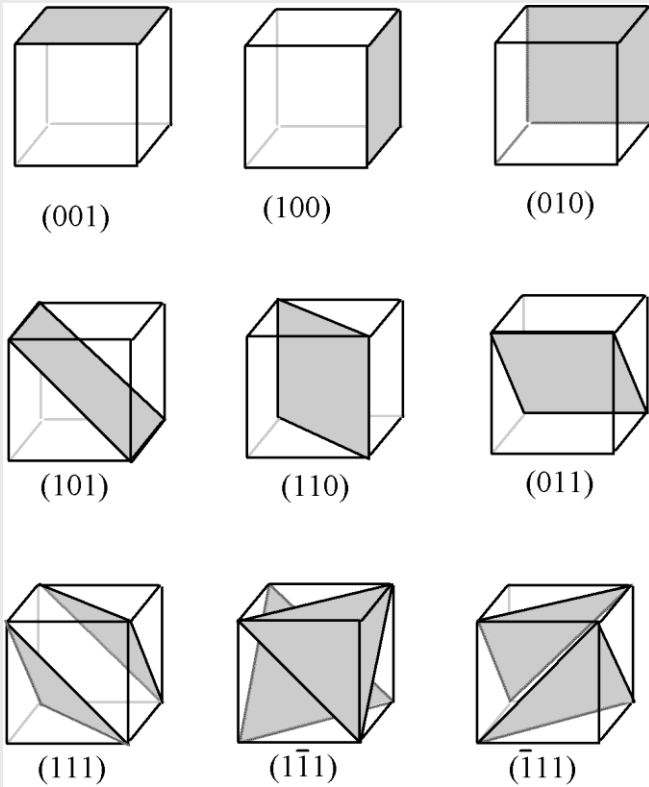
- X-ray diffraction analysis uses the interaction of x-rays with the atomic structure of a **crystalline phase** to deduce the arrangement of atoms within the **lattice**. X-rays are scattered by the atoms (primarily by electrons), and interfere with one another to form a unique pattern.
- Each phase can be identified by a unique “fingerprint” of peak locations.



$$\text{Bragg's Law: } 2d \sin \theta = n\lambda$$

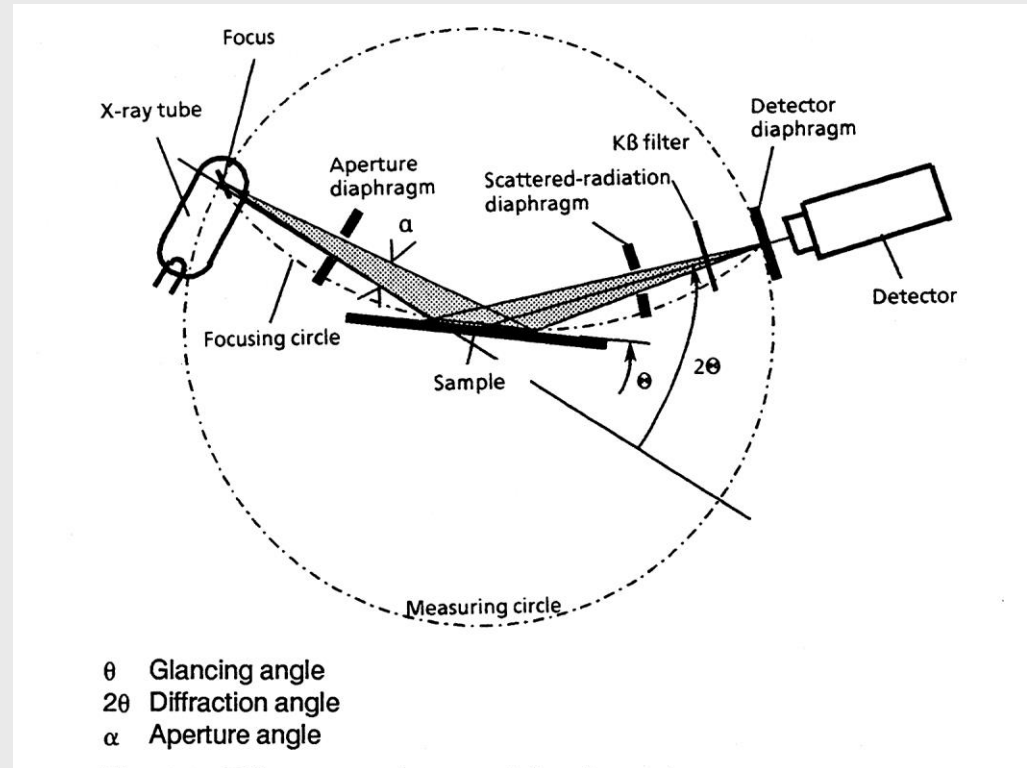


XRD & Crystallography



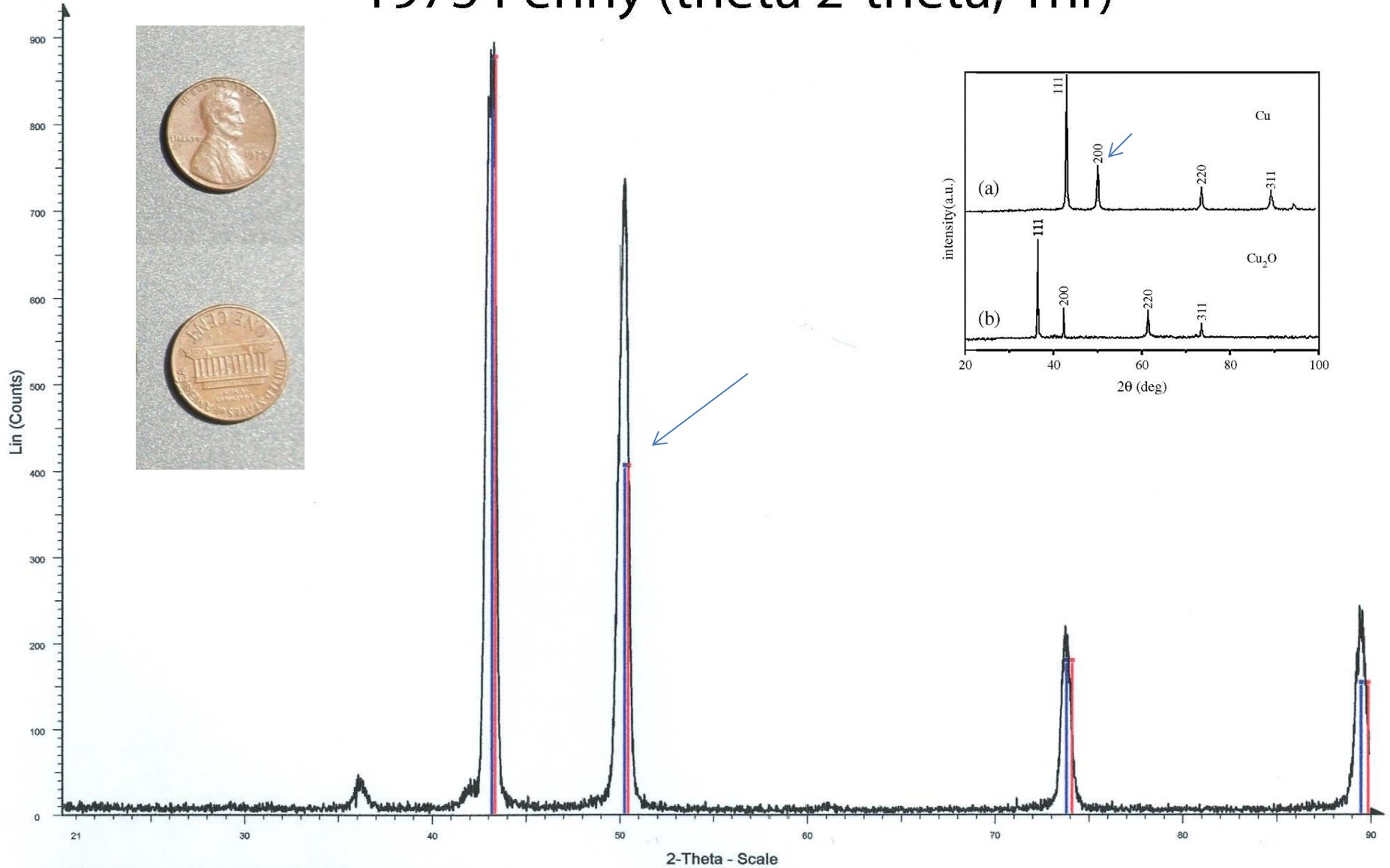
Diffractometry

- θ - 2θ Scan
 - “deep”
- Glancing Angle Scan
 - “shallow”



