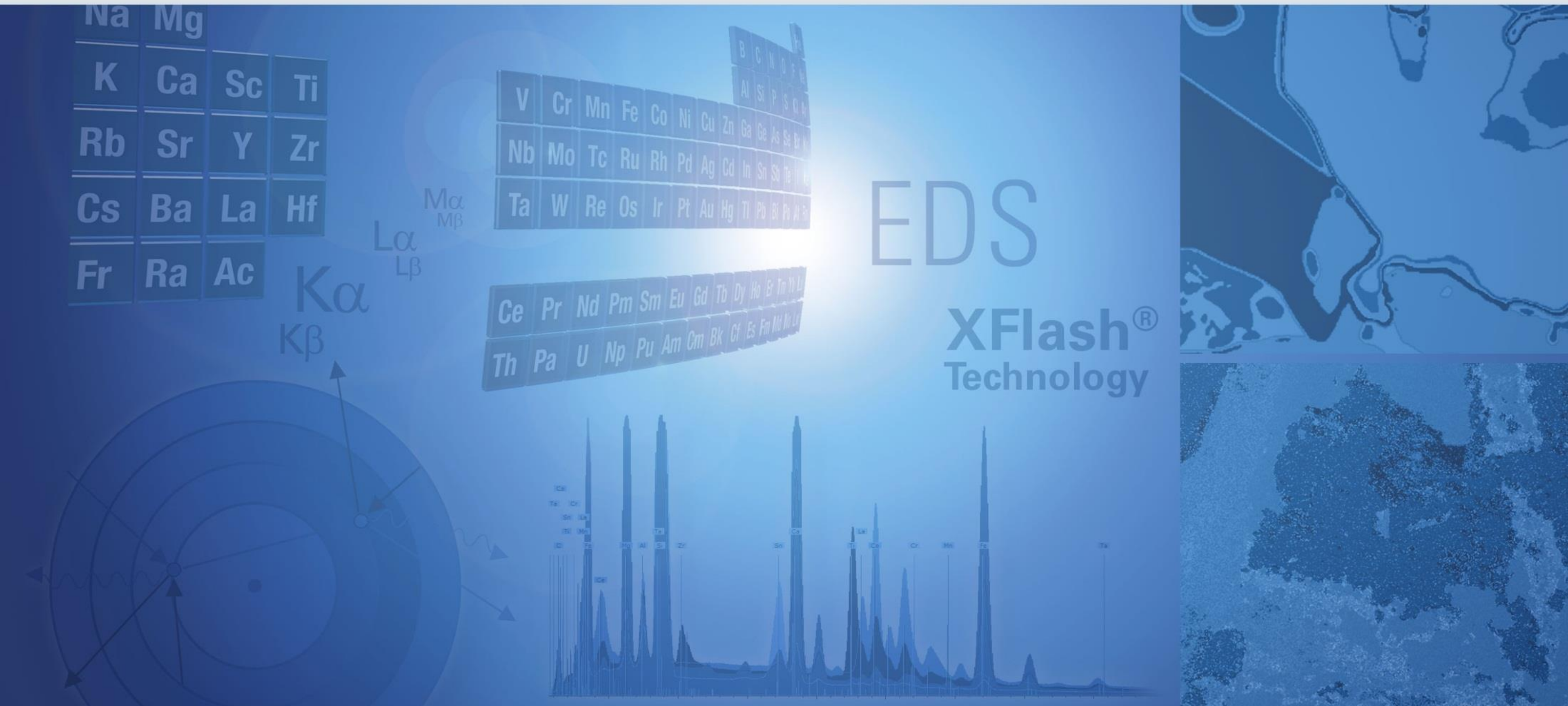
Fast, Accurate and Precise Quantification Results Using An Annular Silicon Drift Detector: Bruker's XFlash FlatQUAD

Bruker Nano Analytics, Berlin, Germany
Webinar, May, 2020



Presenters

Max Patzschke

Application Scientist EDS
Bruker Nano Analytics, Berlin, Germany

Andrew Menzies, PhD

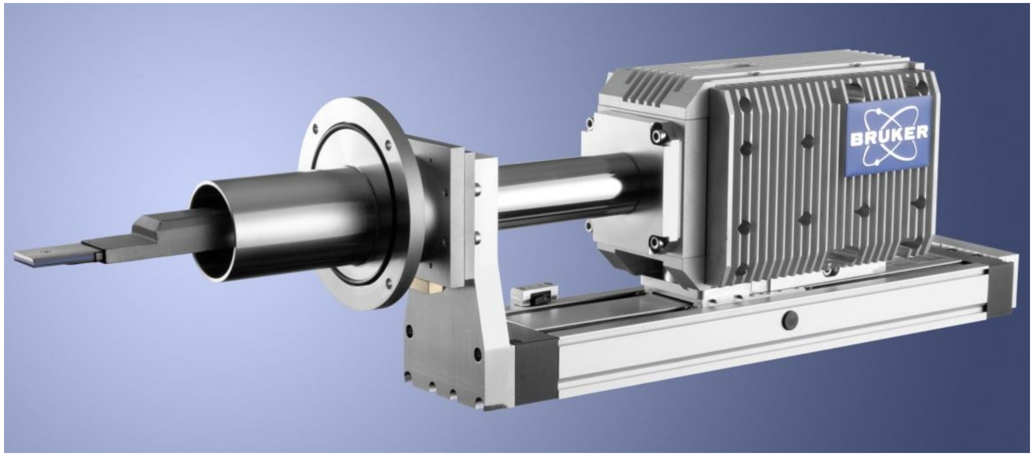
Sr. Applications Scientist Geology and Mining,
Bruker Nano Analytics, Berlin, Germany

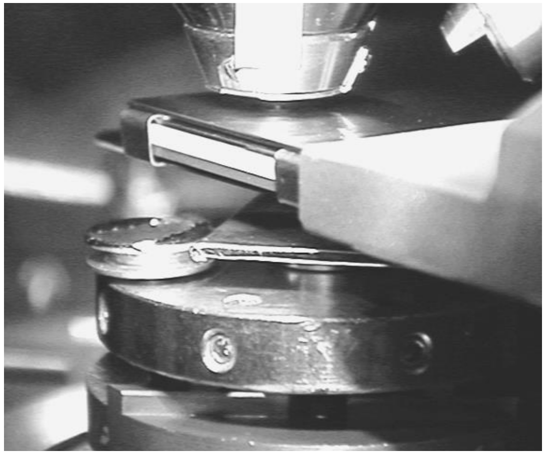
Overview

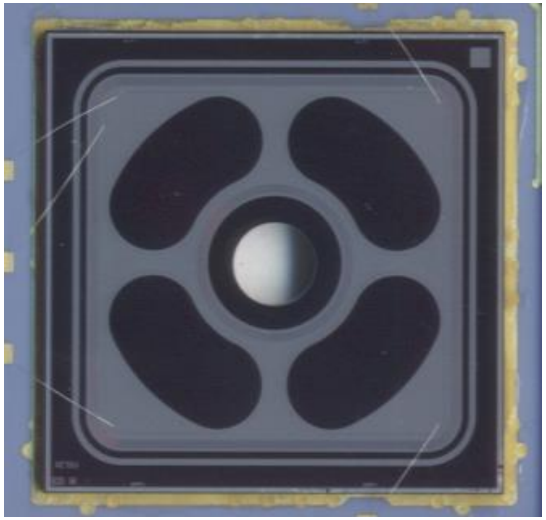
- Introduction
- Microanalysis and the FlatQUAD: Technical Introduction
- Analytical Considerations
- Examples: Quantification
- Examples: Mapping and Mineralogy
- Summary and Conclusions

Bruker SEM Analyzers
Our “evolving eyes”

Facts for the XFlash® FlatQUAD

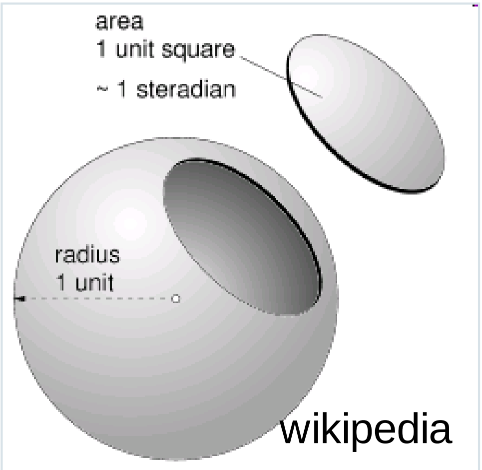




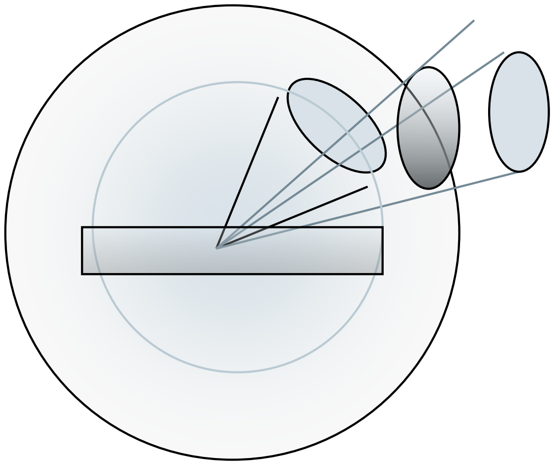


- Annular design, 4x15 mm²= 60 mm²
- Placed between pole piece and sample (hole in the center for the primary beam)
- Energy resolution Mn Kα ≤ 129 eV
- Combination of high count rate capability and high solid angle (Ω ~ 1.1 sr)

Collection Efficiency:
Solid Angle for X-ray collection



$$\Omega = \frac{A}{d^2}$$



Achieve higher solid angle by:
- Chip <u>area A</u> but,
smaller areas have advantages:
less cooling, less weight > higher stability, less pile up, better TOA > better P/B, better energy resolution, higher OCR/ICR = higher efficiency
- <u>Distance d</u>: get as close as possible

$\Omega_{\text{EDS-SEM}} \sim 0.01 – 0.1$ sr
are typical for side entry

$\Omega_{\text{EDS-S/TEM}} \sim 0.1 – 0.4$ sr
are typical for side entry

Some 100 mm^2 in STEM ~ 0.5 sr

XFlash® FlatQUAD:
Advantage of large solid angle

- Guaranteed energy resolution Mn-Ka 129 eV (other resolutions on request)
- 4 x 15 mm² = 60 mm²
- Annular design
- Central aperture for the primary beam
- Designed to be placed between pole piece and sample
- Segments very close to sample
- 4 x 600.000 cps = 2.400.000 cps

