WEATHERED GREENSCHIST OF THE GREAT UNCONFORMITY OF SOUTH EAST NORTH DAKOTA

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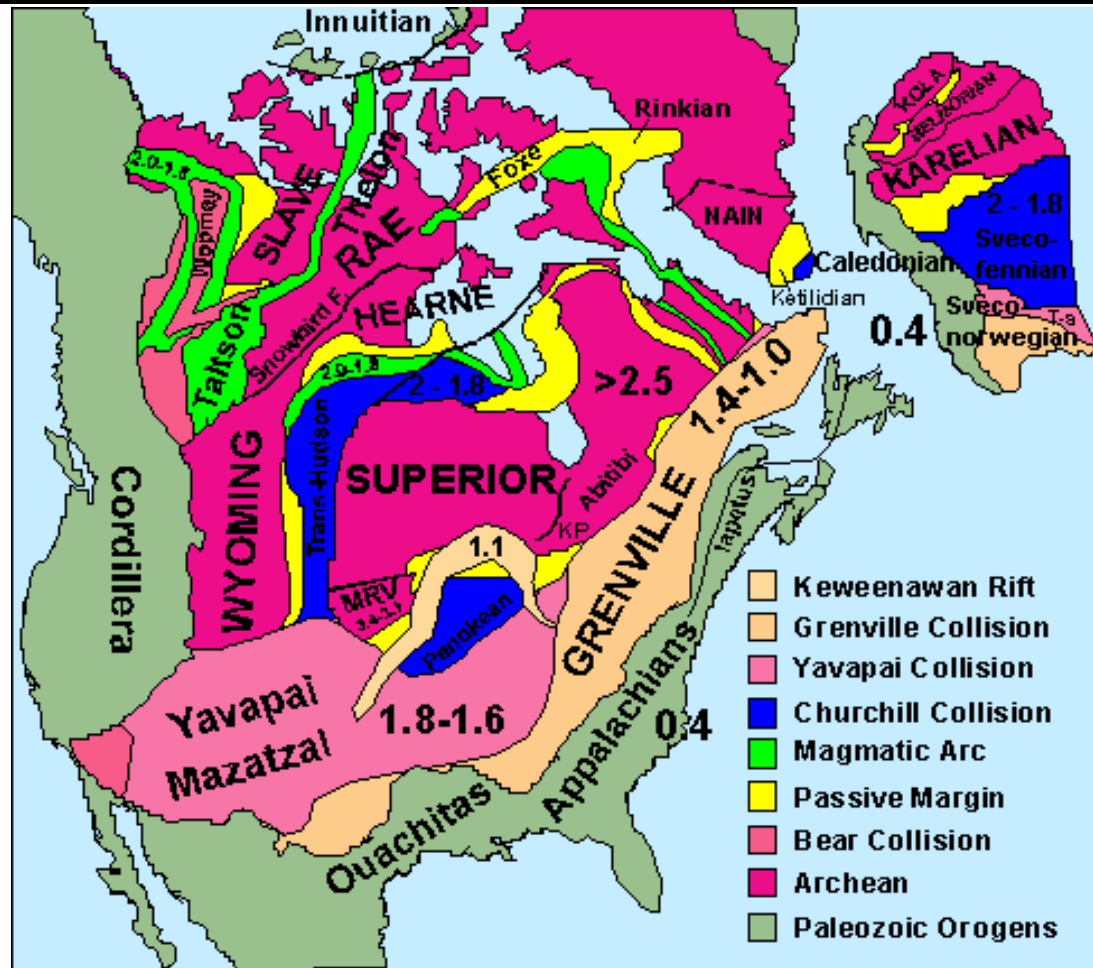
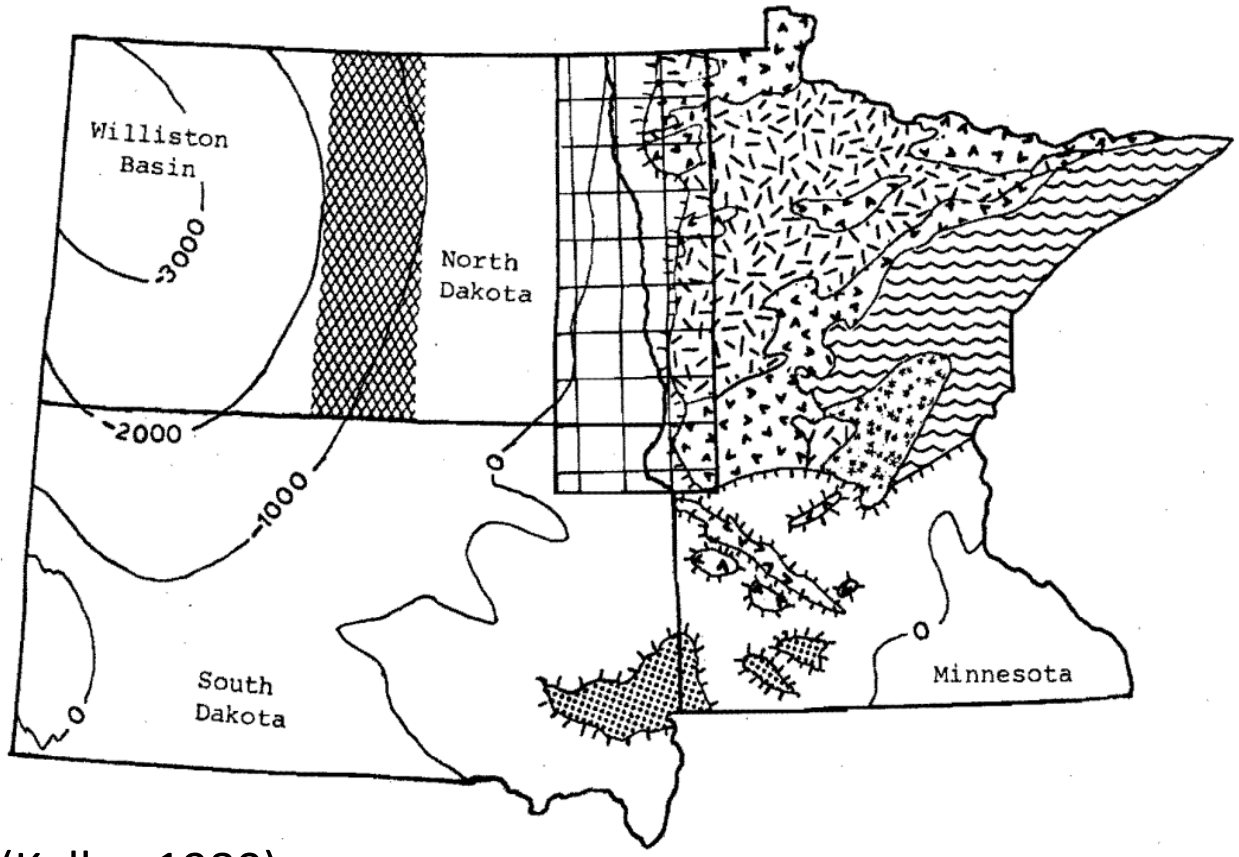
GEOLOGIC HISTORY