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1975 Penny (theta 2-theta, 1hr)



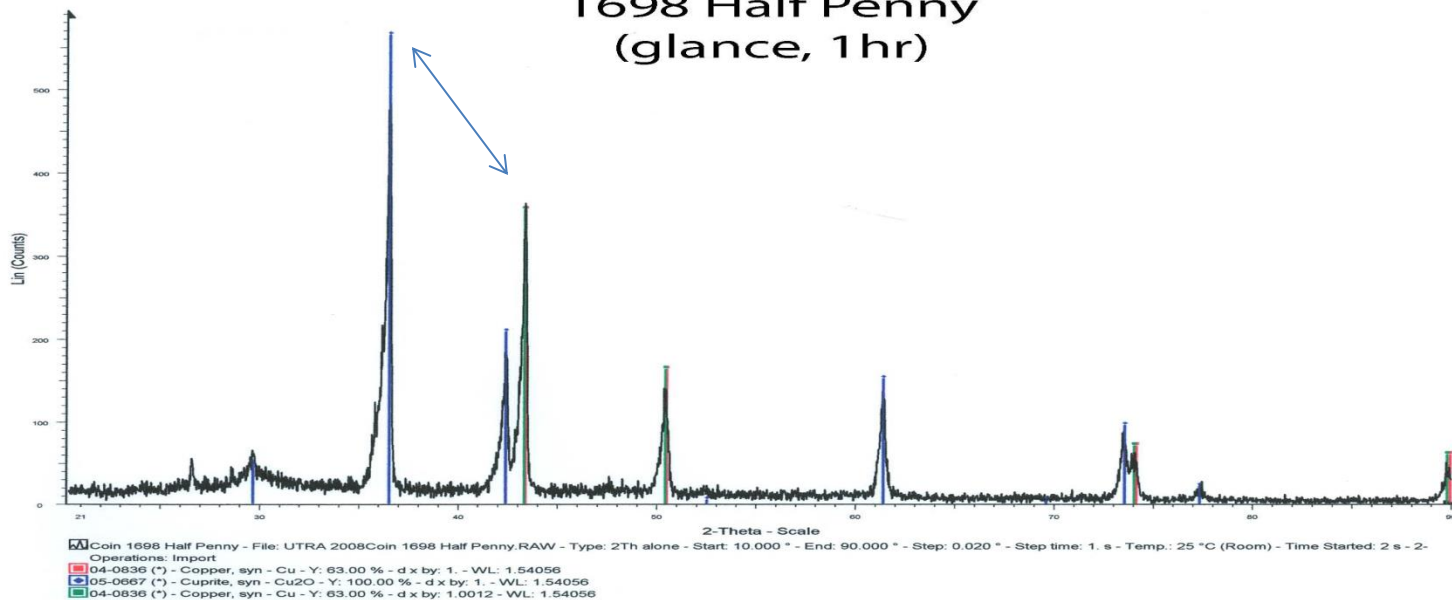
Penny 1975 theta 2 - File: Penny 1975 theta 2.RAW - Type: 2Th/Th locked - Start: 10.000 ° - End: 90.000 ° - Step: 0.020 ° - Step time: 1. s - Temp.: 25 °C (Room) - Time Started: 2 s - 2-Theta: 10.00

Operations: Import

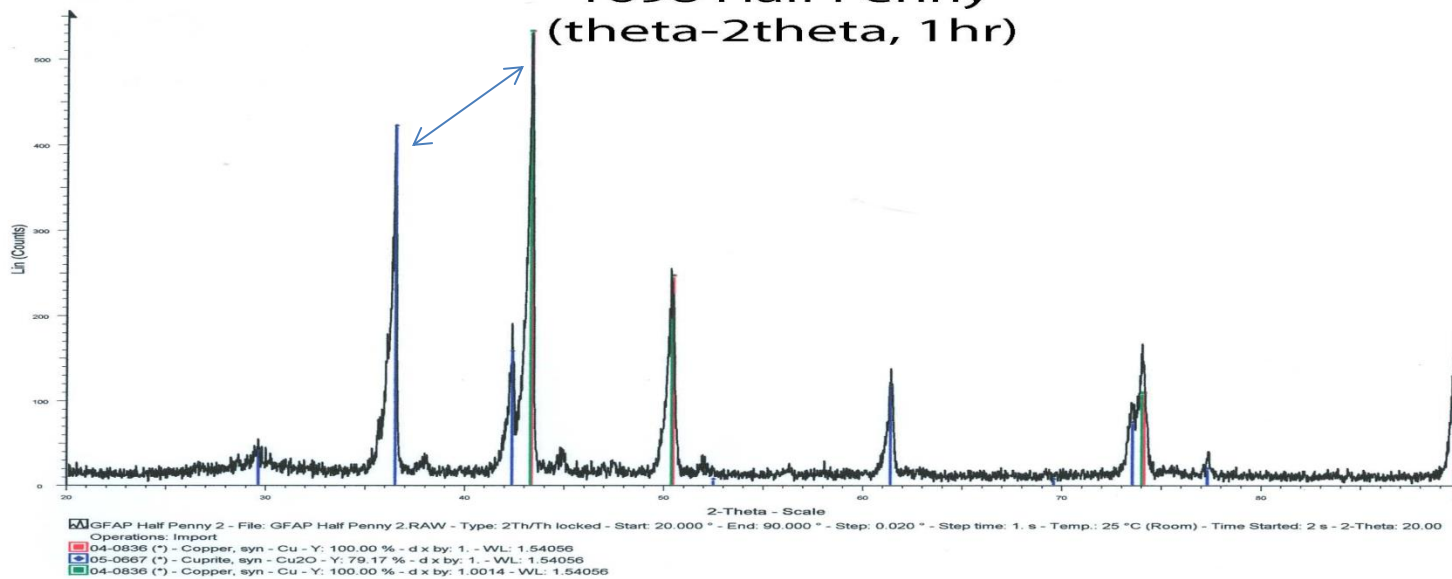
04-0836 (*) - Copper, syn - Cu - Y: 97.75 % - d x by: 1. - WL: 1.54056