combination of

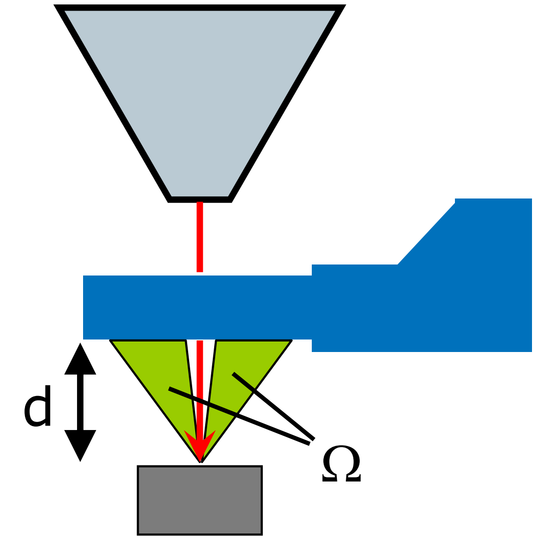
high count rate capability

large solid angle + high TOA

max solid angle at

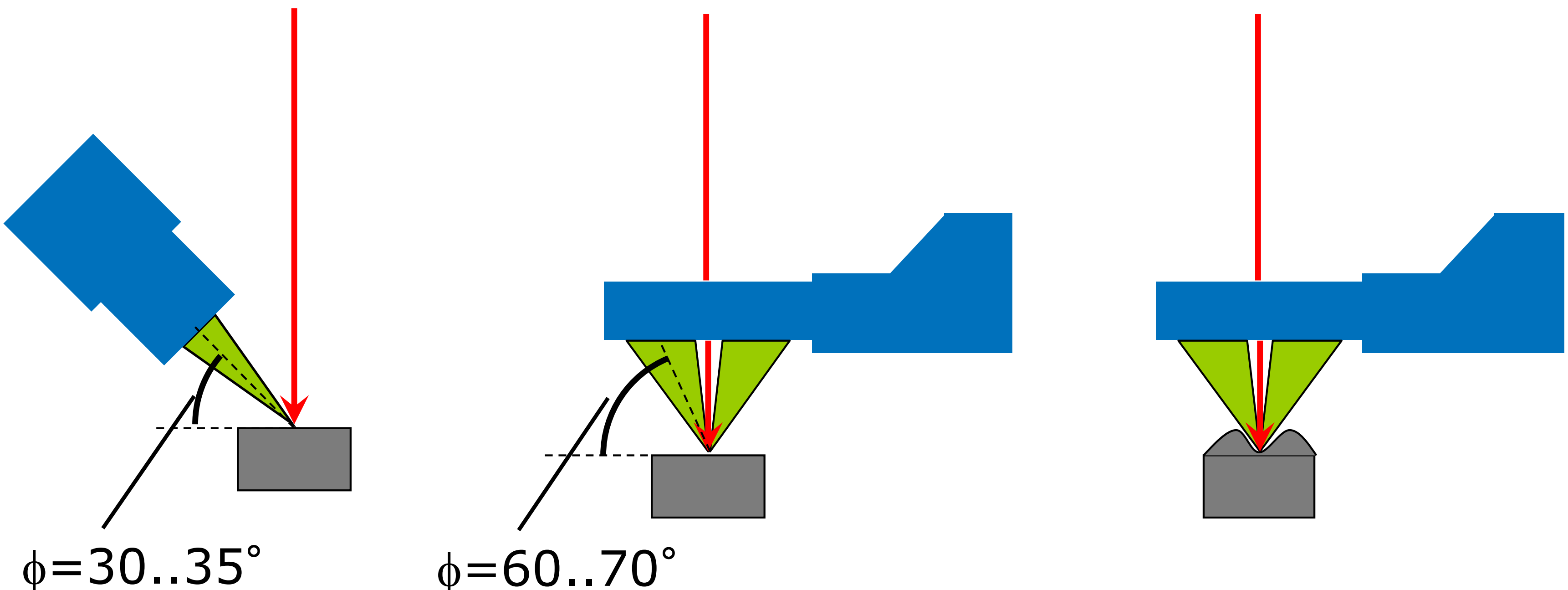
d = 2.5 mm:

Ω > 1.1 sr



XFlash® FlatQUAD:
Advantage of high take-off angle and annular design

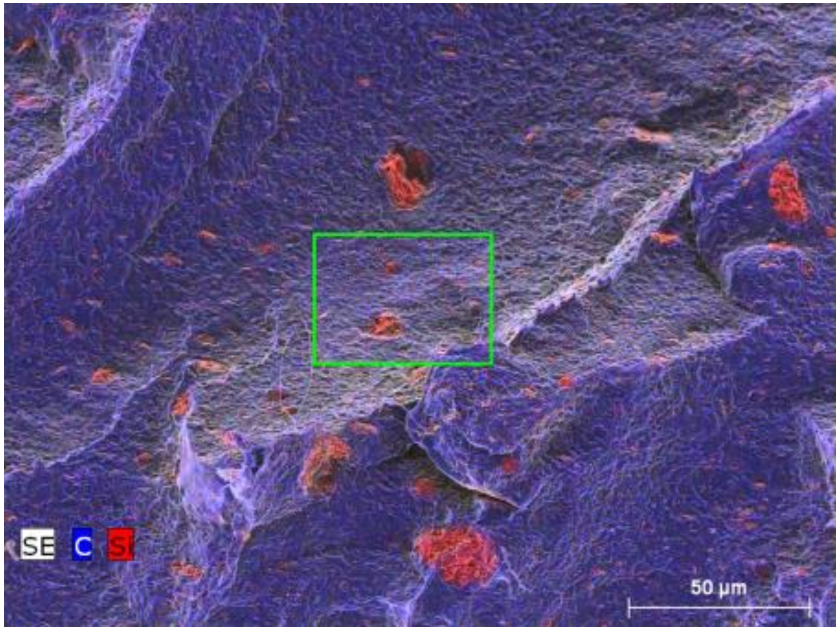
Take-off angle comparison: XFlash® FQ vs. conventional SDDs:



Note change in topography of sample

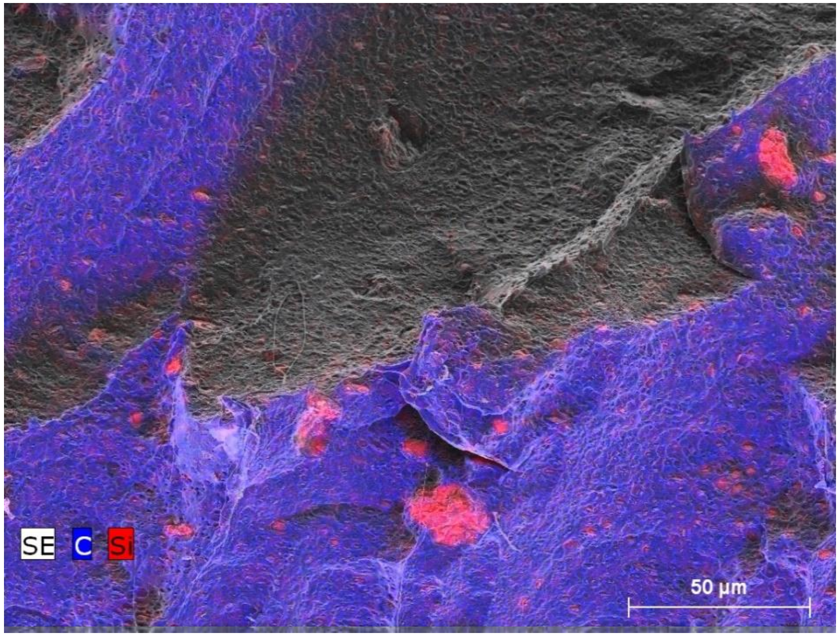
Polymer compound
XFlash® FlatQUAD vs. 30 mm² SDD

- Polymer composite containing organic clays



XFlash® FlatQUAD

- 3 kV, 220 pA, **10 kcps**
- >12 times higher count rate
- No shadow effects

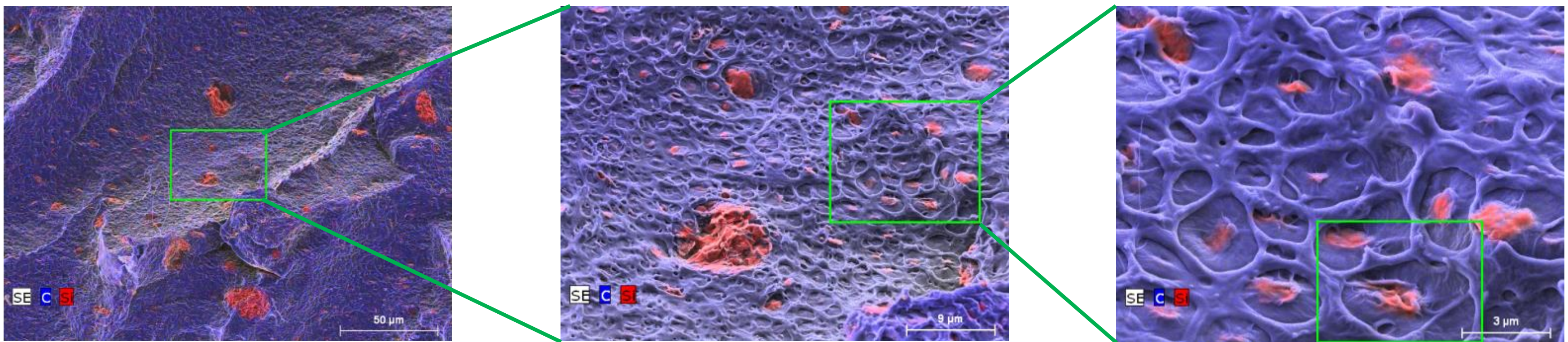


XFlash® 30 mm²

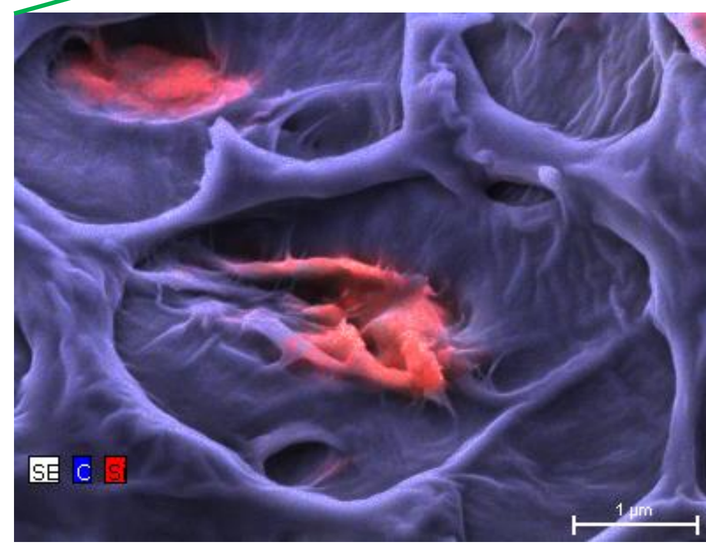
- 3 kV, 220 pA, **0.8 kcps**
- Shadow effects due to rough surface

Specimen Courtesy: Dalto et al., Universidade Federal do Rio de Janeiro

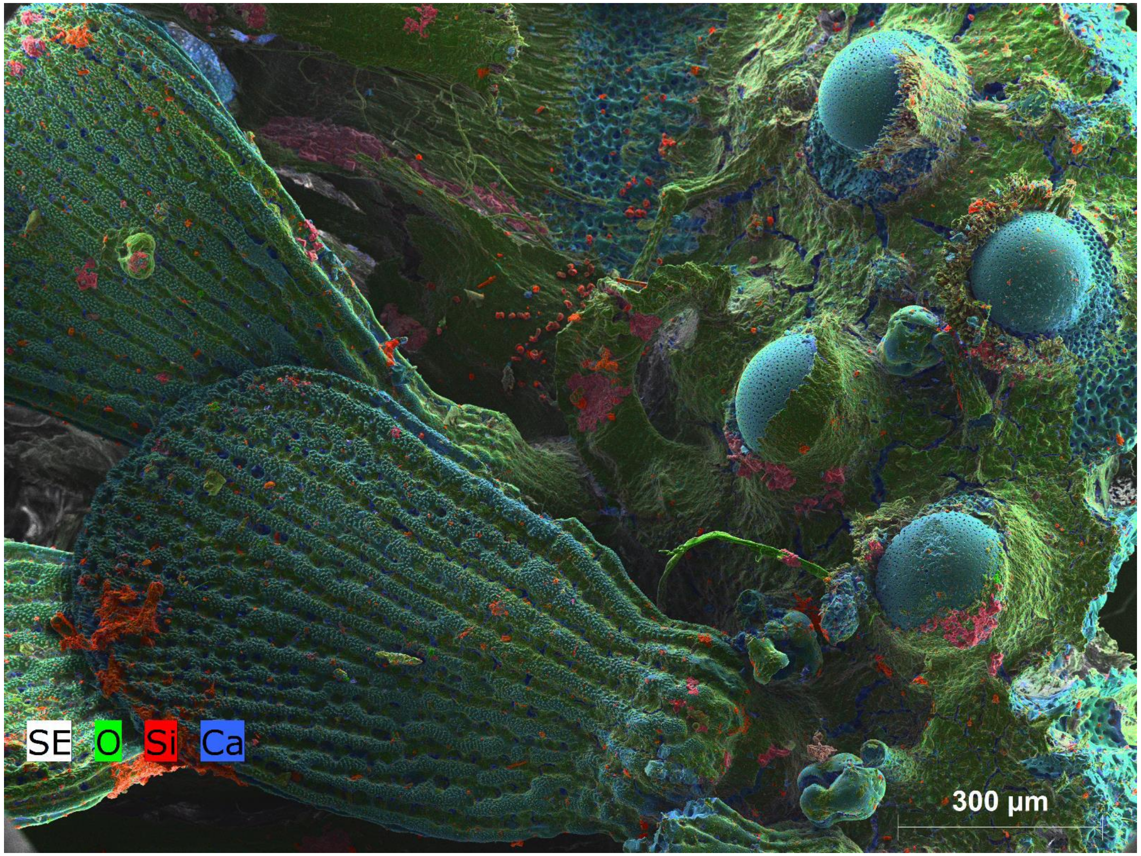
Polymer compound
XFlash® FlatQUAD



- Using the zoom function in Esprit, smallest features and pores can be investigated due to annular design of the FlatQUAD
- Shadow effects are minimized.