- Superior Province formed during Archean at 4000 ma - 2500 ma
  - Reaches west into middle of the Dakotas, and south into southern Minnesota
- Trans-Hudson orogeny at 2000 ma caused regional metamorphism in the west



RED RIVER VALLEY DRILLING PROJECT

- Red River Valley Drilling Project conducted in Eastern North Dakota, Western Minnesota, and Northeastern South Dakota
- Sample #1 found in Southeastern North Dakota in Sargent County
- 31 samples were taken overall.



(Kelley 1980)

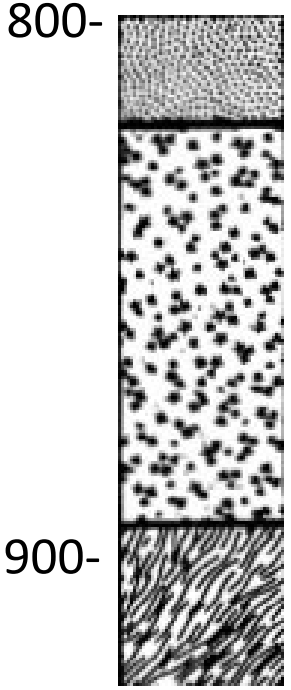
KELLEY MASTER'S THESIS 1980

- Based on 26 drill cores done at the time as part of the Red River Valley Drilling Project
- Precambrian rocks are interpreted as an extension of the Canadian Shield
- Precambrian generally overlain by Cretaceous rocks
- Extension of Canadian shield made primarily of granite and schist
- Weathering took place under humid subtropical conditions.

DRILL CORE #1

Tops	Depth
Base Pleistocene	228'
Cretaceous Shale	228'
Greenhorn Formation	418'
Belle Fourche Formation	448'
Basal Cretaceous clastics	710'
Weathered Precambrian	820'
Un-weathered Precambrian	893'

(Kelley 1980)



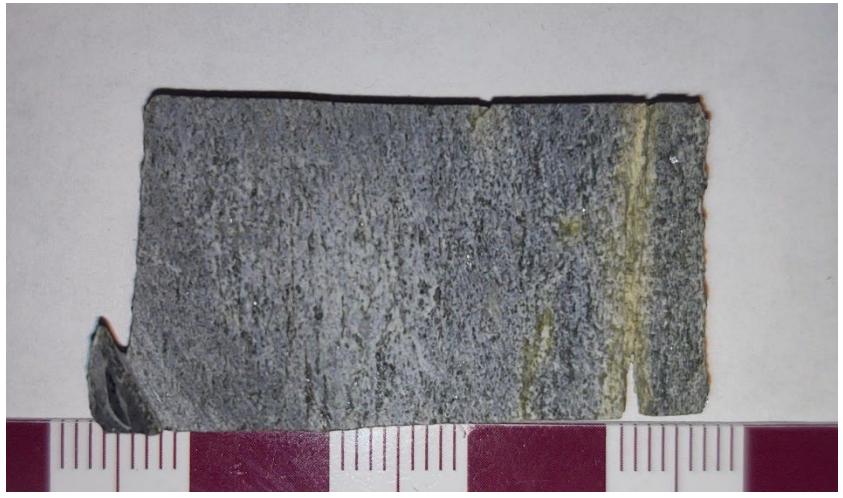
820-893: Light gray to pale blue, clay near top, progressively turns to a sandy mix

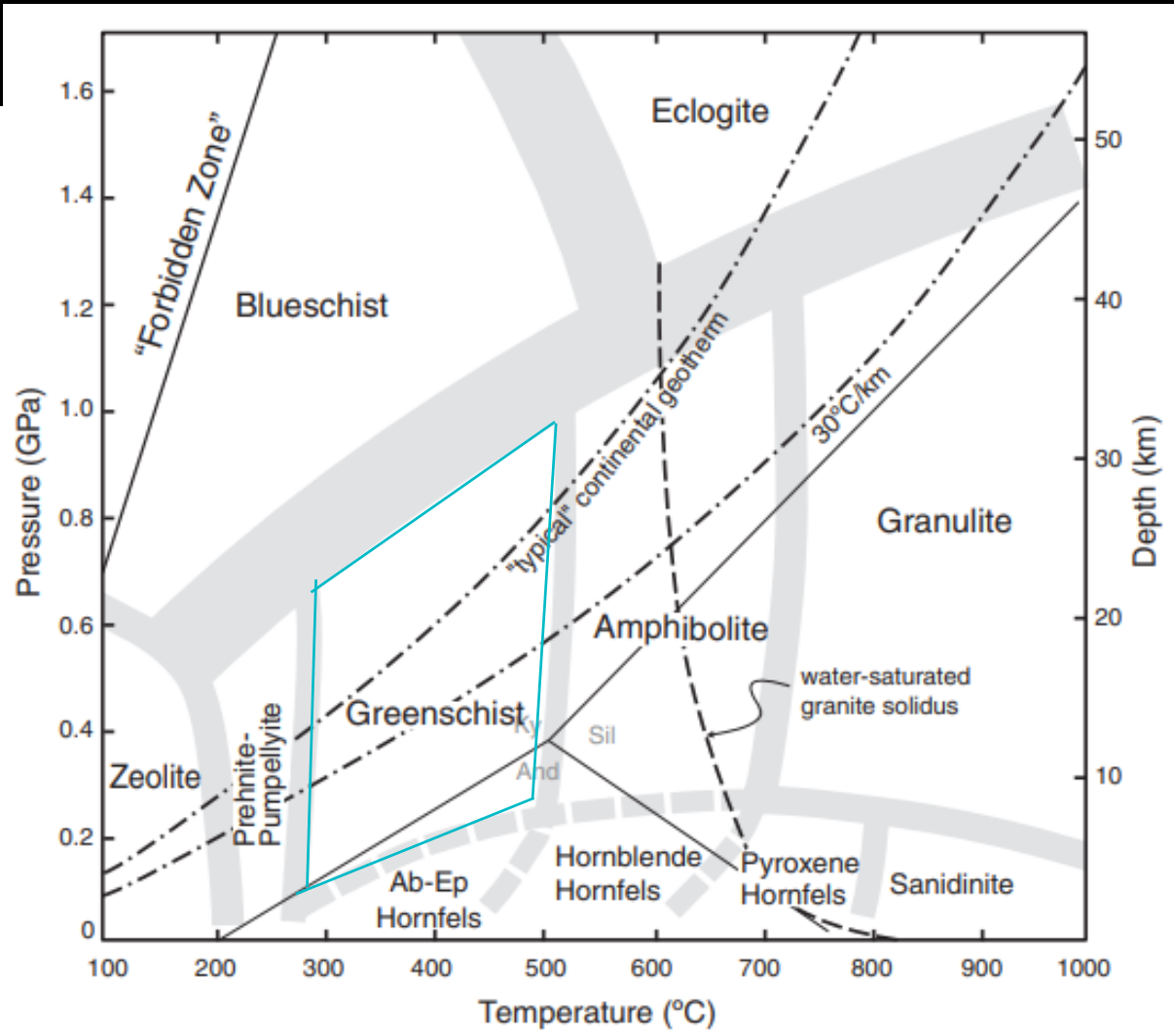
893-924: Greenish black, vertical schistosity, chlorite schist