04-0836 (*) - Copper, syn - Cu - Y: 97.75 % - d x by: 1.0034 - WL: 1.54056

1698 Half Penny (glance, 1 hr)

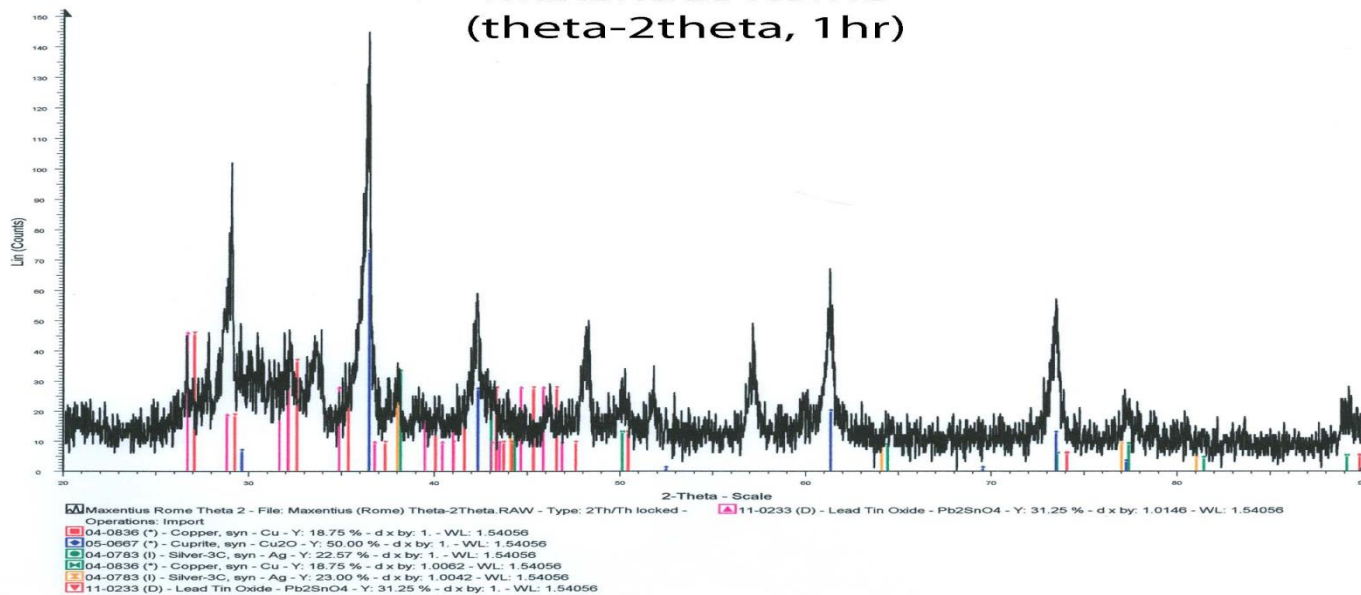


1698 Half Penny (theta-2theta, 1 hr)

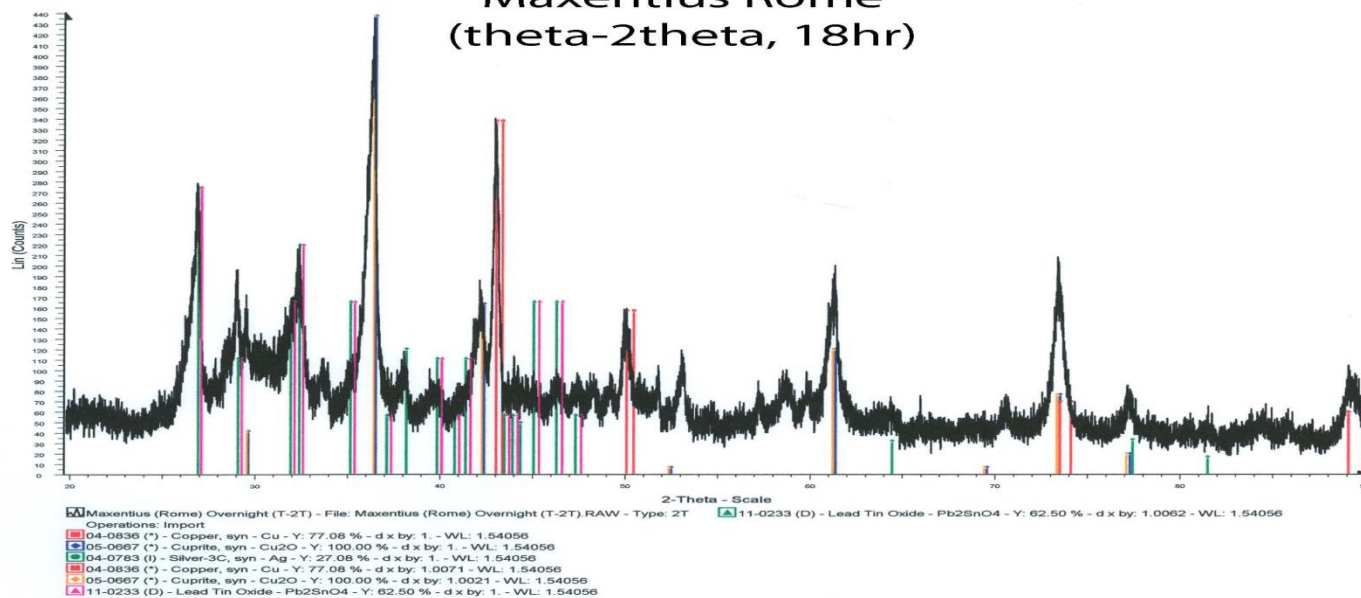




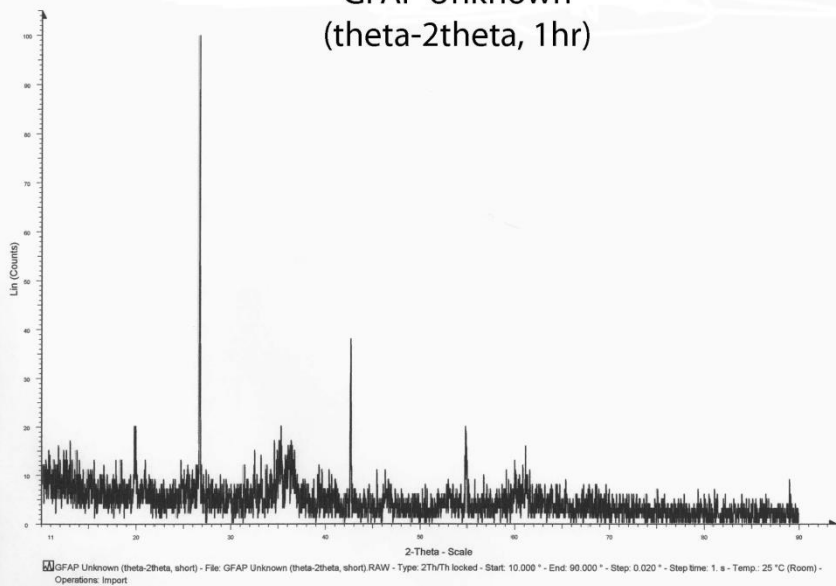
Maxentius Rome (theta-2theta, 1hr)



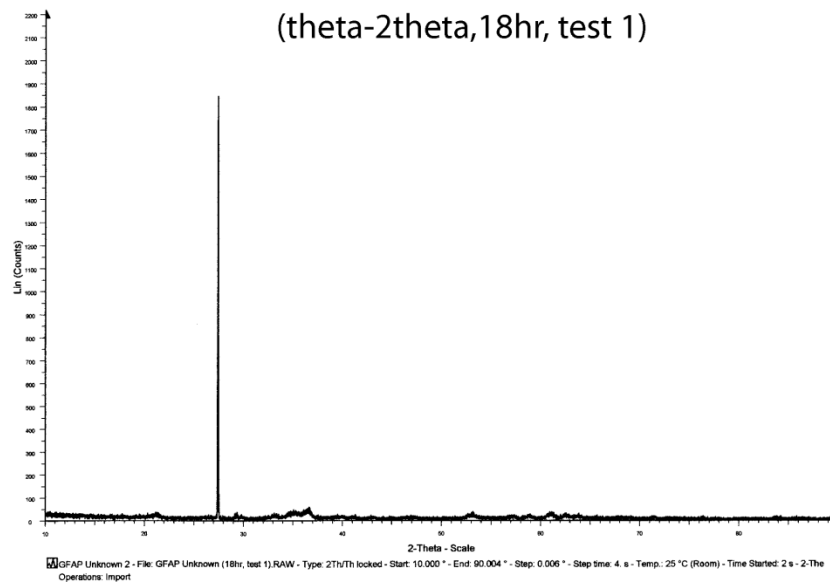
Maxentius Rome (theta-2theta, 18hr)



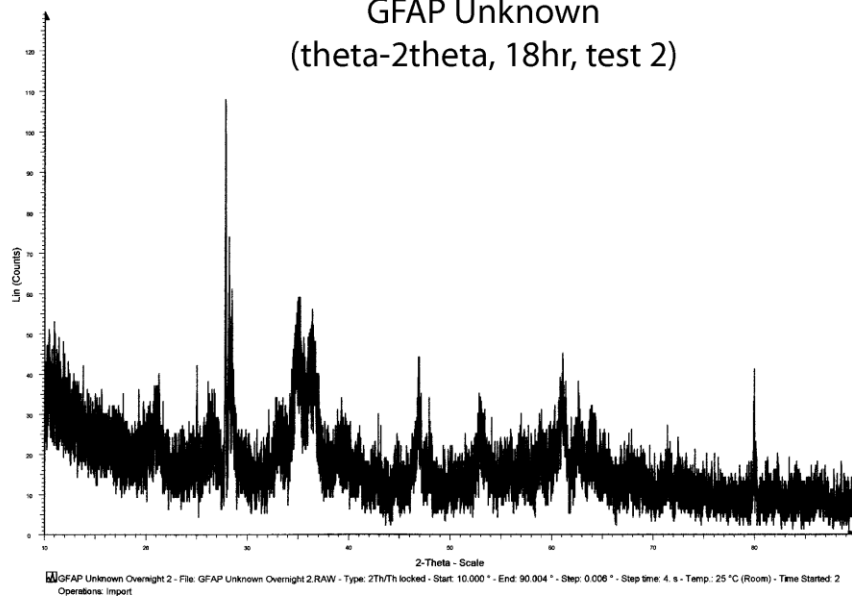
GFAP Unknown
(theta-2theta, 1hr)