Sea Urchin (Paracentrotus lividus)
Imaging: No shadowing effects

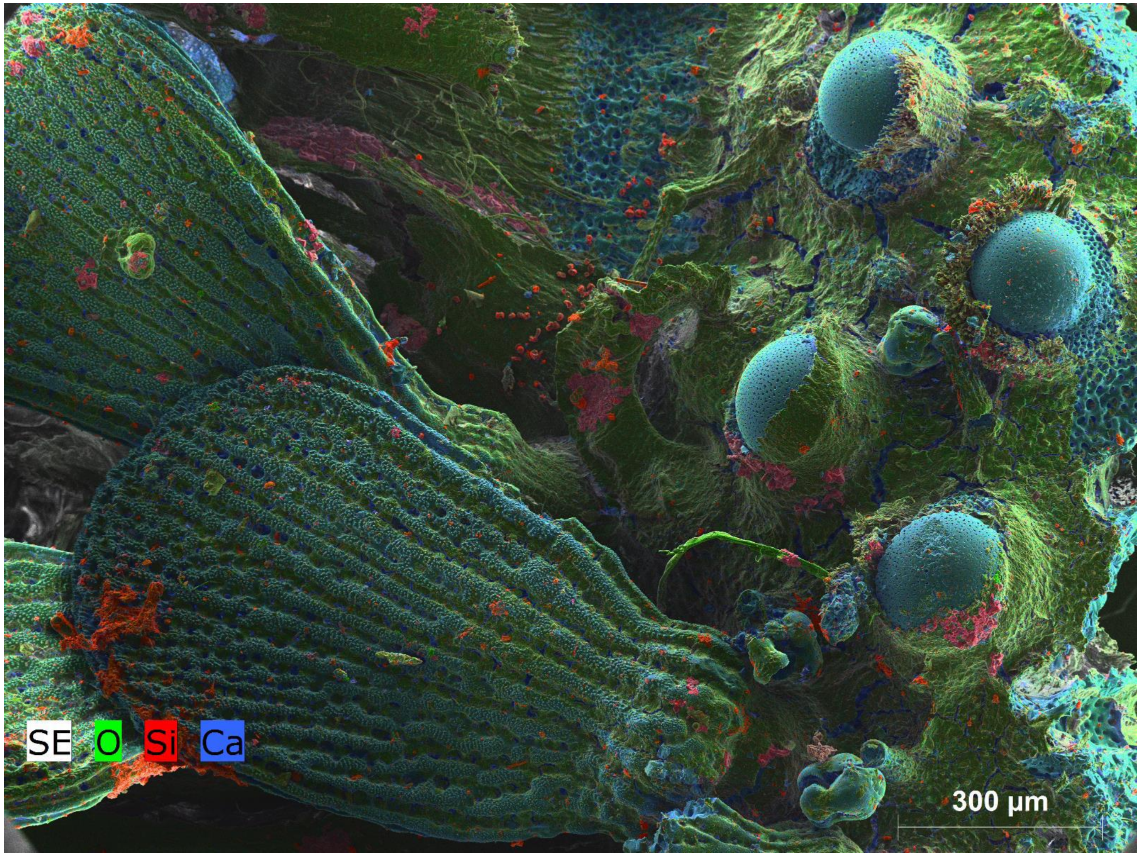


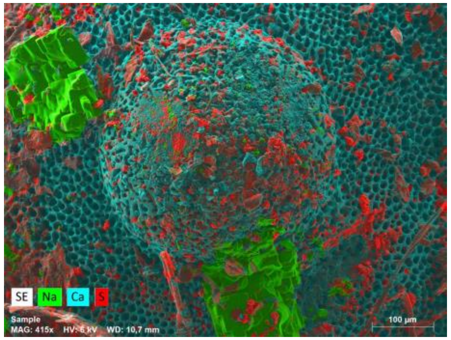
- 51sec acquisition time, 6 kV, 4096pixel

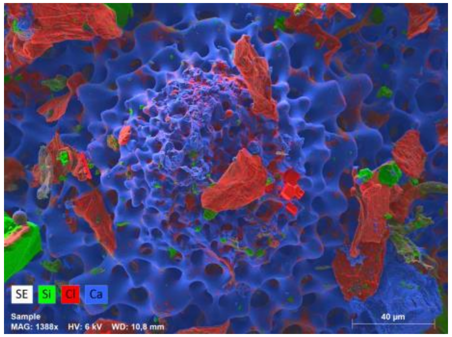
- Shadow effects are minimized
- No sample preparation
- Acquired in 1min with 6 kV under high vacuum.
- The structure can resist heavy weights

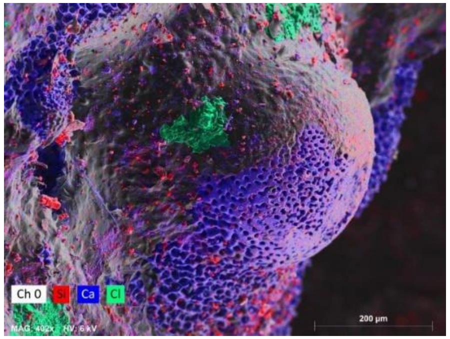
Sea Urchin (Paracentrotus lividus) from the aegean sea

Sea Urchin (Paracentrotus lividus)
Imaging: No shadowing effects





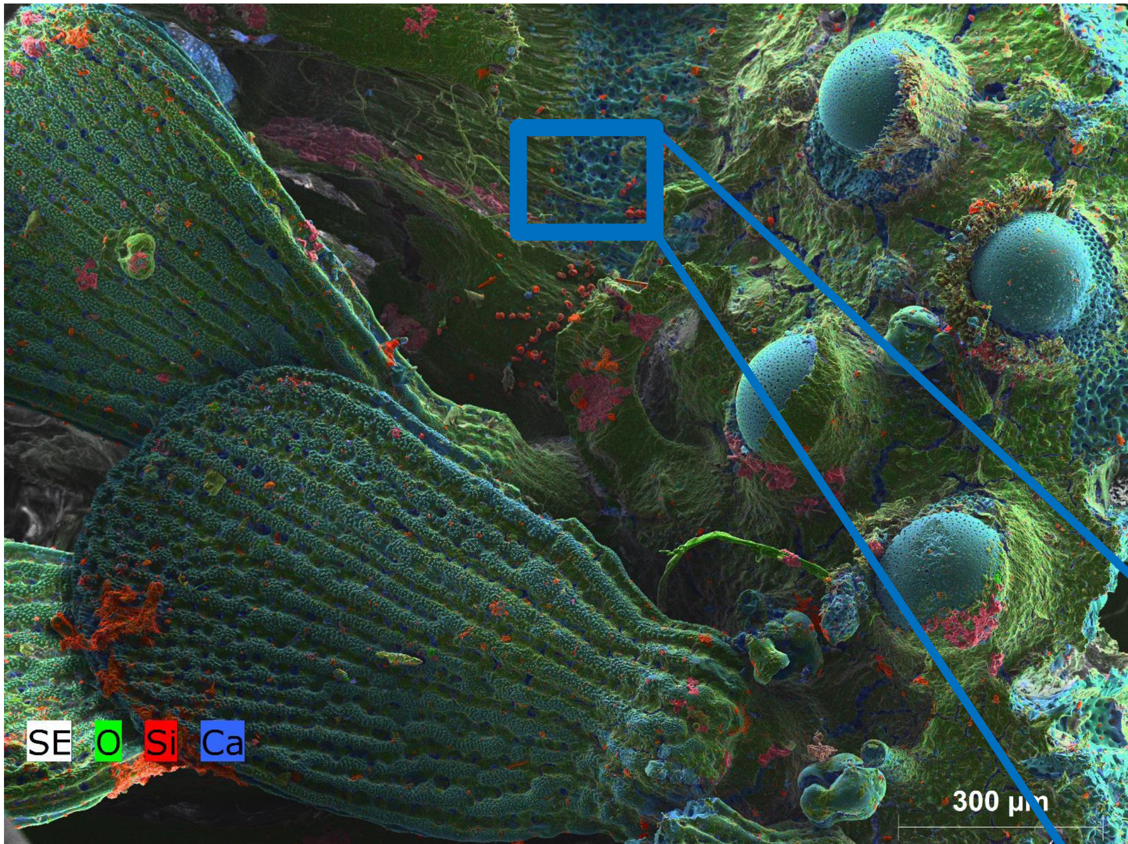




- The structure can resist heavy weights
- Influences researchers on new materials and also architecture

Sea Urchin (Paracentrotus lividus)

Imaging: No shadowing effects

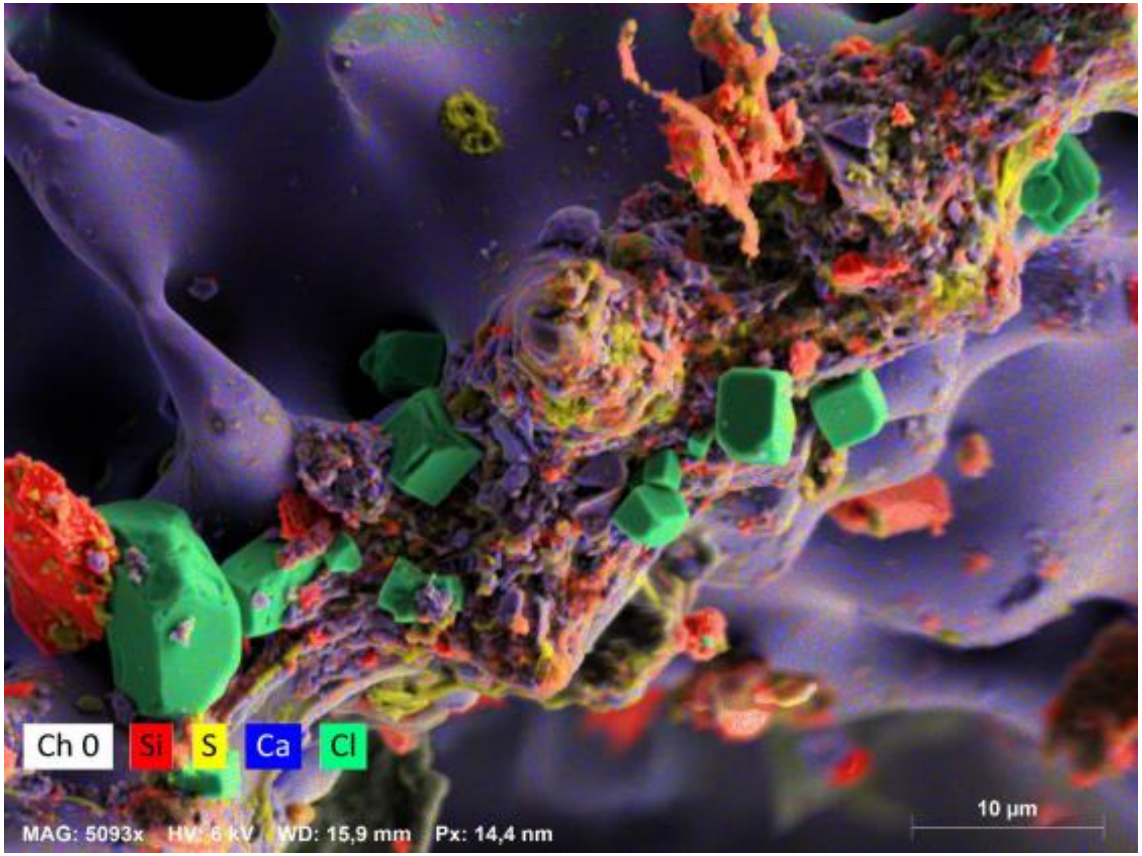


- Shadow effects are minimized
- No sample preparation
- Acquired in 1min with 6 kV under high vacuum.