(Moore 1978)

GREENSCHIST: AN OVERVIEW

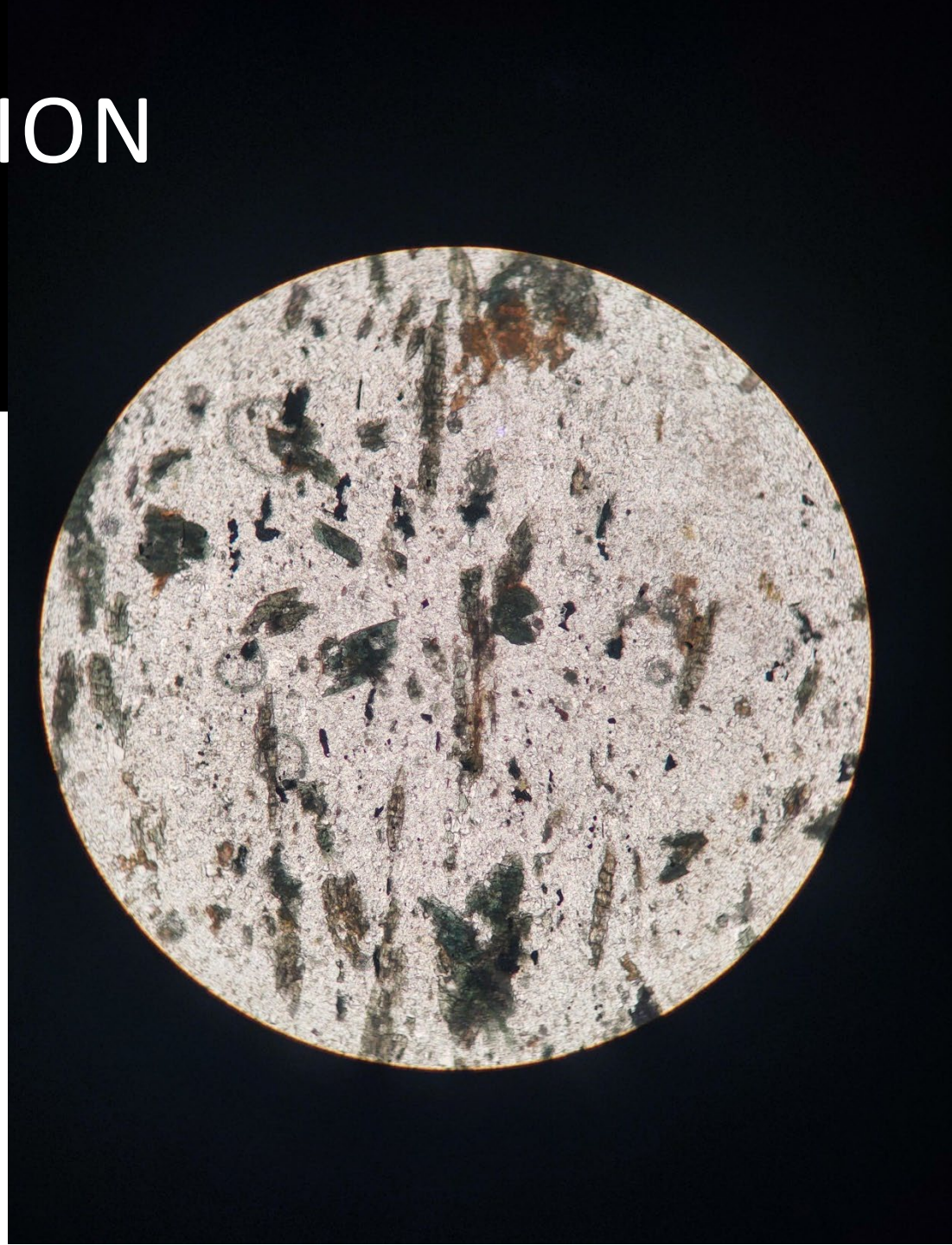
- Metamorphic Rock
- Low temperature and low pressure
- Well Foliated
- Minerals are quartz, chlorite, actinolite, and little amounts of biotite