GFAP Unknown
(theta-2theta, 18hr, test 1)

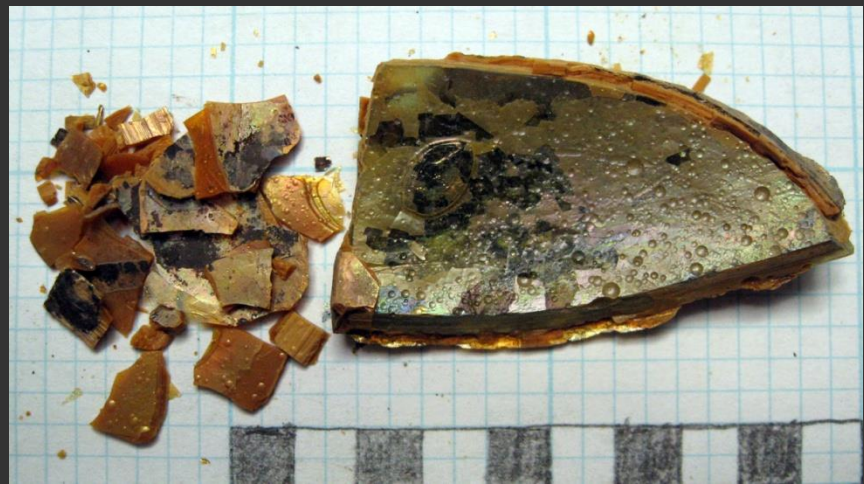
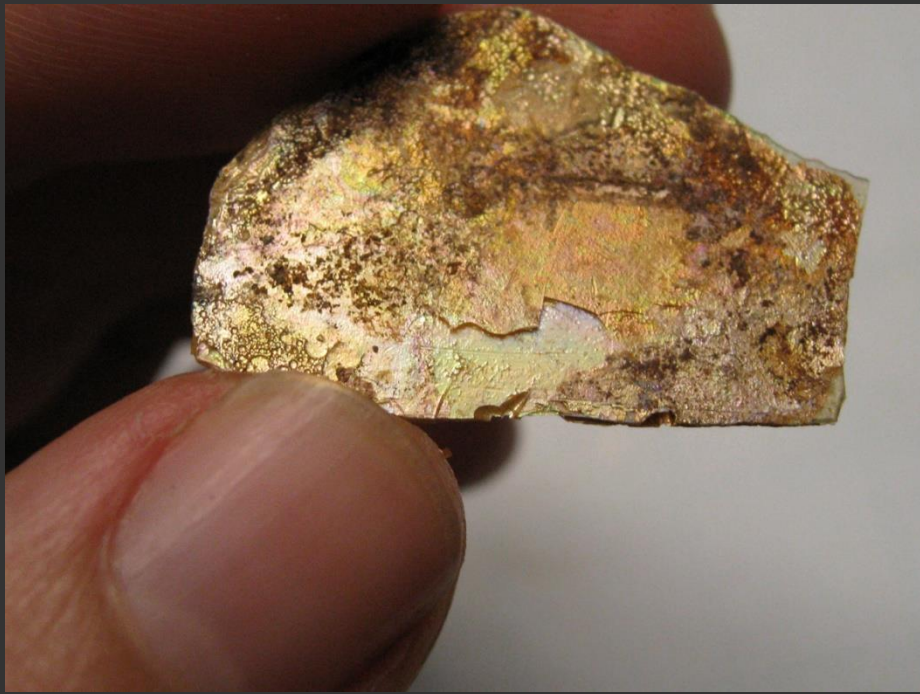


GFAP Unknown
(theta-2theta, 18hr, test 2)

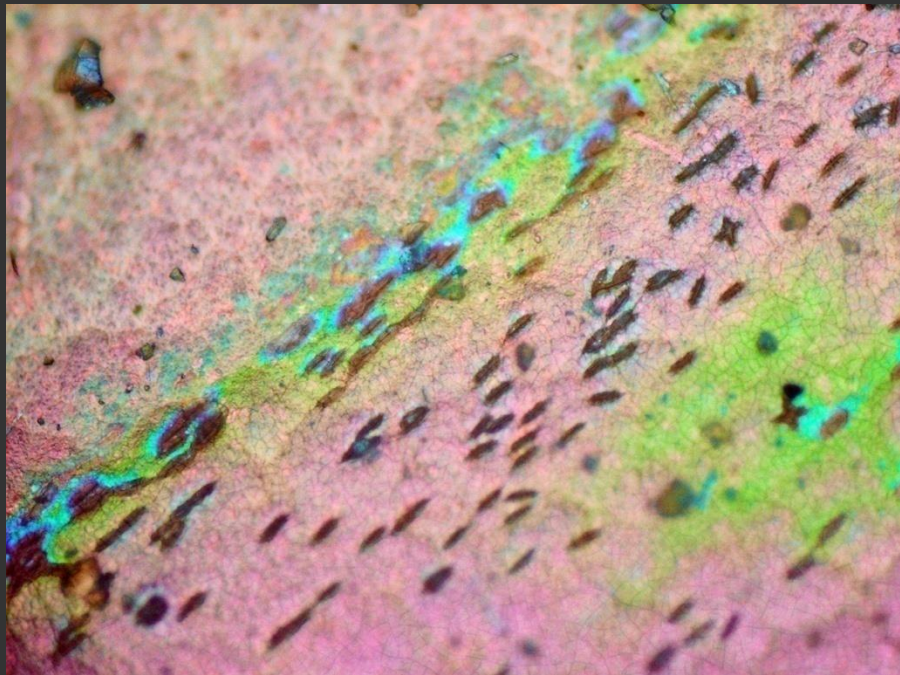
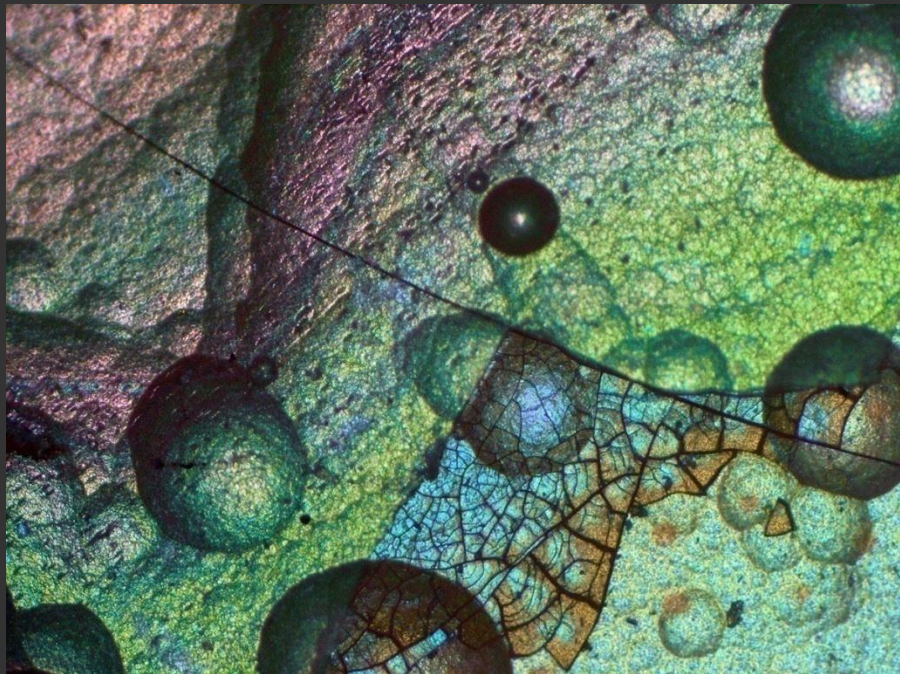


Weathering of Historical Glasses: A Record of Time?