- 51sec acquisition time, 6 kV, 4096pixel

Sea Urchin (Paracentrotus lividus) from the aegean sea

Sea Urchin (Paracentrotus lividus)
Imaging: No shadowing effects



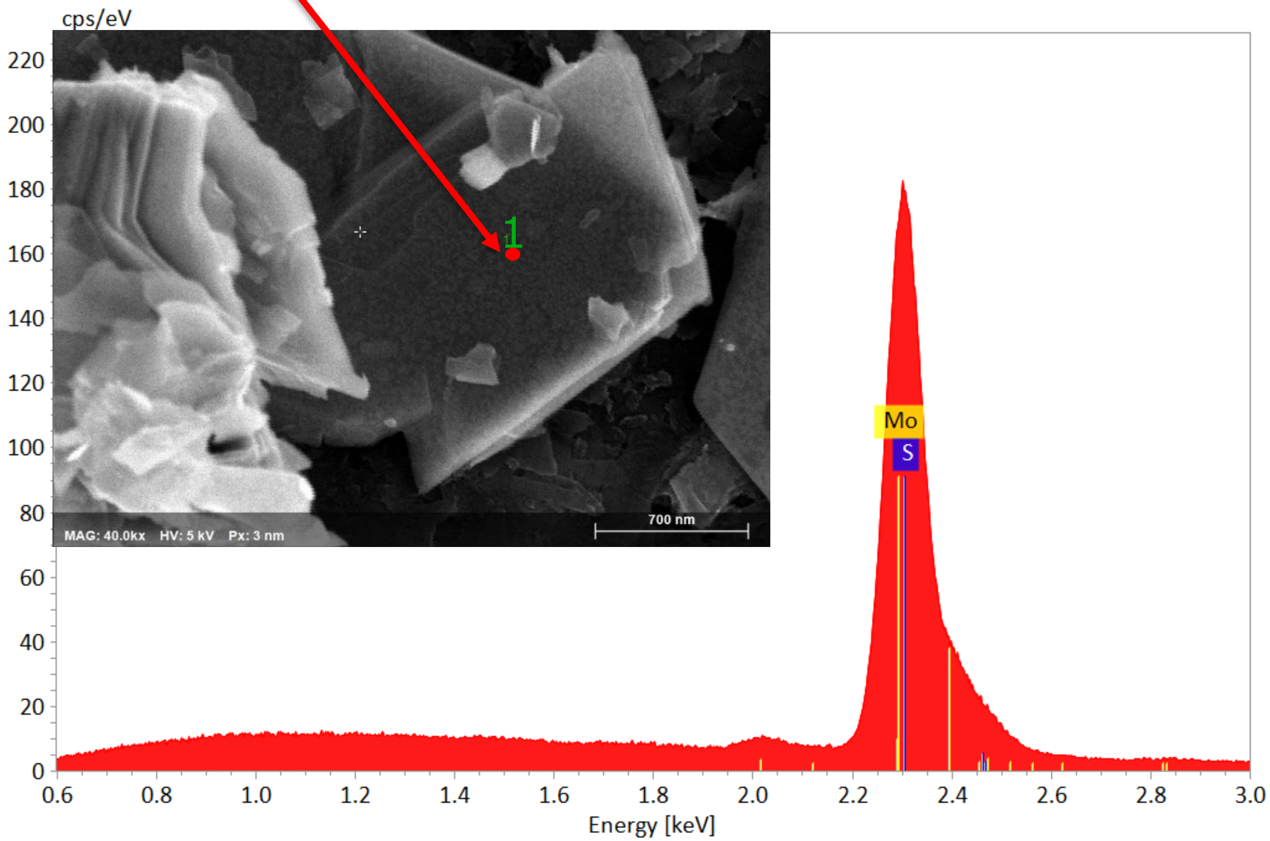
- 51sec acquisition time, 6 kV, 4096pixel

- Small sandgrains and deposits of NaCl can be observed in detail
- Shadow effects are minimized
- No sample preparation
- Acquired in 1min with 6 kV under high vacuum.

Sea Urchin (Paracentrotus lividus) from the aegean sea

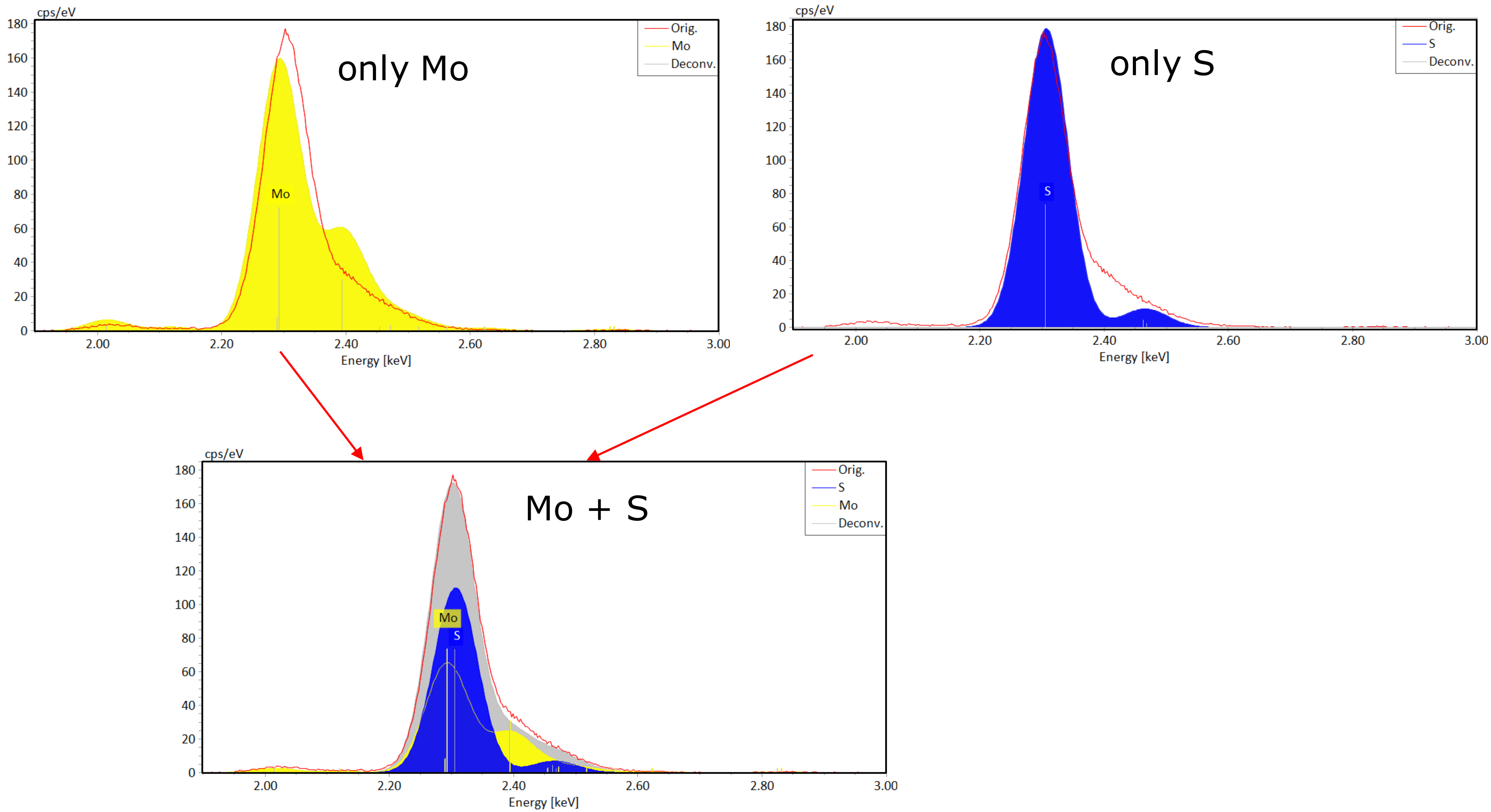
Quantification of MoS_2 at 5kV
Sample with Topography

MoS_2 point spectrum



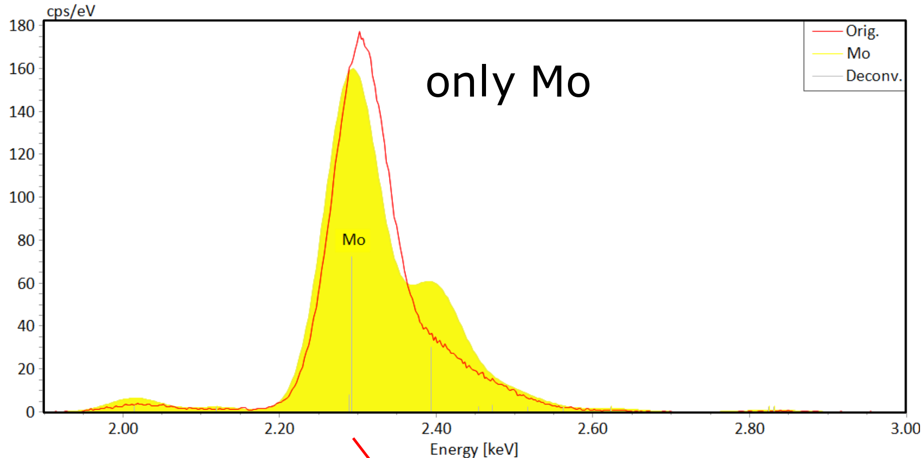
EDS Measurement parameters	
Acquisition time	50 sec
HV	5 kV
Output countrate	21 kcps

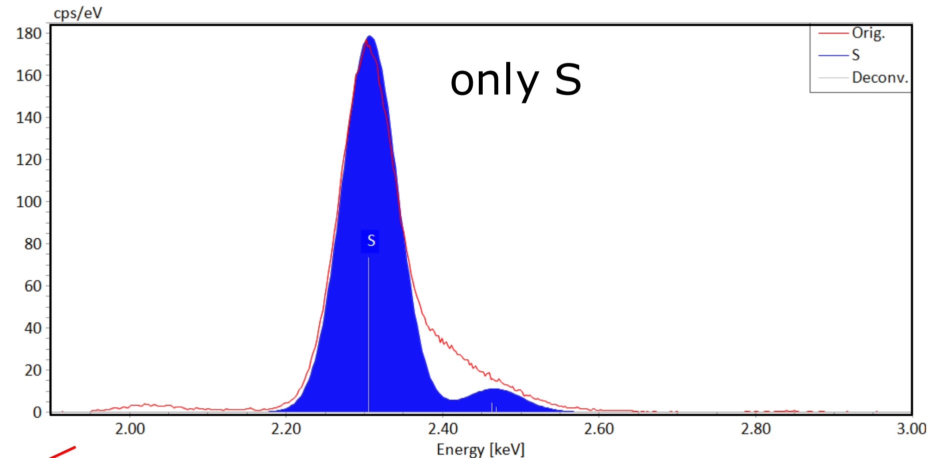
Quantification of MoS_2 at 5kV
Deconvolution and Quantification Results

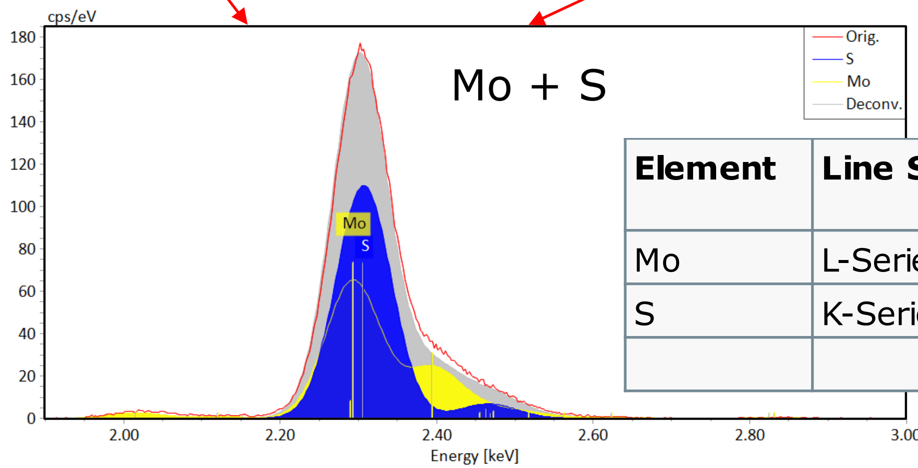


Quantification of MoS_2 at 5kV

Deconvolution and Quantification Results







Element	**Line S.**	**Mass Norm. [%]**	**Atom [%]**	***Stoic. Atom [%]***
Mo	L-Series	59.70	33.12	*33.33*
S	K-Series	40.30	66.88	*66.66*
			100.00	*100.00*

Presentation Example Overview

Point Analysis:

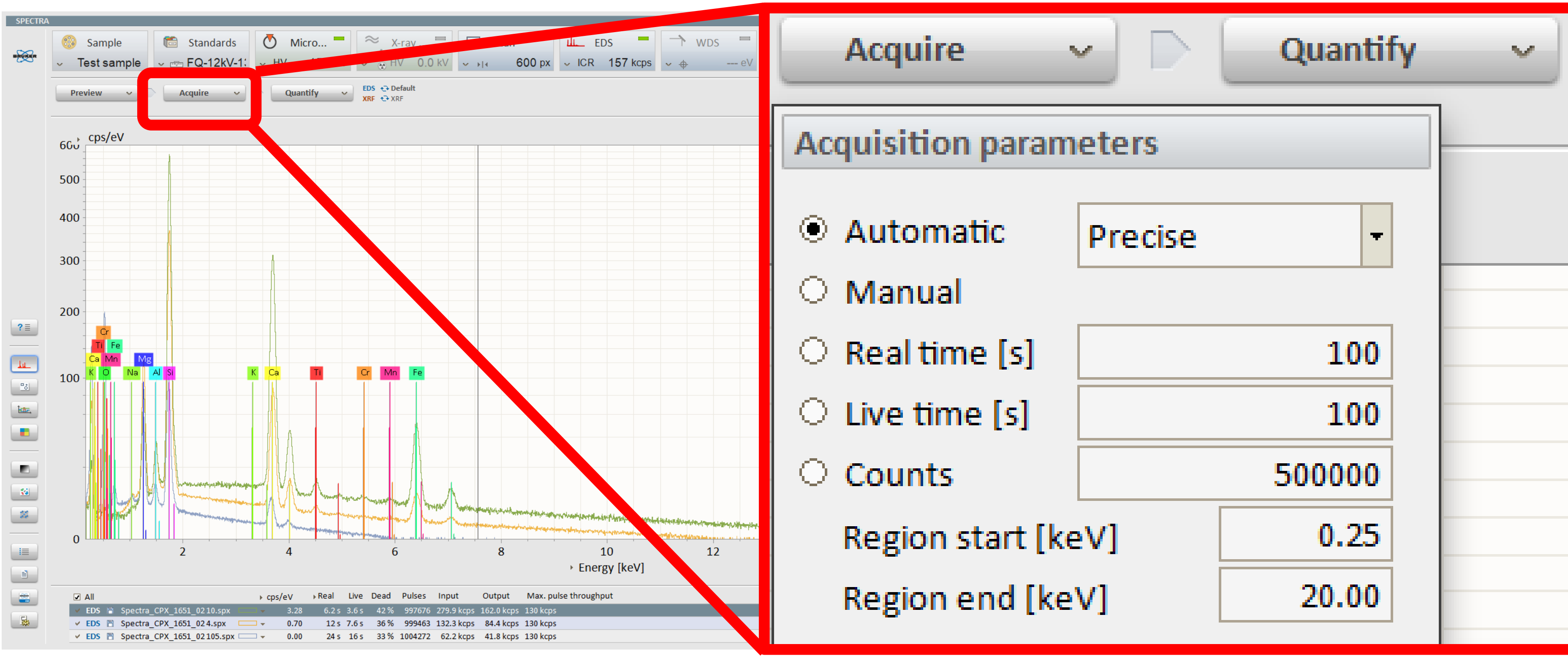
- Mineral Grains: Mantle and Volcanic
  - Mounted, Polished and Carbon Coated
  - Standard-based and Standardless Quantification
  - Different accelerating voltage (kV)

Hypermap Analysis:

- Mineral Grains: Mantle and Volcanic
- Mantle Peridotite
  - Feature / Phase Analysis
  - AMICS Automated Mineralogy

SEM-EDS: FlatQUAD
Point Analysis: Quantification

Esprit Software: Analytical Parameters



	Exhaustive	Precise	Fast
Counts	1 000 000	250 000	50 000

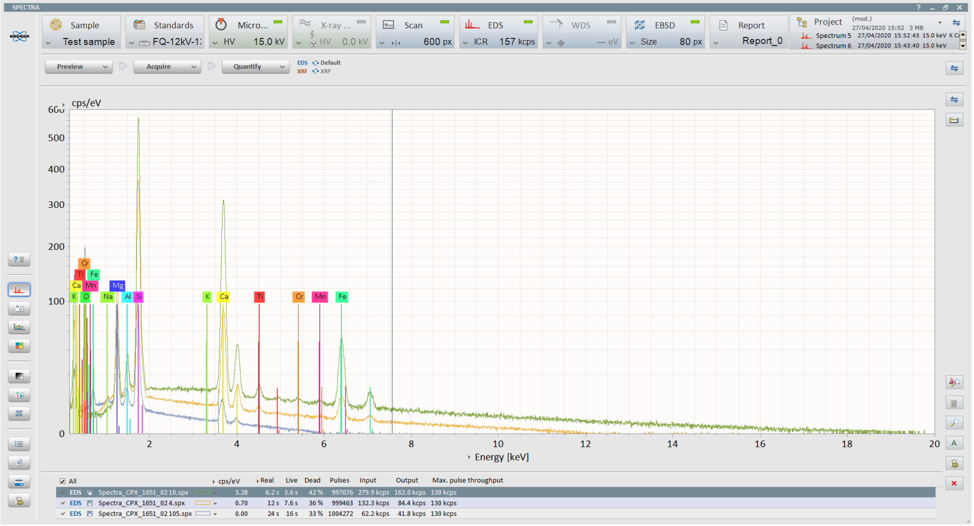
SEM-EDS: FlatQUAD
Point Analysis: Spectrum Acquisition

Hardware considerations:

20 kV: 1 + 6 µm mylar window

12 kV: 1 +2 µm mylar window

6 kV: 1 µm mylar window



Higher kV → Higher backscatter electron signal

Require different windows to filter this increased signal

Thus there is a different transmission of X-ray signal intensities depending on kV / window combination selected

However, this is accounted for in the quantification procedures

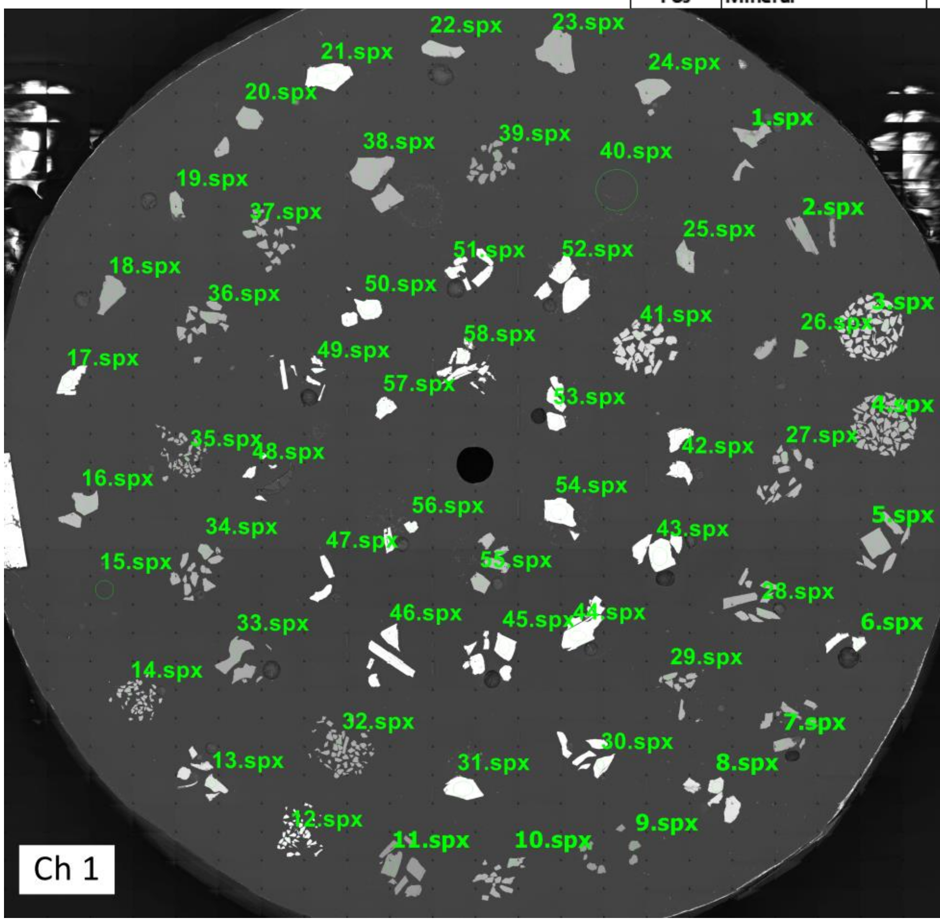
Lower kV → Higher signal intensity for low energy elements

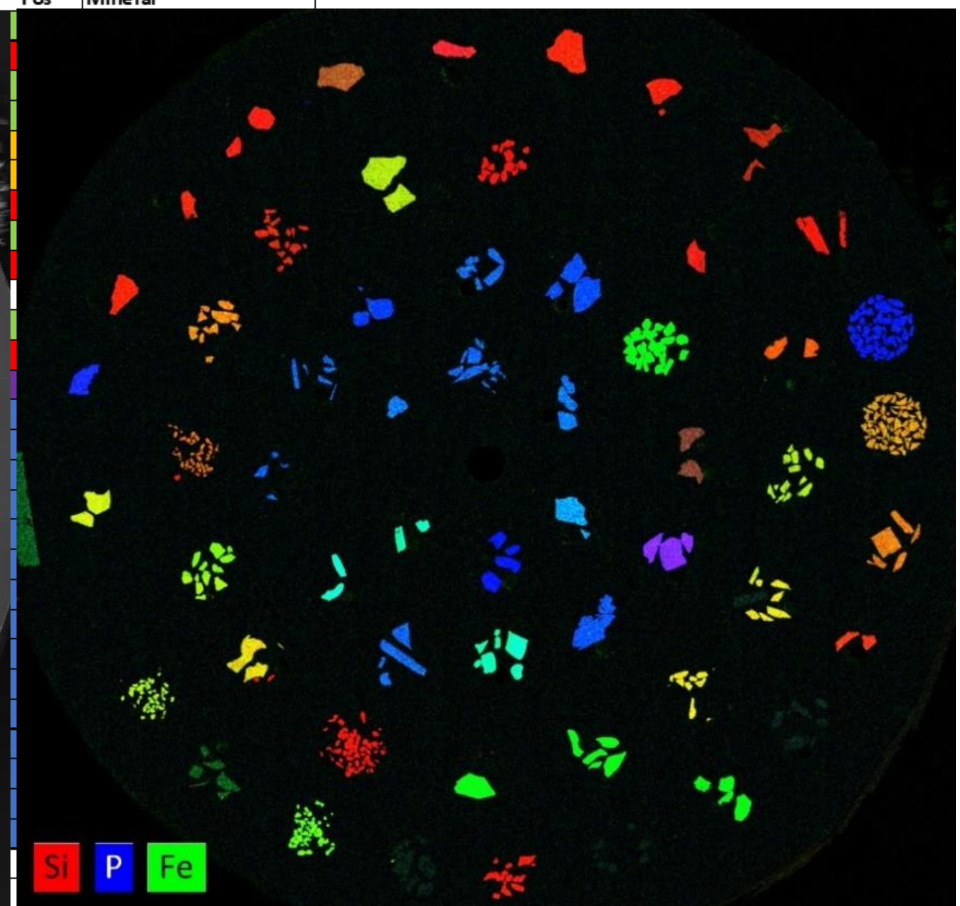
Quantitative Microanalysis
Smithsonian Standards

SEM-BSE Image

Combined Elemental Maps (Si, P, and Fe)

Pos	Mineral	Pos	Mineral





SEM-EDS: FlatQUAD
Point Analysis: Quantification

Smithsonian Standards Reference:

Jarosewich, E., Nelen, J. A., and Norberg, J.A., 1980. Reference samples for electron microprobe analyses, Geostandards Newsletter, Vol. 4, p.43-47.

Element	Clinopyroxene: Standards Used	Garnet: Standards Used
Si	Augite	Garnet (Almandine-Grossular)
Ti	Ilmenite	Ilmenite
Al	Augite	Garnet (Almandine-Grossular)
Cr	Chromite	Chromite
Fe	Ilmenite	Garnet
Mn	Ilmenite	Ilmenite
Mg	Diopside	Garnet (Pyrope)
Ca	Diopside	Garnet (Almandine-Grossular)
Na	Augite	
K	Microcline	
O	Augite	Garnet

Geological Applications:
Mantle Minerals

Mantle Minerals		
Garnet	Peridotite Pyrope	Red Purple
Orthopyroxene	Peridotite Enstatite	Green
Spinel	Peridotite Chromite	Black
Olivine	Peridotite	Green
Ilmenite	Peridotite	Black
Garnet	Eclogite Pyrope-Almandine	Orange
Clinopyroxene	Peridotite Cr-Diopside	Green

Kimberlite Indicator Minerals (KIM´s)

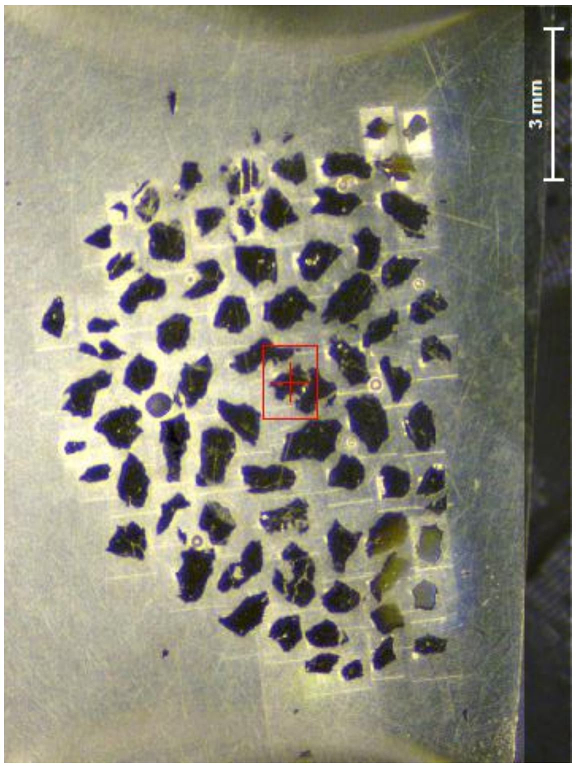
Geological Applications:
Mantle Minerals - Composition