PETROGRAPHIC DESCRIPTION OF SAMPLE RRVD 1-920

- FOV: 5mm PPL
- Quartz
- Chlorite
- Actinolite
- Small amount of biotite

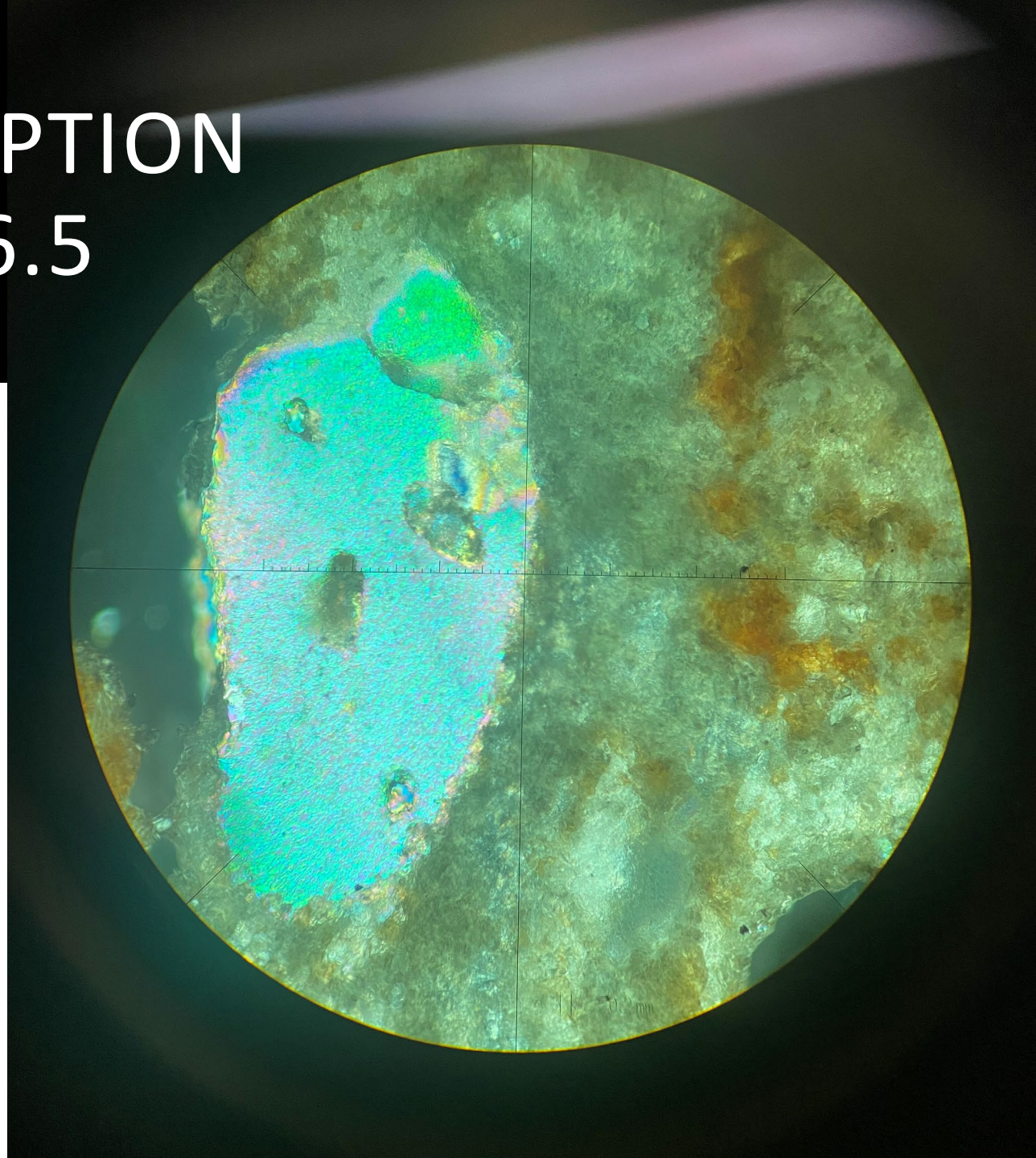


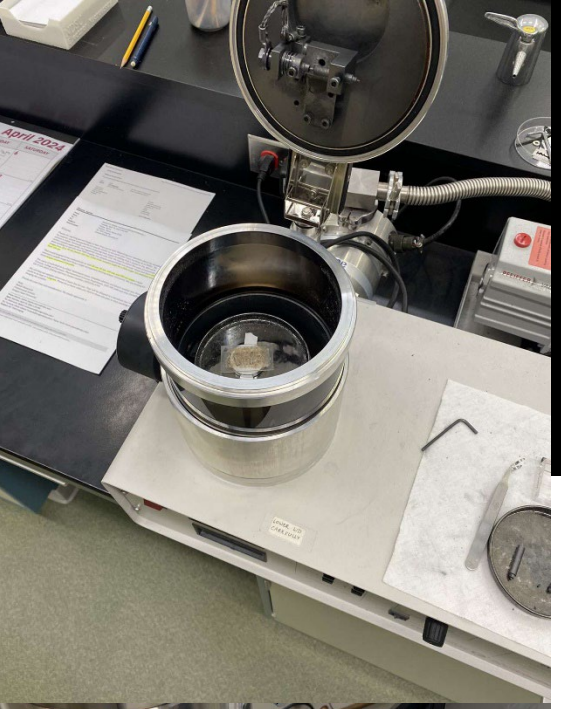
WEATHERING OF SAMPLE #1

1. Greenschist was created and deposited
2. Underground for a period of time
3. Unearthed and subjected to weathering
4. Reburied