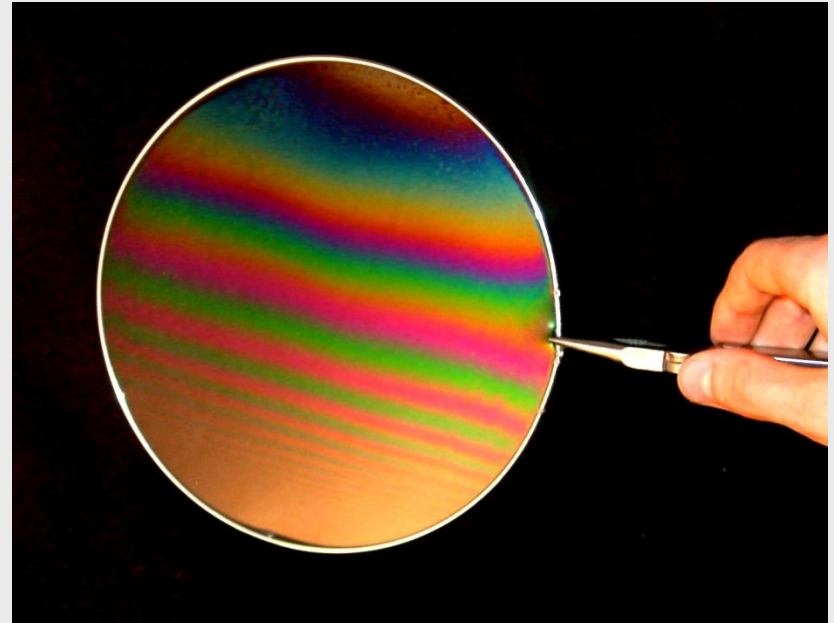
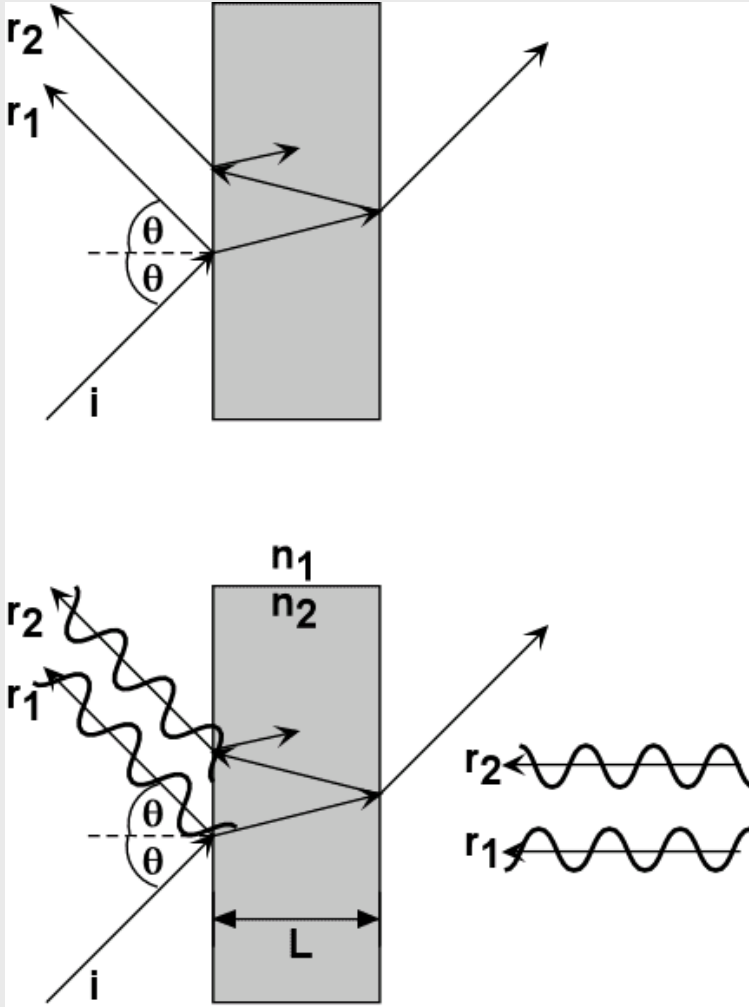
Andrew Bearnot





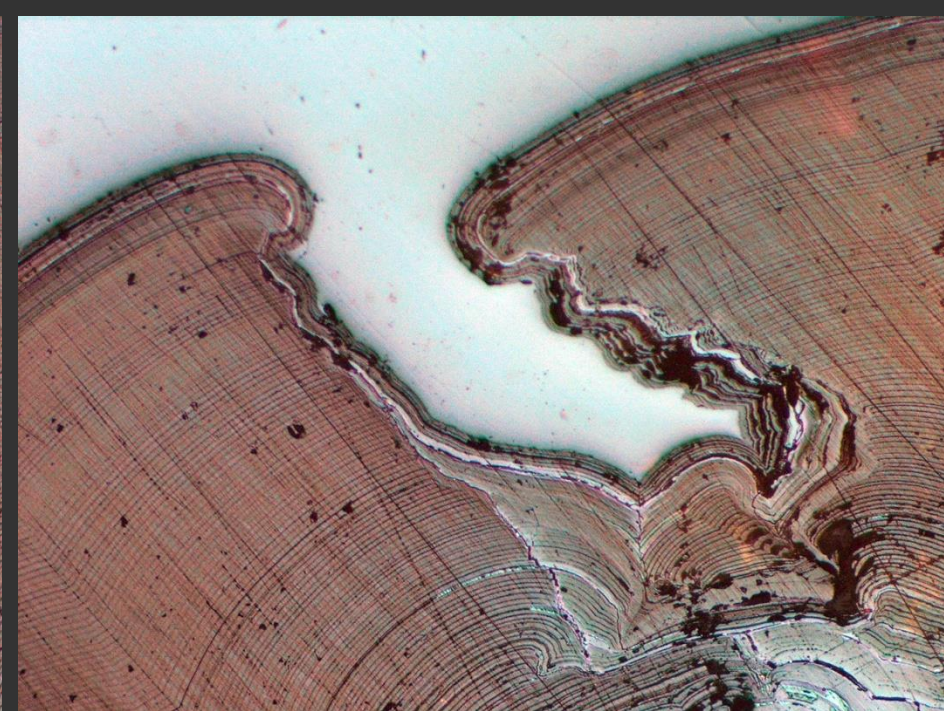
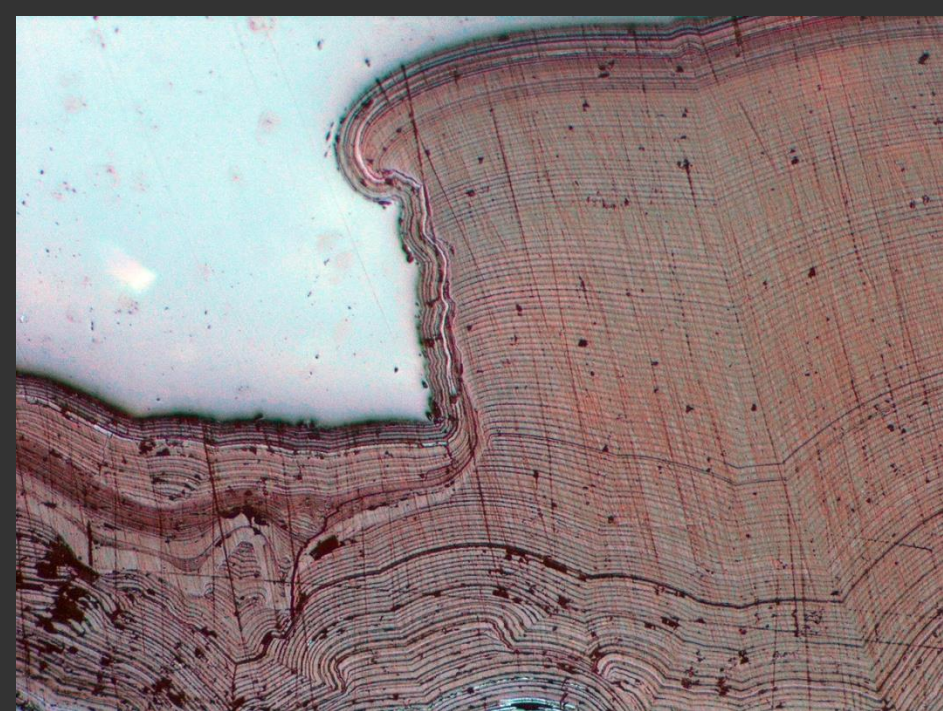