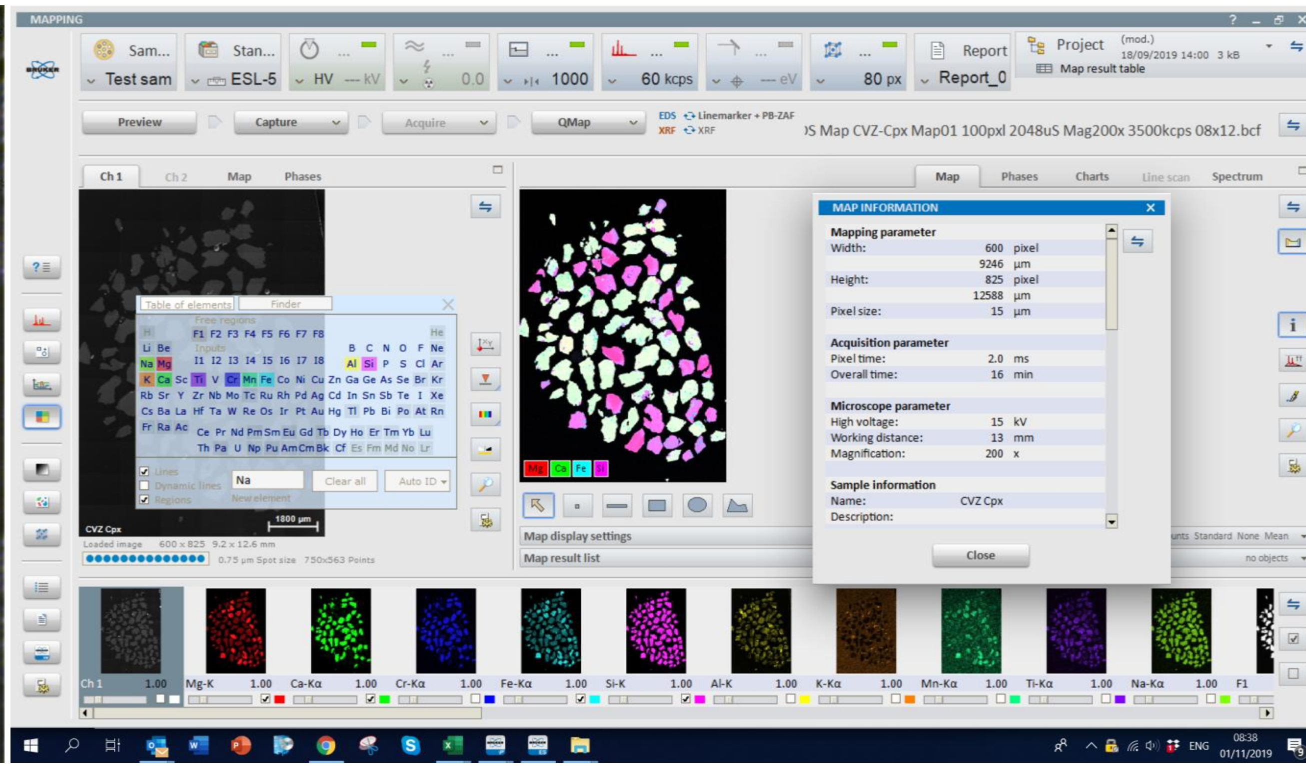
Garnet	• $(Ca,Mg,Fe)_3(Al,Cr,Fe^{3+})_2(SiO_4)_3$ • Minor: Mn y Ti, y Trace: Ni
Olivine	• $(Mg,Fe)_2SiO_4$ • Minor: Ca, Mn, y Trace: Ni
Clinopyroxene	• $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$ • Minor: Cr
Orthopyroxene	• $(Mg,Fe)SiO_3$ • Minor: Al
Spinel	• $(Mg,Fe)(Al,Cr,Fe^{3+})_2O_4$ • Minor: Ti

FlatQUAD: Standard Based Point Analysis
Volcanic Grain Mounts

Carbon Coated

High Quality Polish



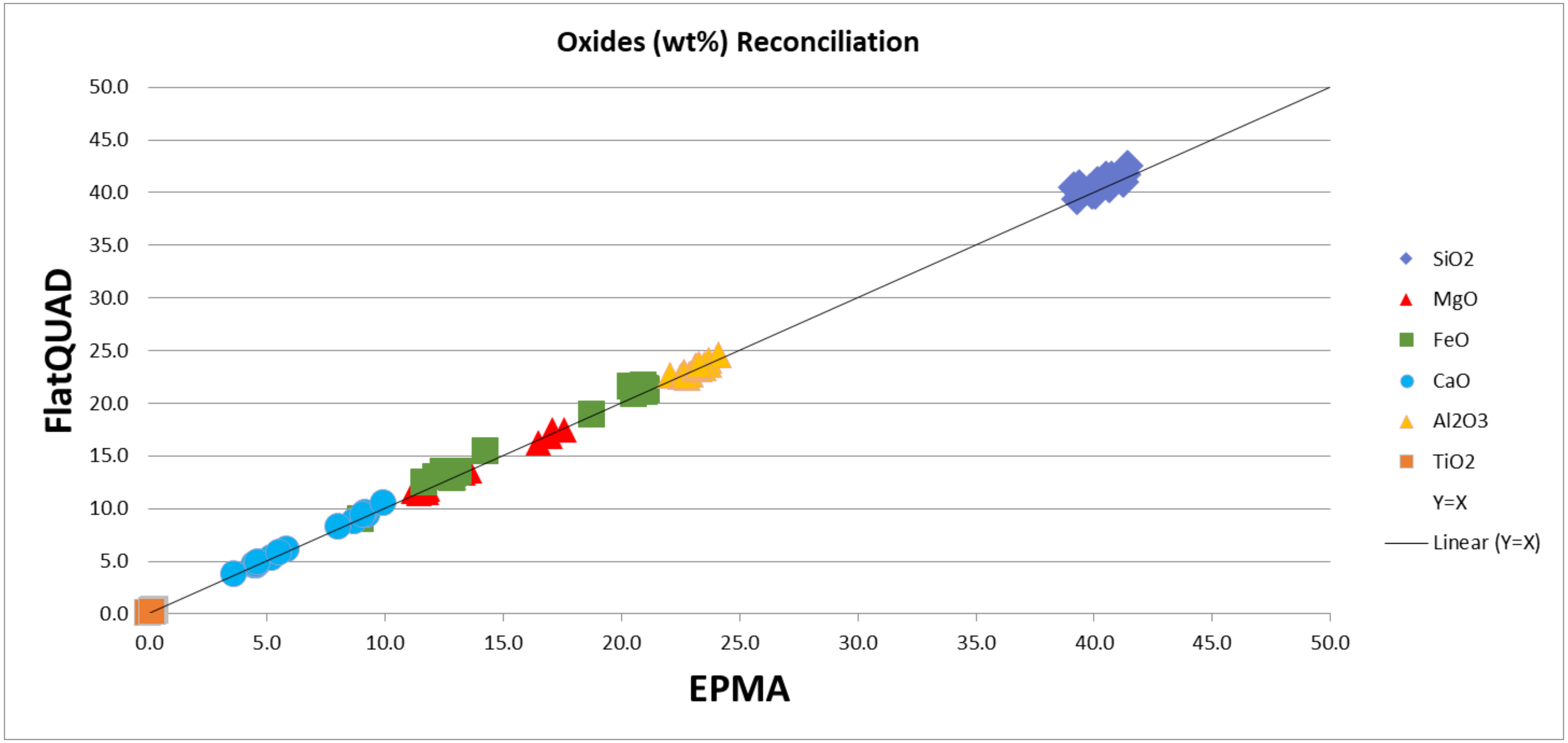


FlatQUAD: Standard Based Analysis
Voltage: 12 kV
Garnet: 20 Grains

Quickly quantify different mineral phases

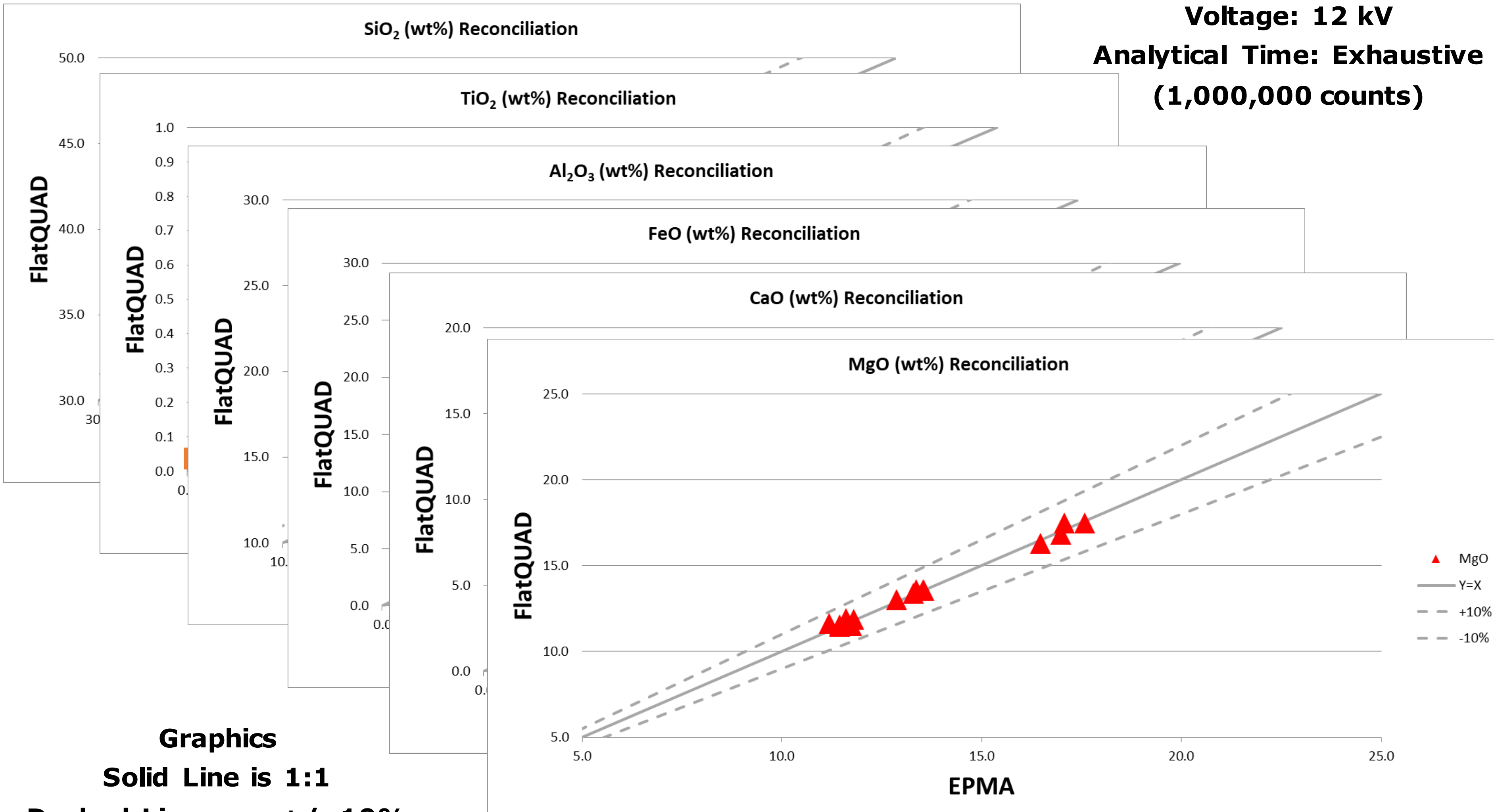
Analysis of 20 Grains

Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)



Graphic
Solid Line is 1:1

FlatQUAD: Standard Based Analysis
Voltage: 12 kV
Garnet: 20 Grains



Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)