PETROGRAPHIC DESCRIPTION OF SAMPLE RRVD 1-846.5

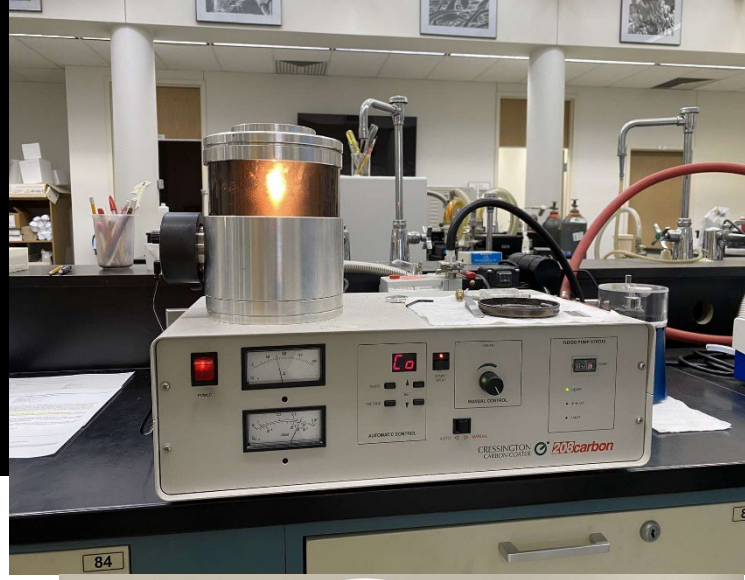
- FOV: 5mm XPL
- Clays
- Mica
- Quartz

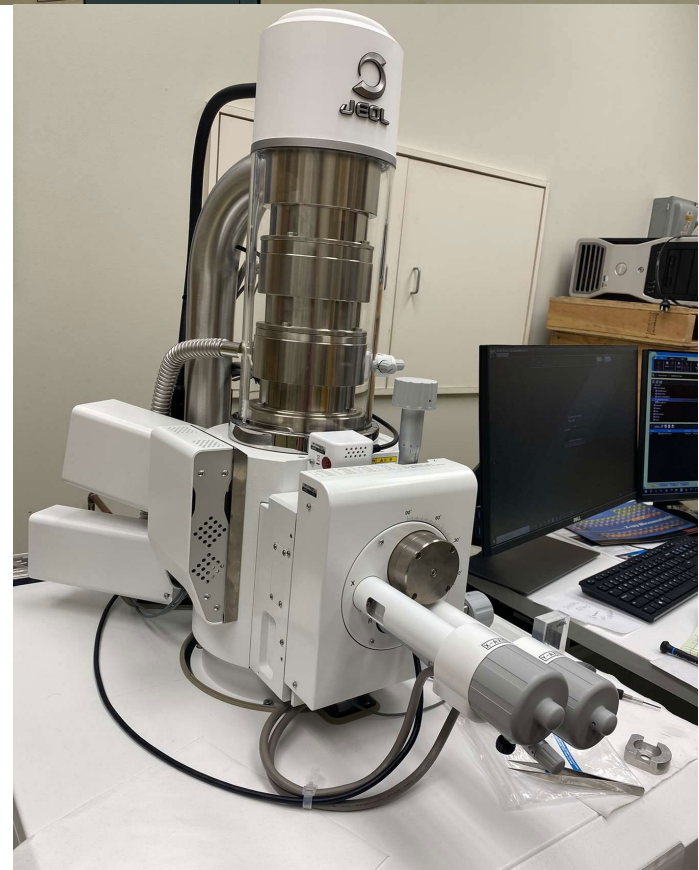




SEM-EDS Methodology

1. Coated the slide with a carbon film
2. Attached the slide to a metal clip
3. Put the clip into the SEM to start data collection
4. Used the computer to move slide and find locations for sampling



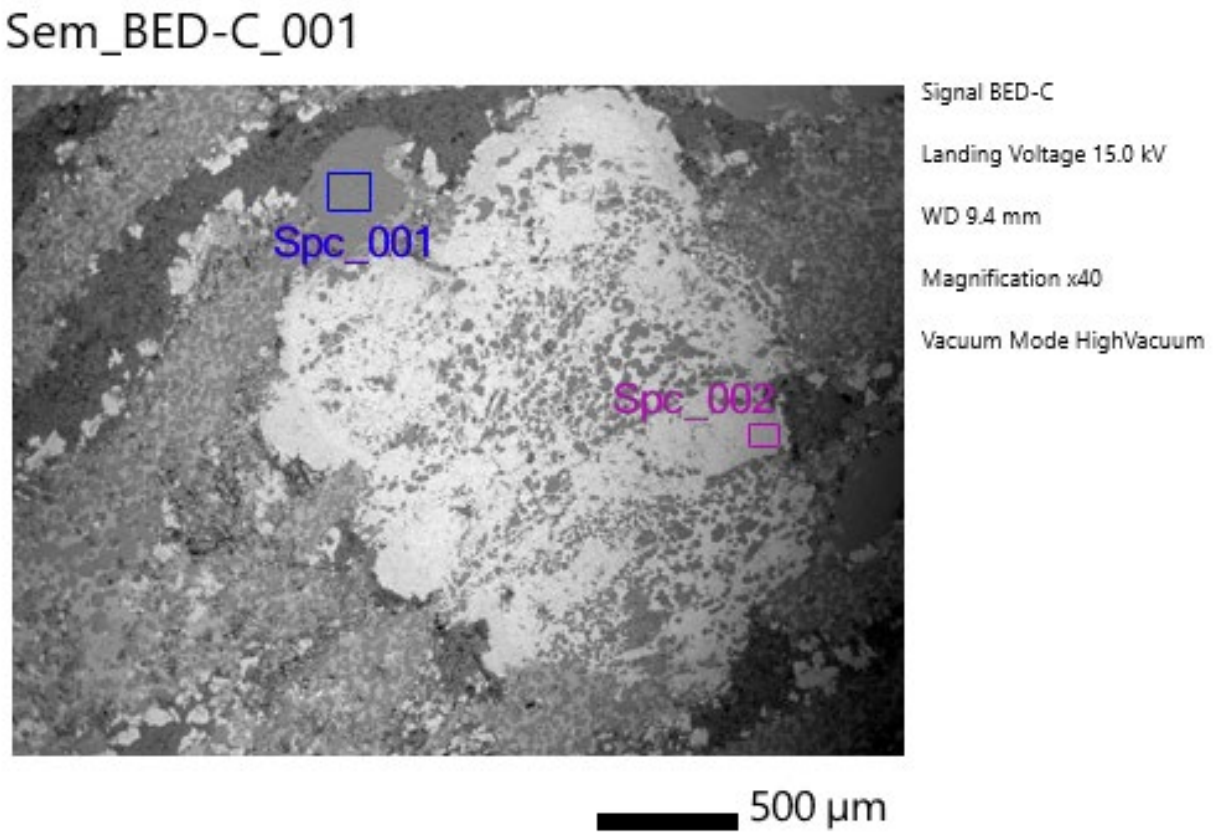


SEM LOCATIONS

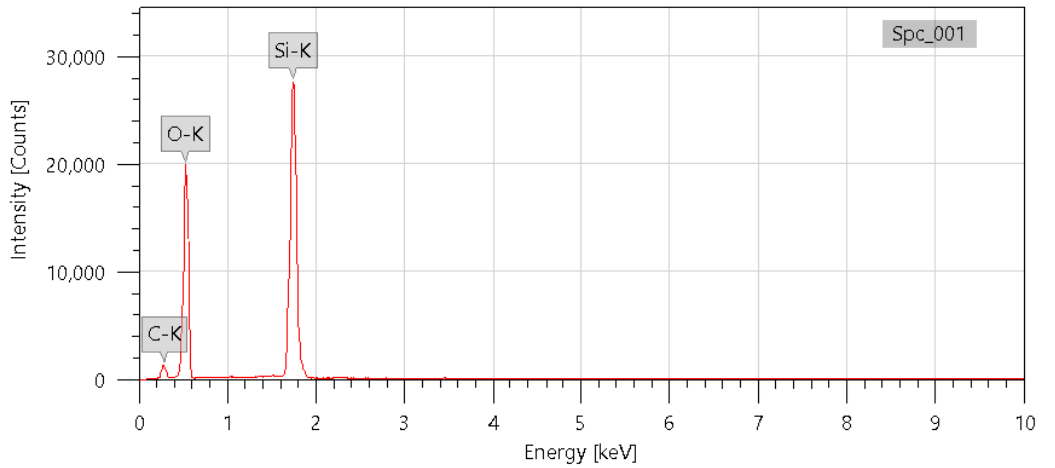
- 4 inclusions were analyzed with SEM.
- Siderite was suspected inside inclusions.
- Quartz and clay was suspected in the rest of the slide.