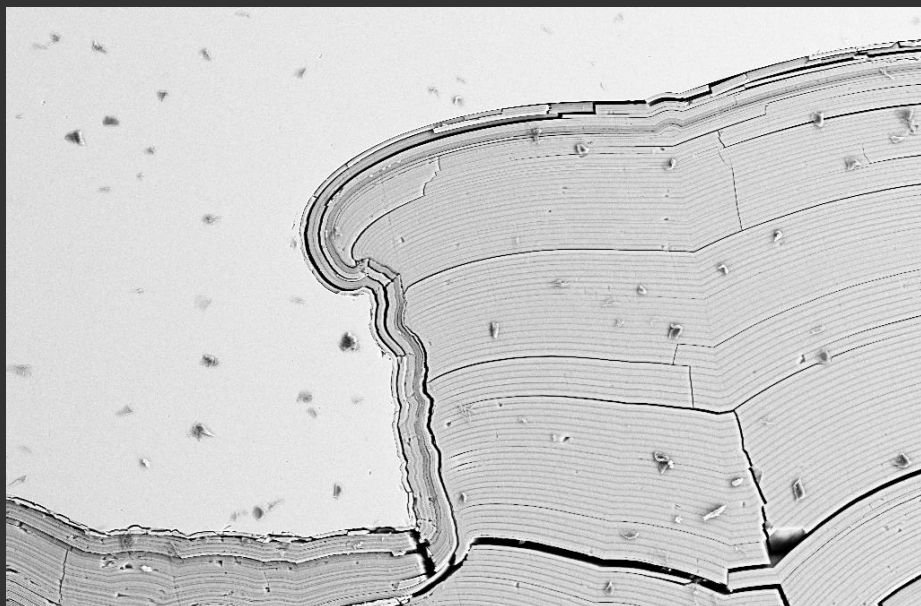
Thin Film Interference



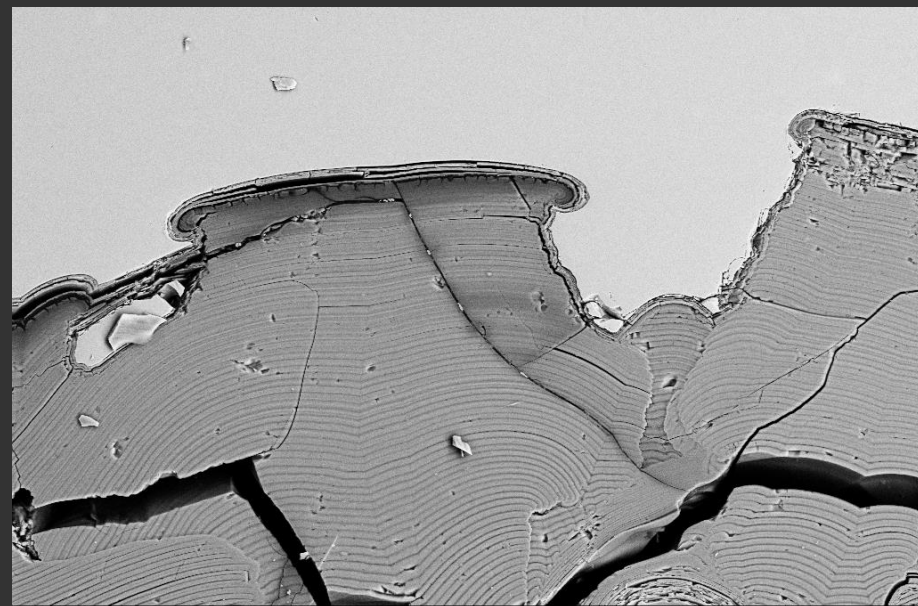




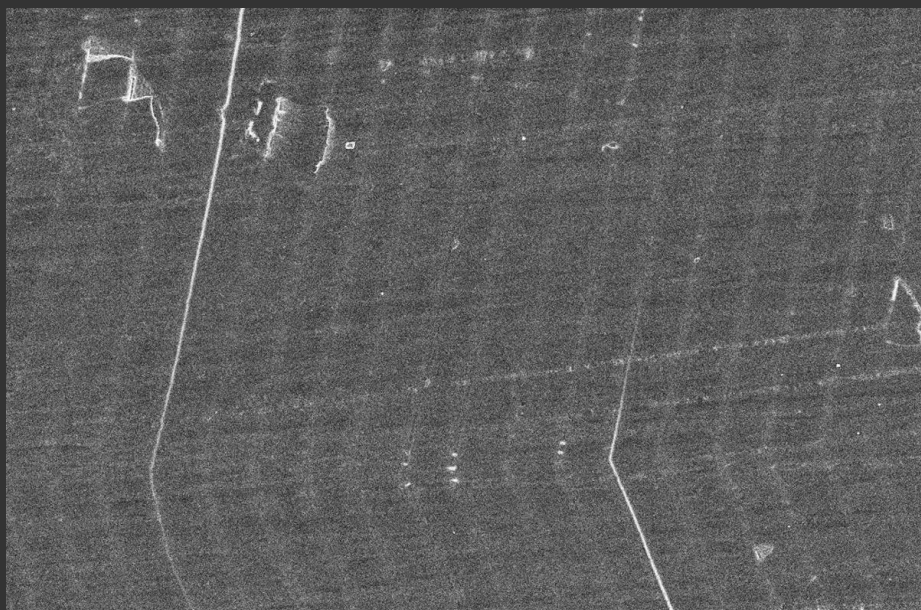




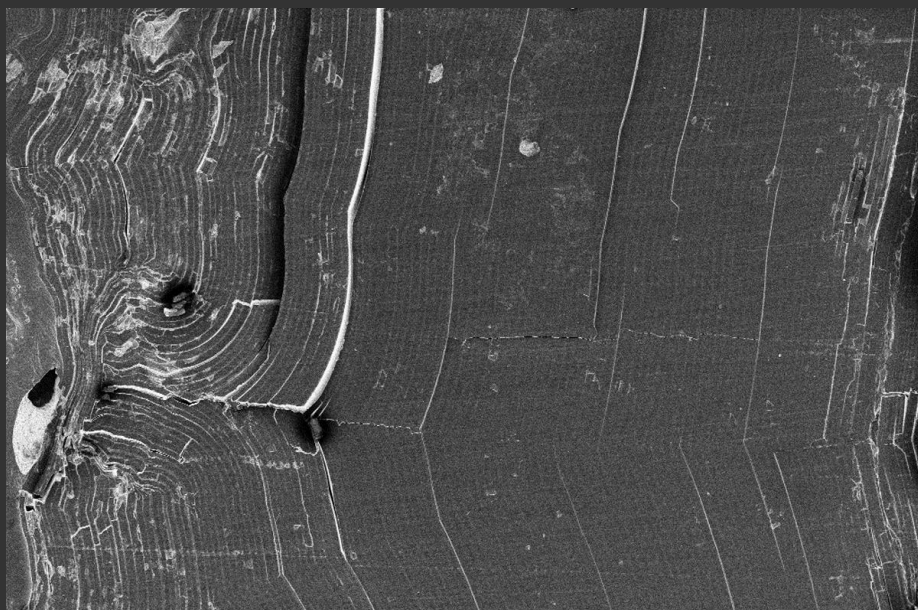
Mag = 150 X 100µm EHT = 25.00 kV Signal A = RBSD Date :8 Aug 2008
WD = 8 mm Photo No. = 5793 Time :9:35:13



Mag = 202 X 100µm EHT = 25.00 kV Signal A = RBSD Date :23 Jul 2008
WD = 12 mm Photo No. = 5290 Time :12:57:50



Mag = 1.58 K X 20µm EHT = 5.00 kV Signal A = InLens Date :18 Jul 2008
WD = 7 mm Photo No. = 5243 Time :13:23:48