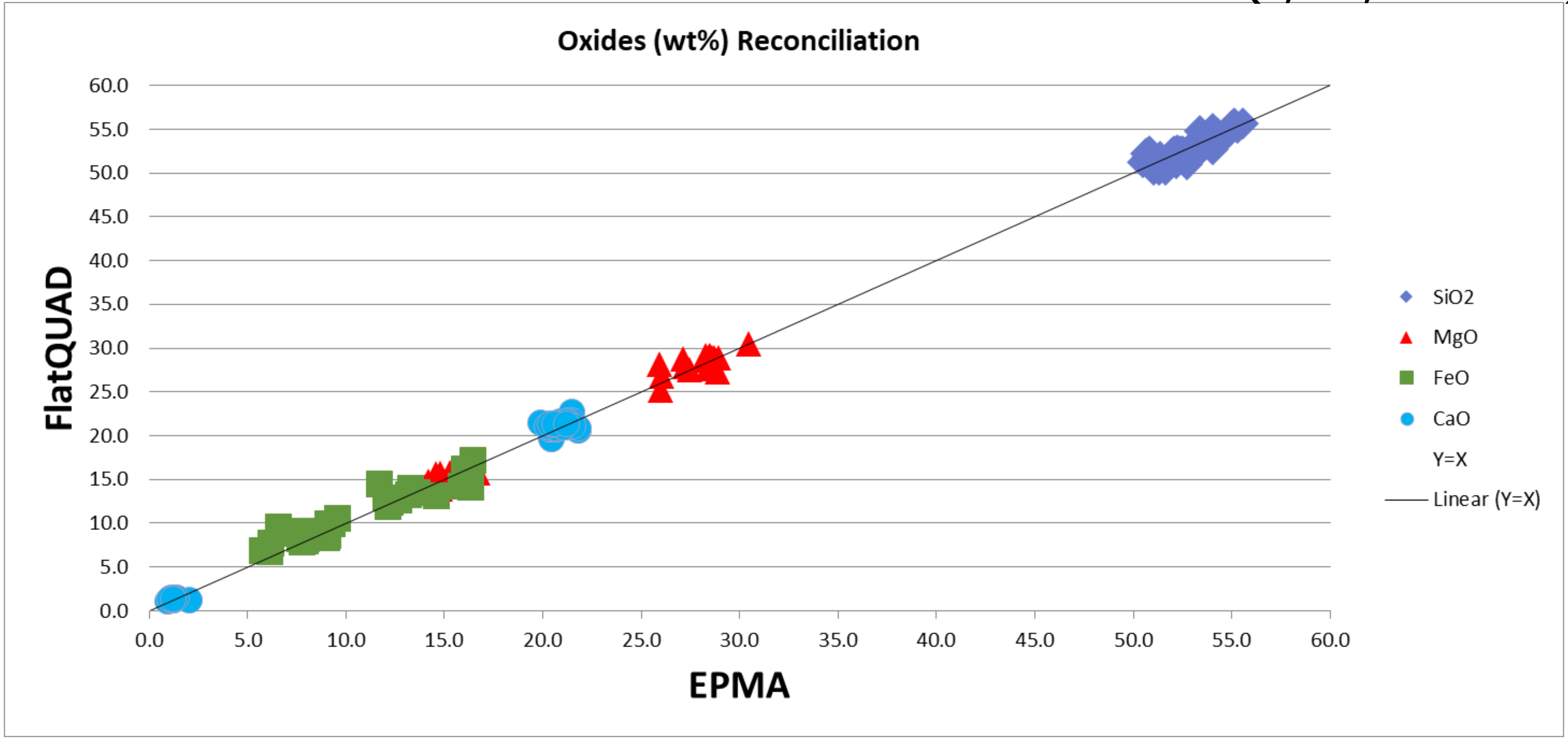
Graphics
Solid Line is 1:1
Dashed Lines are +/- 10%

FlatQUAD: Standard Based Analysis
Voltage: 12 kV
Clinopyroxene: 50 Grains

Quickly quantify different mineral phases

Analysis of 50 Grains

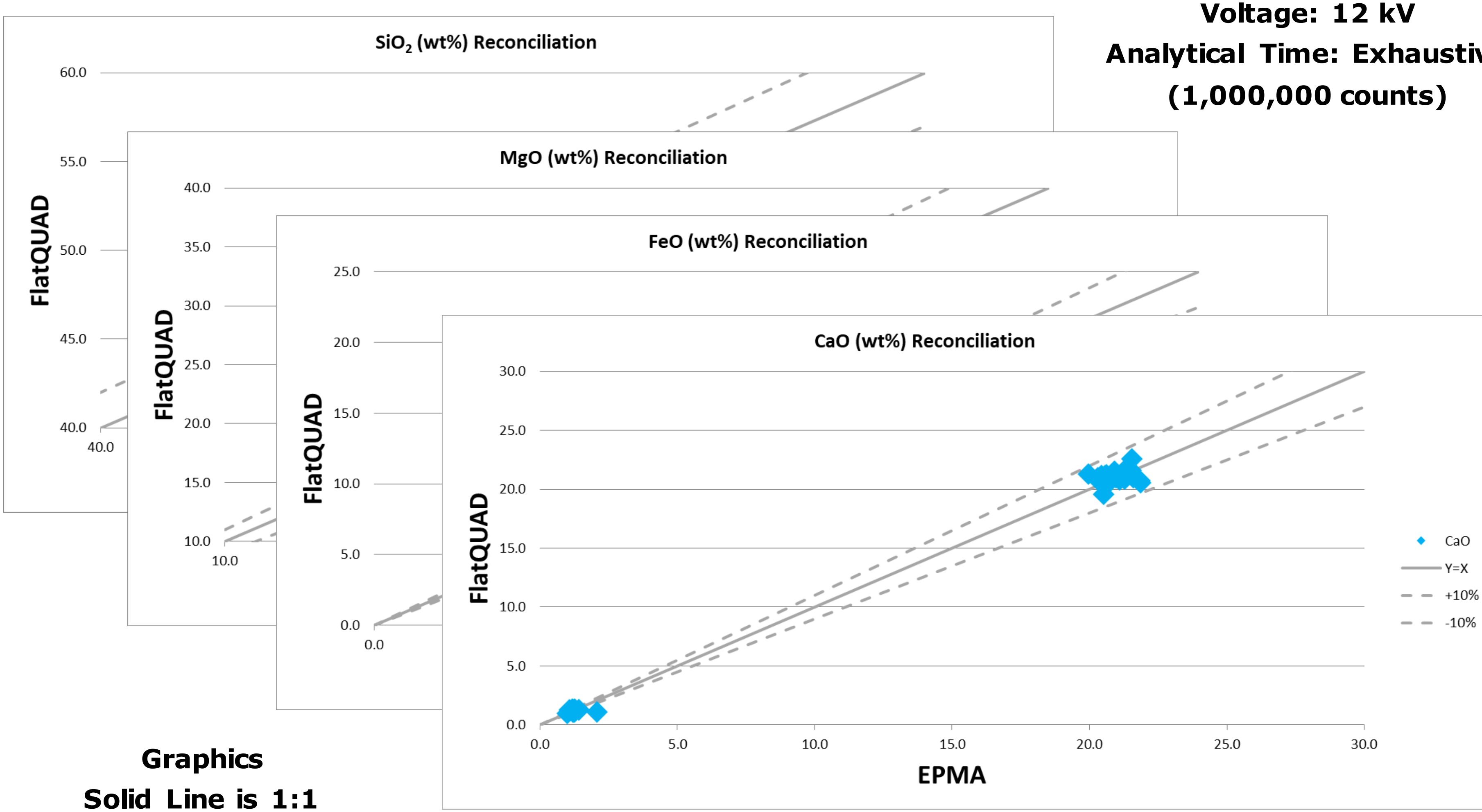
Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)



Graphic
Solid Line is 1:1

FlatQUAD: Standard Based Analysis
Voltage: 12 kV
Clinopyroxene: 50 Grains

Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)



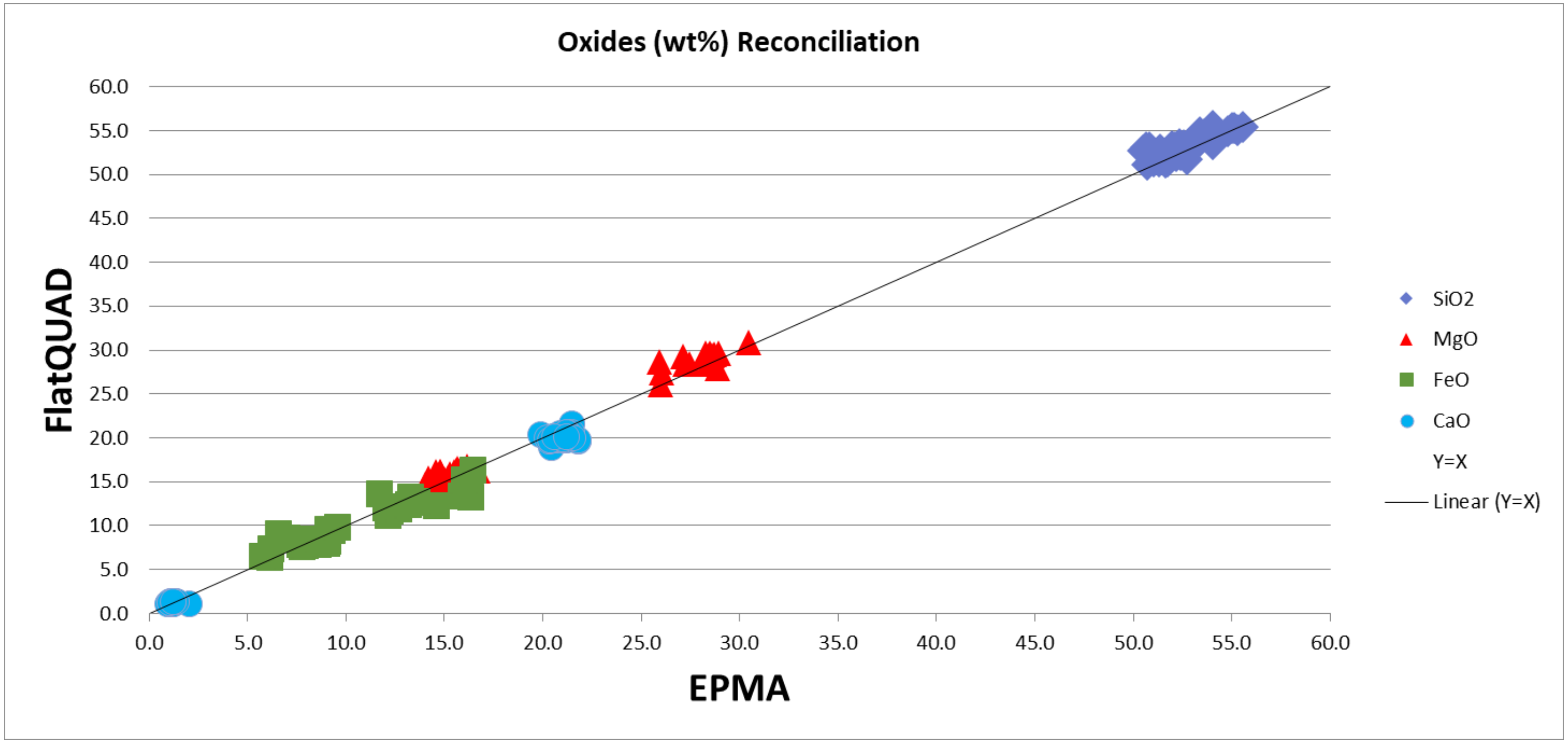
Graphics
Solid Line is 1:1
Dashed Lines are +/- 10%

FlatQUAD: Standardless Normalised
Voltage: 12 kV
Clinopyroxene: 50 Grains

Quickly quantify different mineral phases

Analysis of 50 Grains

Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)