SEM DATA

- SEM taken inside and outside inclusions
- Change in coloration seen
- Multiple SEM locations sampled



Point Counts
Position #1



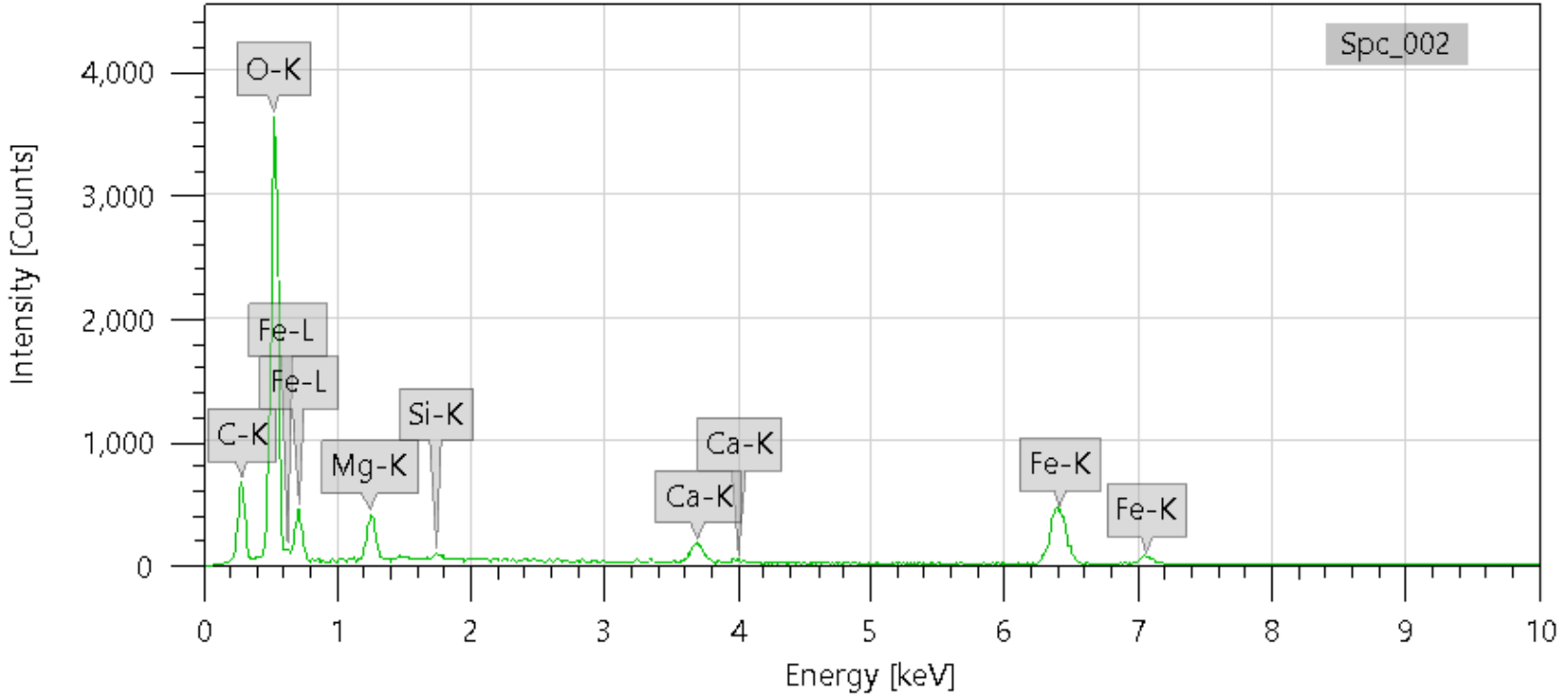
Items	Value
measurement conditions	
Acceleration voltage	15.00 kV
Probe current	-
Magnification	x 40
Process time	T4
Measurement detector	First
Live time	30.00 seconds
Real time	37.81 seconds
Dead time	20.00
Count rate	14869.00 CPS

Display name	Standard data	Quantification method	Result Type
Spc_001	Standardless	ZAF	Metal

Element	Line	Mass%	Atom%
C	K	12.61±0.08	19.00±0.12
O	K	50.71±0.14	57.37±0.16
Si	K	36.67±0.11	23.63±0.07
Total		100.00	100.00
Spc_001			Fitting ratio 0.0046

Point Counts Position 2

- Siderite: FeCO3
- Suspected Siderite was in inclusions



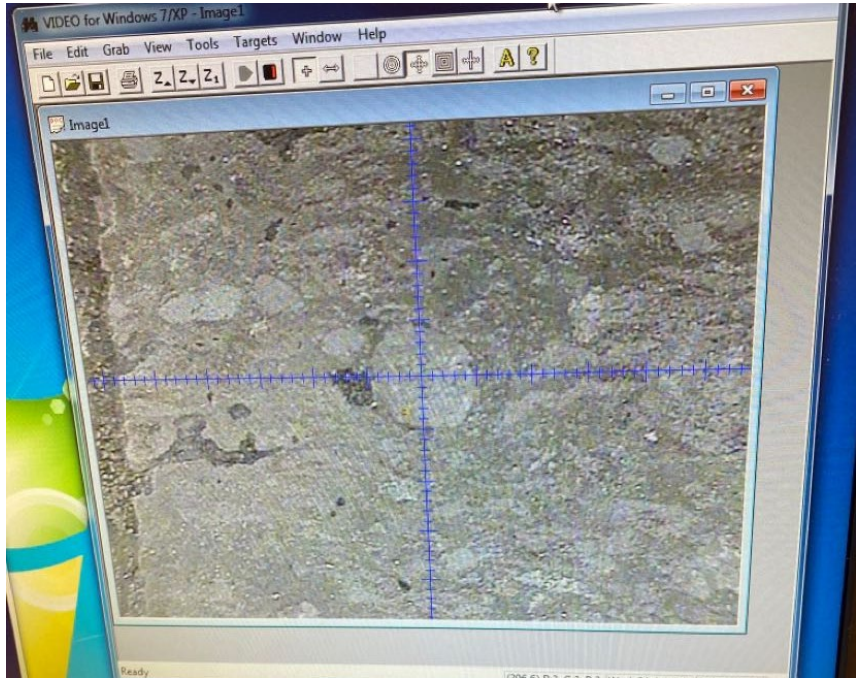
Items	Value
measurement conditions	
Acceleration voltage	15.00 kV
Probe current	-
Magnification	x 40
Process time	T4
Measurement detector	First
Live time	30.00 seconds
Real time	31.35 seconds
Dead time	5.00
Count rate	2304.00 CPS