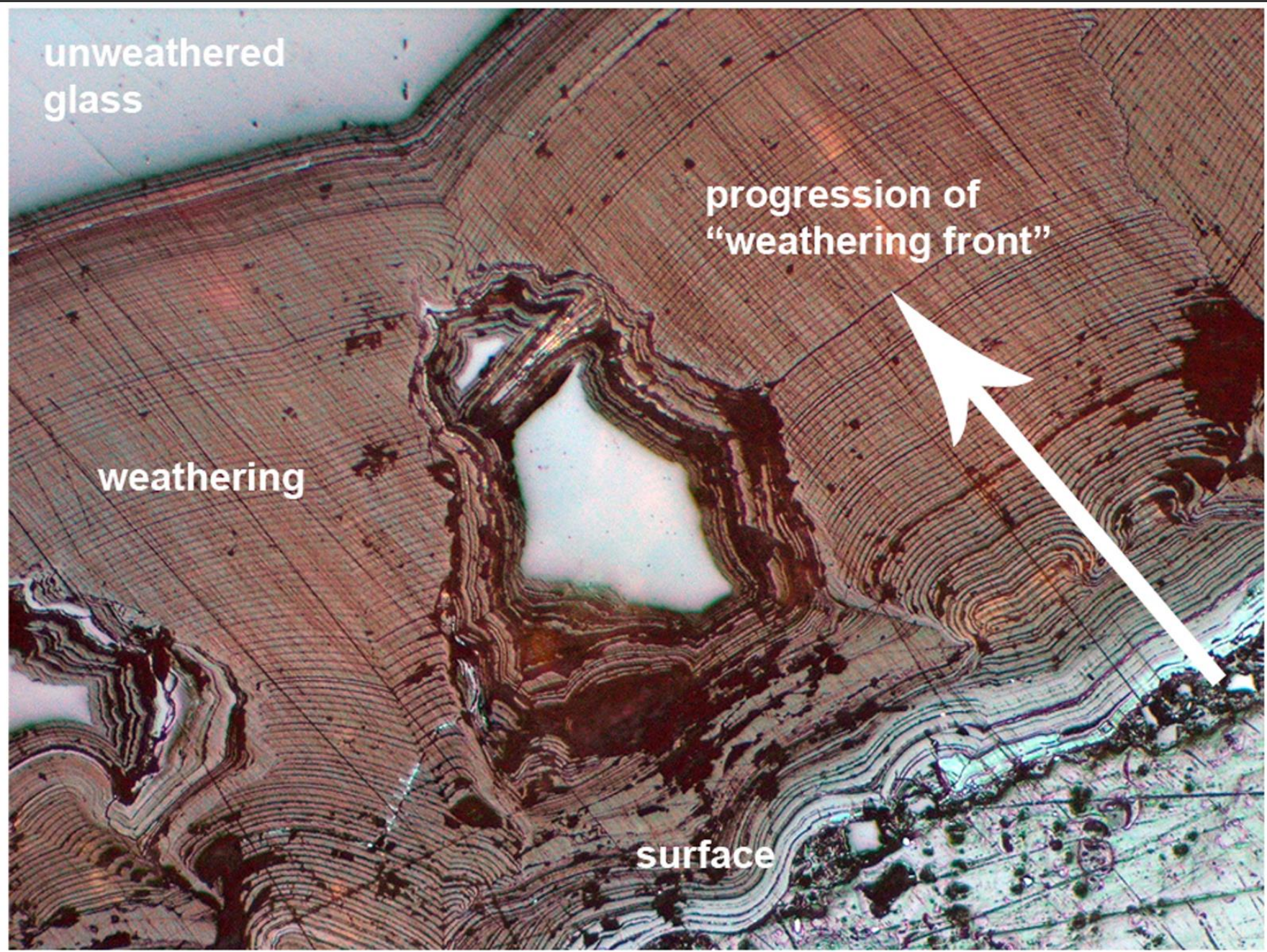
Mag = 282 X 100µm EHT = 5.00 kV Signal A = InLens Date :18 Jul 2008
WD = 7 mm Photo No. = 5239 Time :13:14:18

unweathered
glass

progression of
"weathering front"

weathering

surface



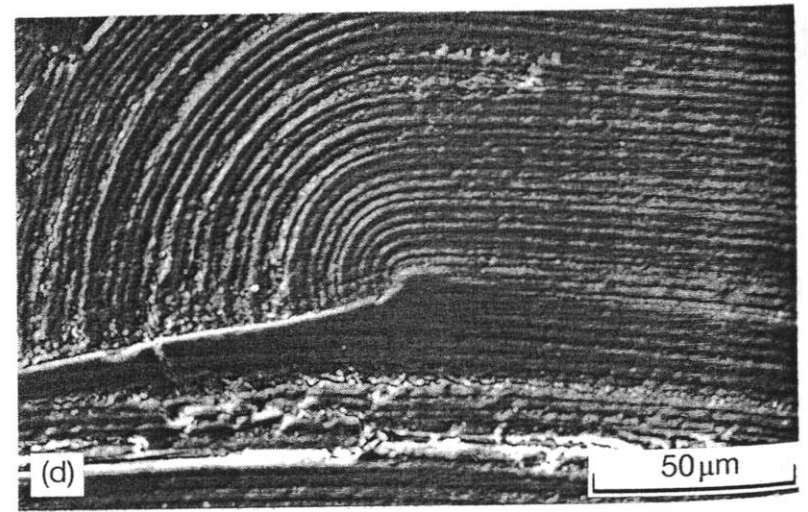
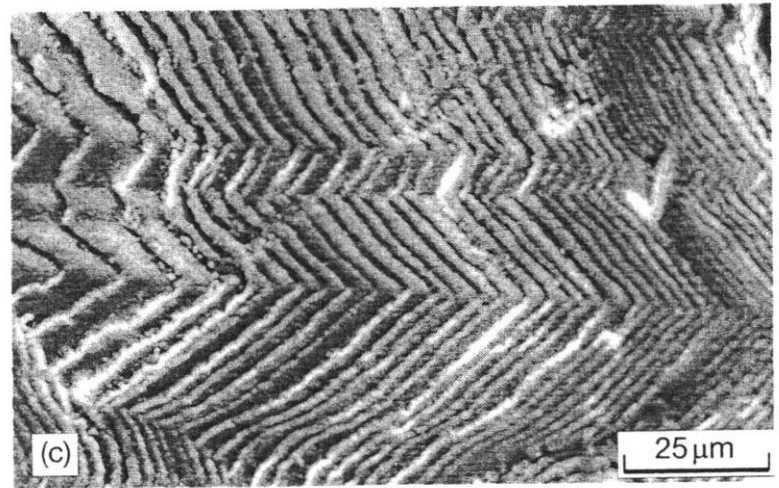


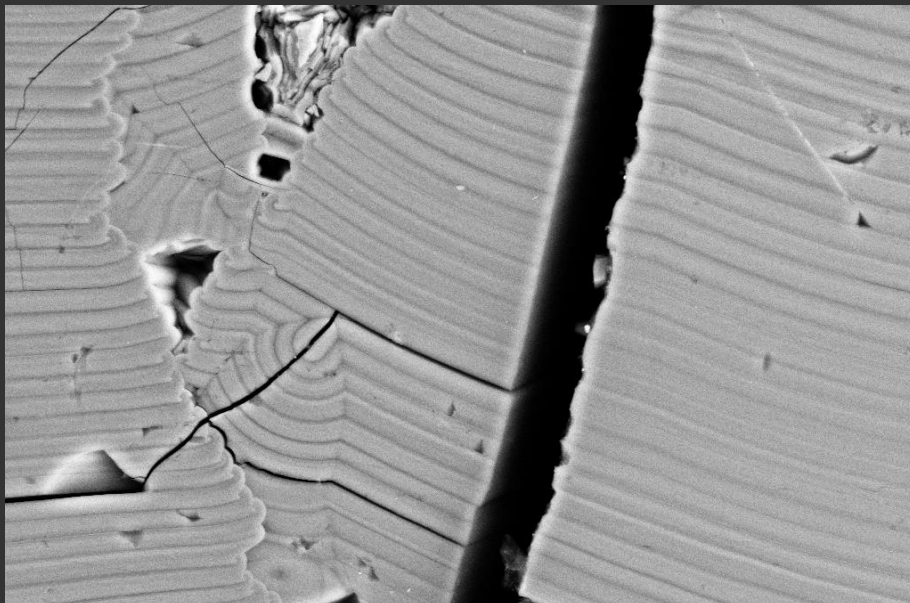
Some Intrinsic Properties

- Chemical Composition
- Surface Flaws (scratches)
- Heterogeneity (cord and ream)
- Seeds (bubbles)
- Thermal History (internal stress)

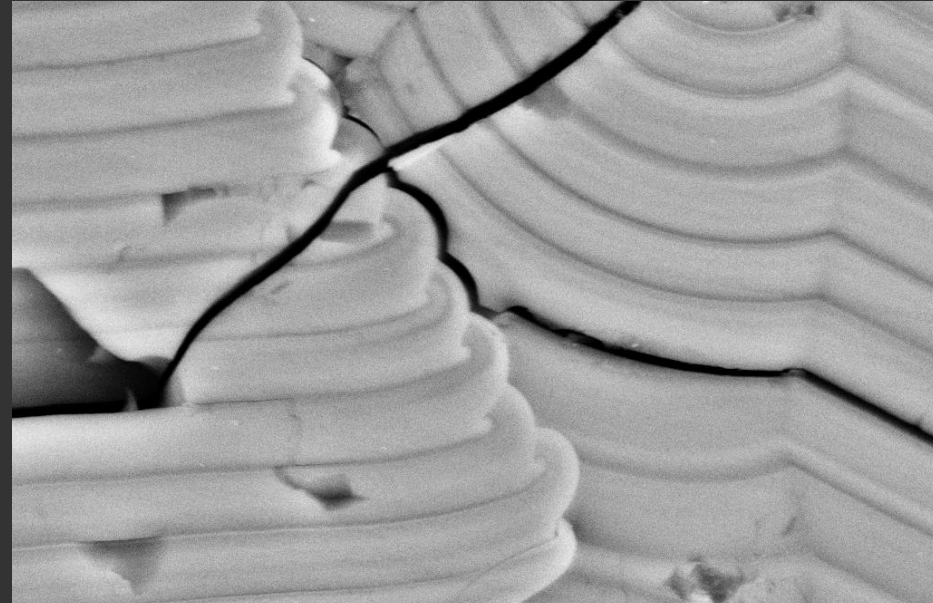
Some Environmental Factors

- Presence of moisture
- Time of exposure
- Soil chemistry, pH, etc.
- Temperature
- Microorganisms

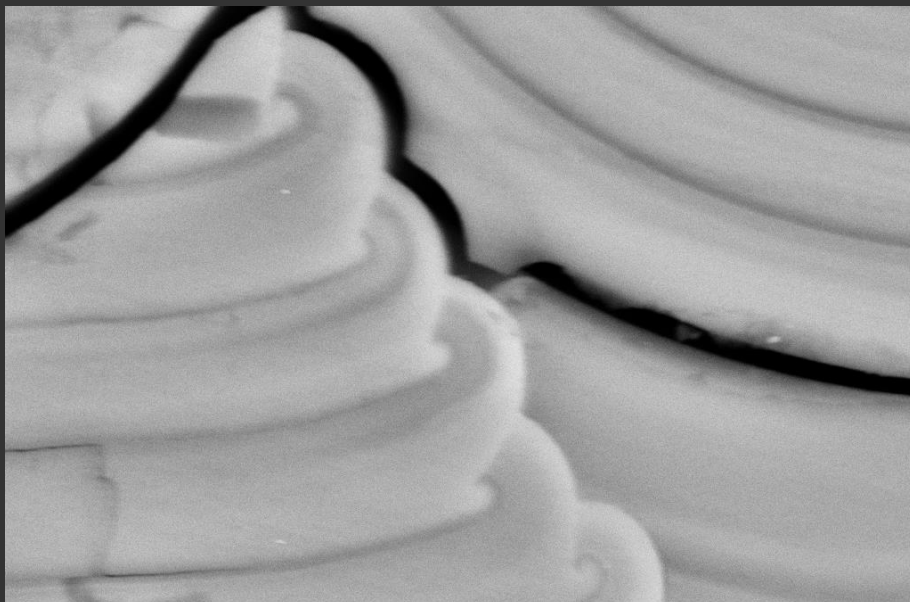




Mag = 600 X 20µm EHT = 25.00 kV Signal A = RBSD Date :8 Aug 2008
WD = 9 mm Photo No. = 5775 Time :8:45:19



Mag = 2.00 K X 20µm EHT = 25.00 kV Signal A = RBSD Date :8 Aug 2008
WD = 9 mm Photo No. = 5776 Time :8:46:43

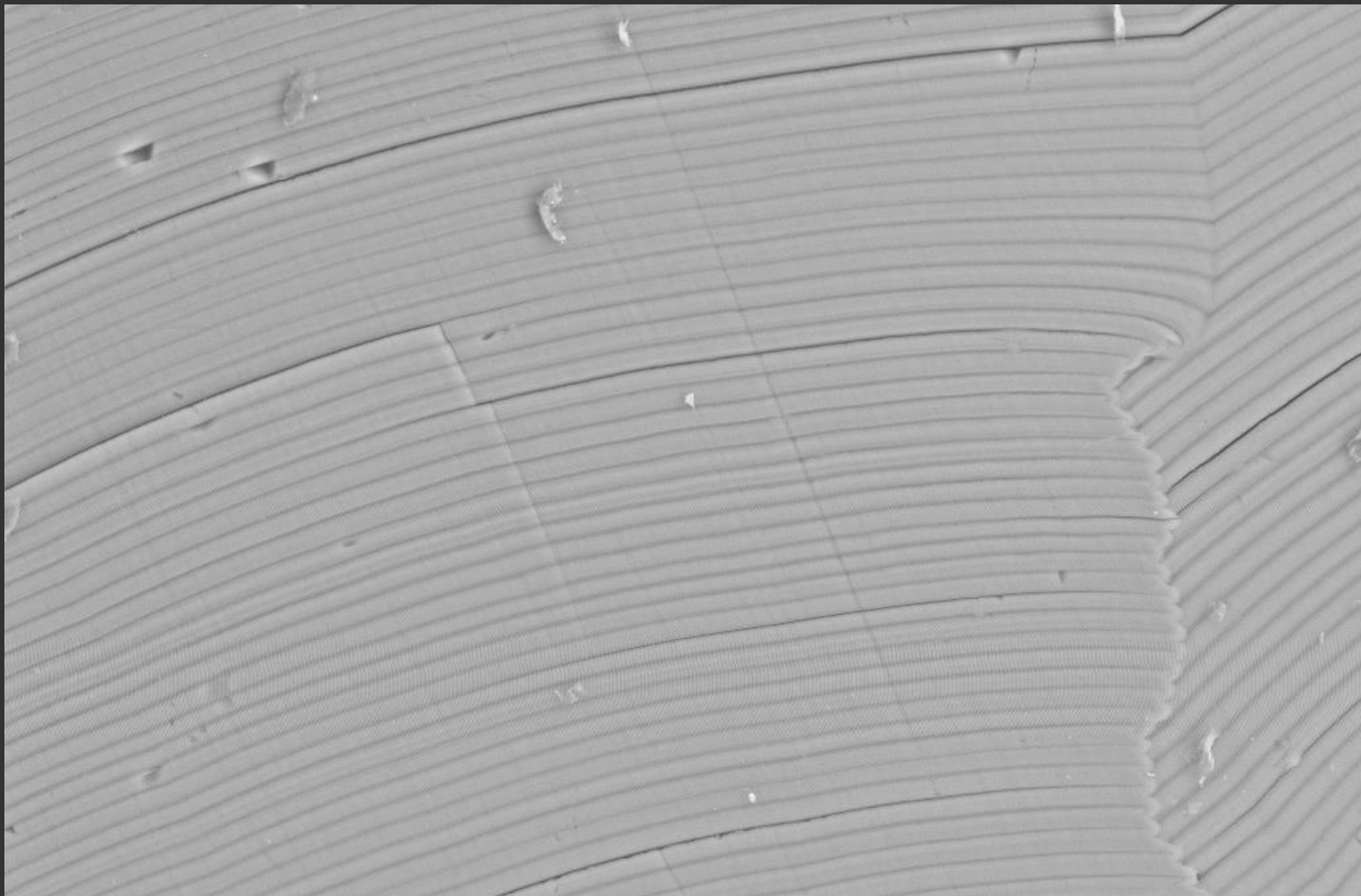


Mag = 4.00 K X 10µm EHT = 25.00 kV Signal A = RBSD Date :8 Aug 2008
WD = 9 mm Photo No. = 5777 Time :8:47:33

Layer Geometry?

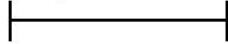
Intersections?

Fracture?



Mag = 505 X

100 μ m



EHT = 25.00 kV

WD = 8 mm

Signal A = RBSD

Photo No. = 5951

Date :1 Aug 2008

Time :8:41:36