Display name	Standard data	Quantification method	Result Type
Spc_002	Standardless	ZAF	Metal

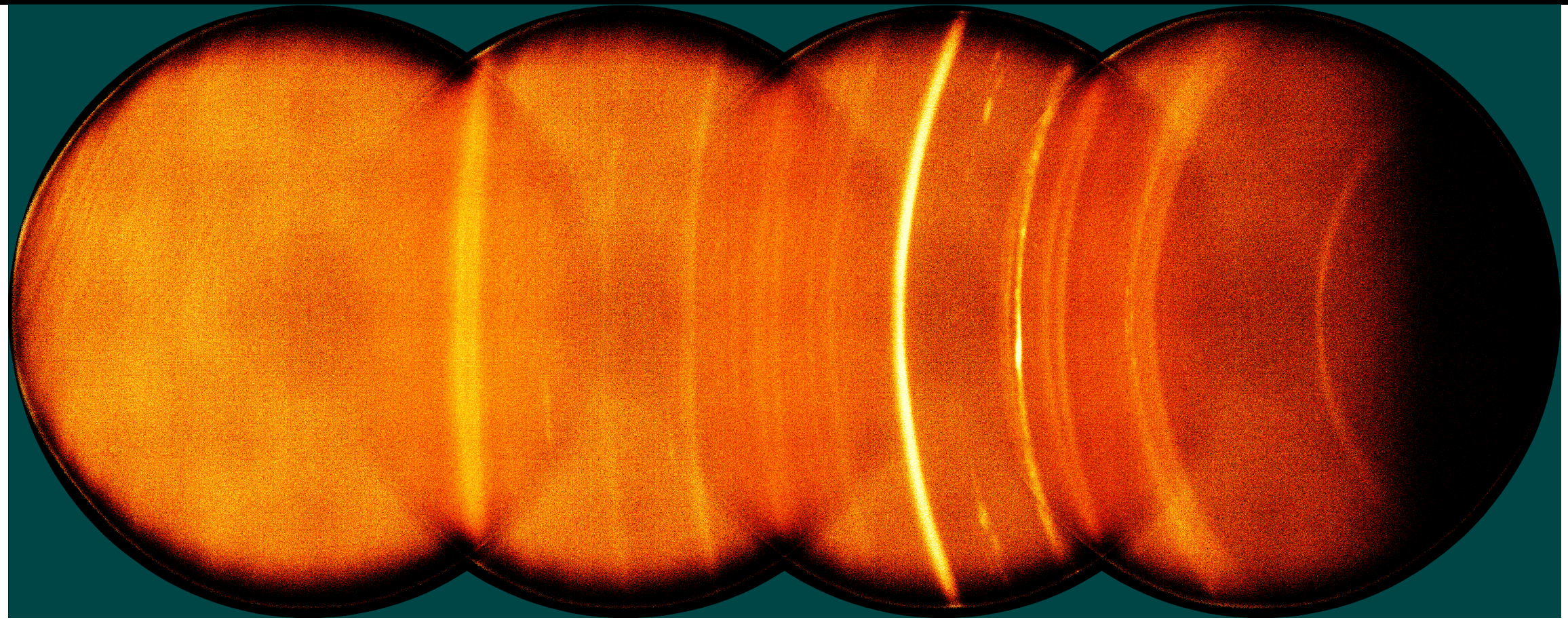
Element	Line	Mass%	Atom%
C	K	14.88±0.13	25.01±0.23
O	K	46.37±0.31	58.51±0.39
Mg	K	3.94±0.11	3.27±0.09
Si	K	0.43±0.04	0.31±0.03
Ca	K	3.33±0.11	1.68±0.06
Fe	K	31.05±0.50	11.22±0.18
Total		100.00	100.00
Spc_002			Fitting ratio 0.0177

XRD METHODOLOGY

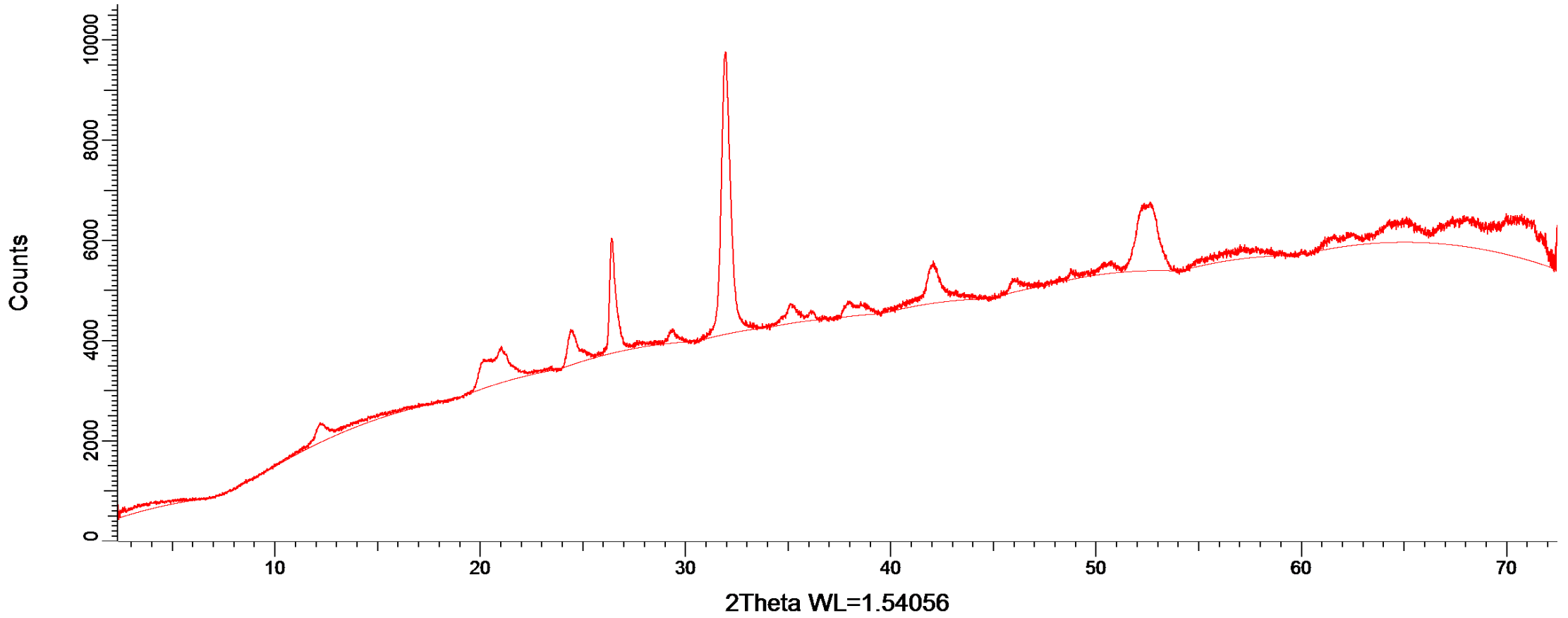
1. Attached tape to thin section slide
2. Put thin section on horizontal stand in the XRD machine
3. Aimed laser at specific point on slide
4. Laser is rotated while it collects data



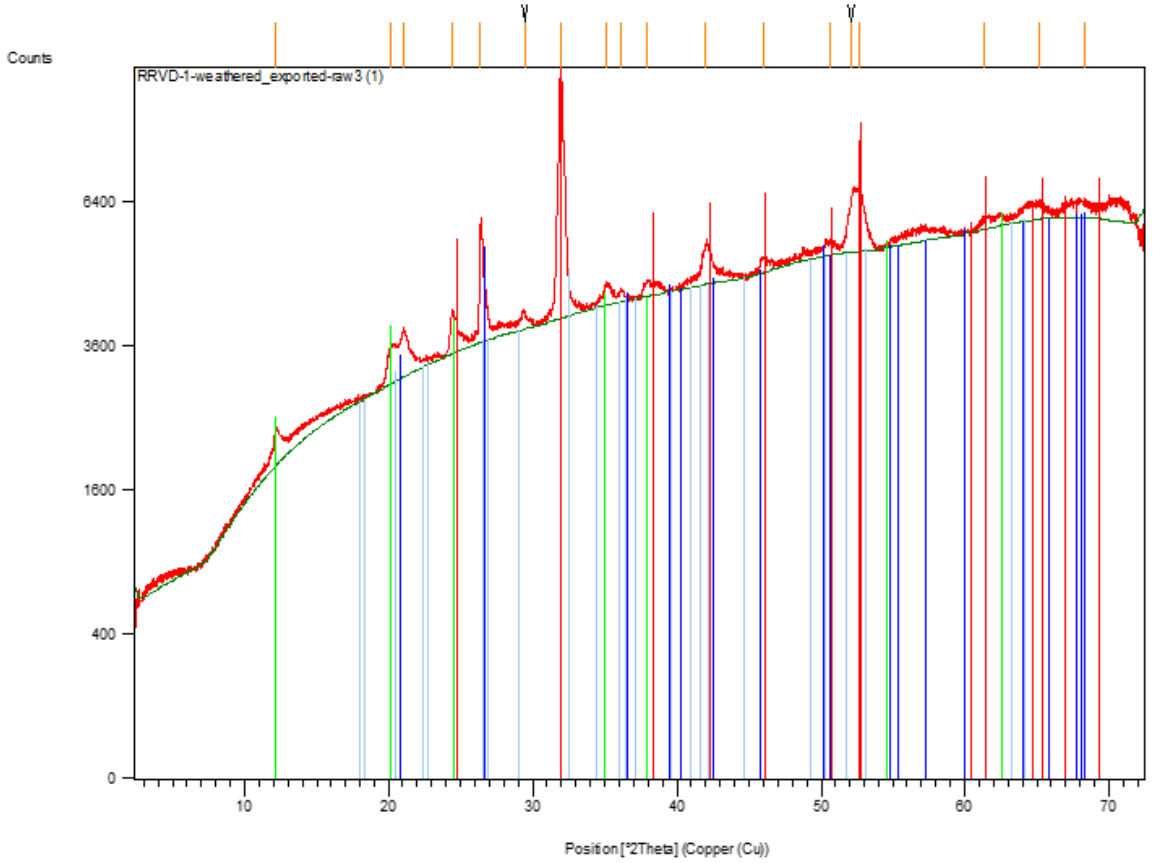
RRVD 1-846.5 FRAMES FROM XRD



POINT COUNTS FROM XRD



XRD POINT COUNTS X'PERT HIGH SCORE ON RRVD 1-846.5



Pattern List: (Bookmark 4)

Visible	Ref. Code	Score	Compound Name	Displacement [°2Th.]	Scale Factor	Chemical Formula
*	00-029-0696	33	Siderite	0.000	0.867	Fe C O3
*	00-033-1161	22	silica	0.000	0.182	Si O2
*	00-029-1487	44	metahalloysite	0.000	0.101	Al2 Si2 O5 (O H)4

XRF METHODOLOGY

1. Crushed samples down to a small size
2. Used Powderizer to crush samples even further
3. Mixed powder with polyvinyl alcohol to bind the powder
4. Mixture was put into the press
5. Pellet was taken out of the press and put into oven
6. Dried pellet used in XRF analysis

XRF DATA

- RRVD 1-920
  - High SiO_2 weight percent
  - Lower percentages of other minerals
- RRVD 1-846.5
  - Lowered SiO_2 percent
  - Higher Al_2O_3 and Fe_2O_3 percents

	RRVD 1-920 %	RRVD 1-846.5 %
SiO_2	68.6	47.2
Al_2O_3	14.6	32.8
Na_2O	5.13	0
CaO	5.03	0.947
Fe_2O_3	3.19	14.4
MgO	1.46	0.795
TiO_2	1.05	1.91
K_2O	0.366	1.23
P_2O_5	0.235	0.139
MnO	0.117	0.225

ACKNOWLEDGMENTS

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