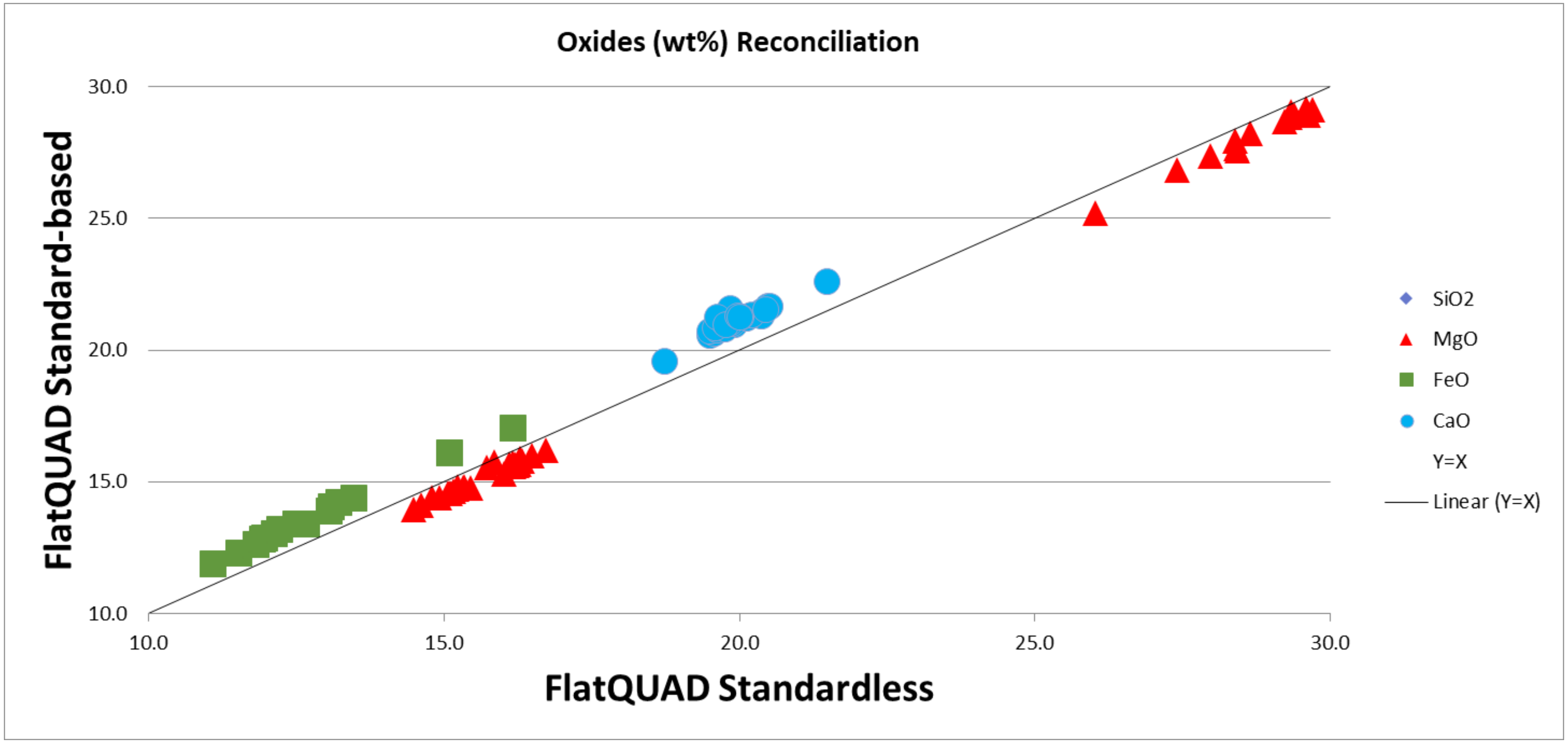
Graphic
Solid Line is 1:1

FlatQUAD: Standardless Normalised
Voltage: 12 kV
Clinopyroxene: 50 Grains

Quickly quantify different mineral phases

Analysis of 50 Grains

Voltage: 12 kV
Analytical Time: Exhaustive
(1,000,000 counts)



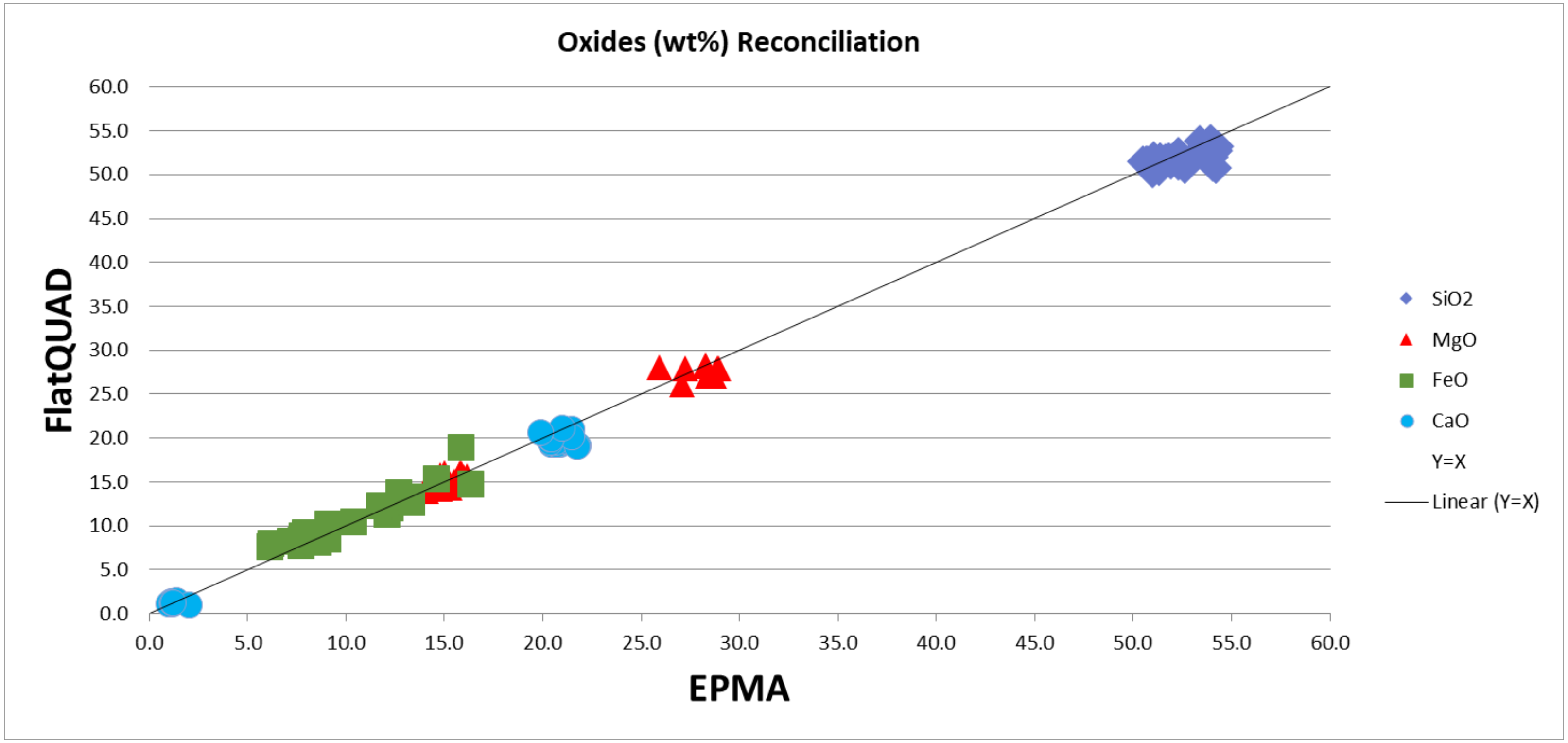
Graphic
Solid Line is 1:1

FlatQUAD: Standard Based Analysis
Voltage: 6 kV
Clinopyroxene: 30 Grains

Quickly quantify different mineral phases

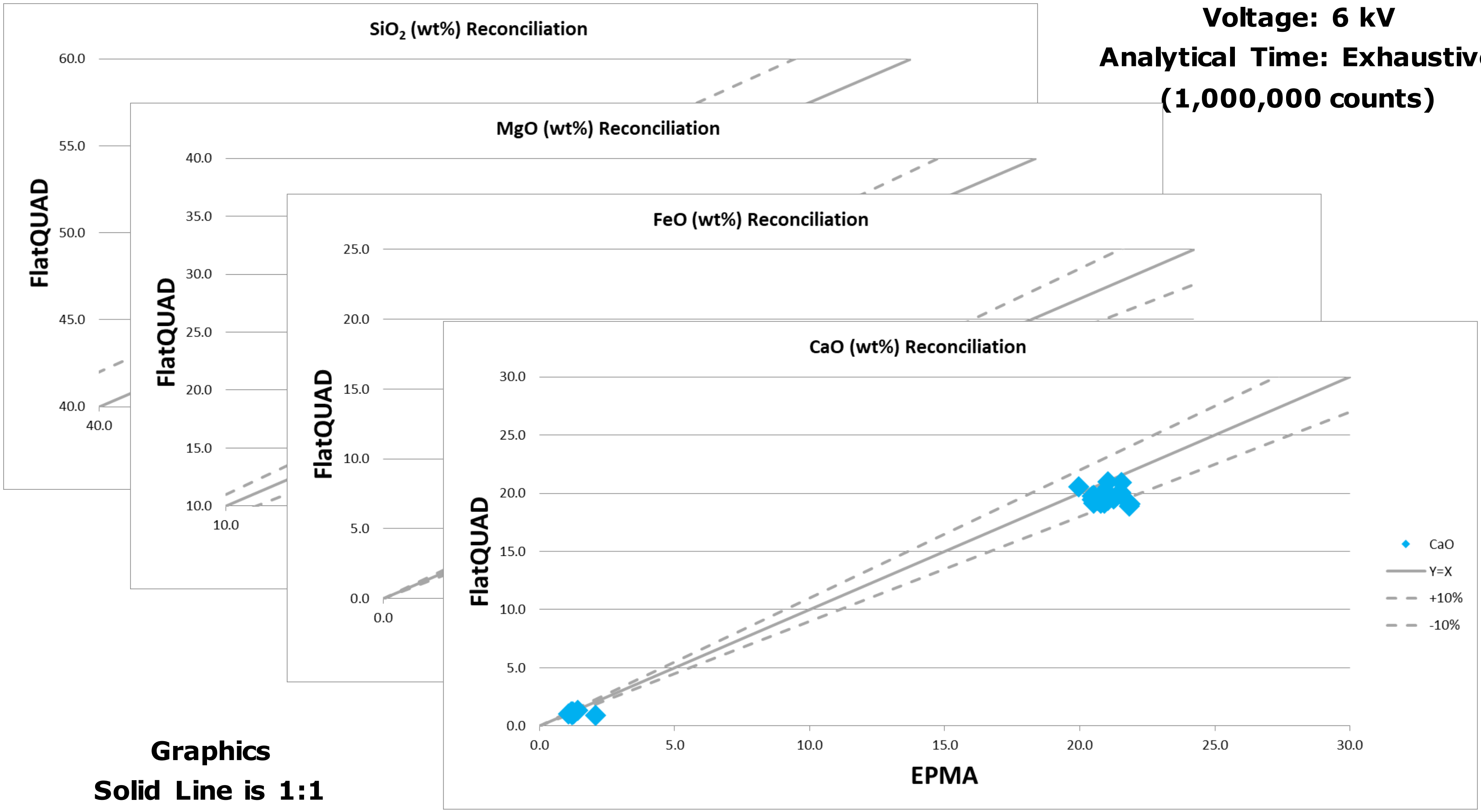
Analysis of 30 Grains

Voltage: 6 kV
Analytical Time: Exhaustive
(1,000,000 counts)



Graphics
Solid Line is 1:1

FlatQUAD: Standard Based Analysis
Voltage: 6 kV
Clinopyroxene: 30 Grains



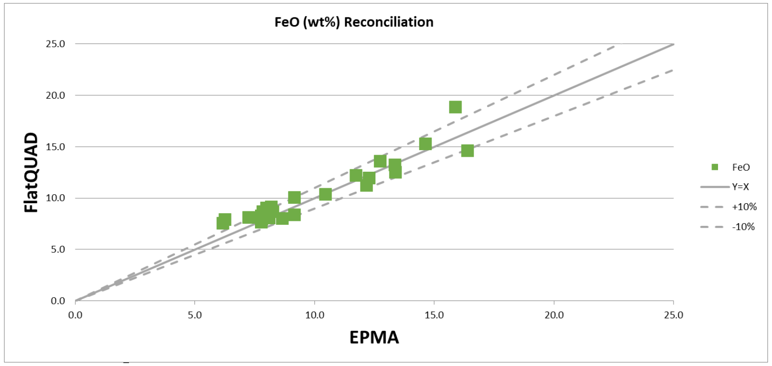
Voltage: 6 kV
Analytical Time: Exhaustive
(1,000,000 counts)

Graphics
Solid Line is 1:1
Dashed Lines are +/- 10%

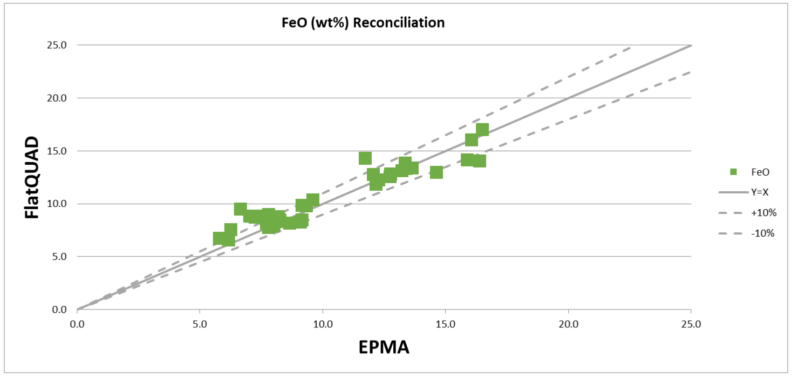
FlatQUAD: Standard Based Analysis
Voltage: 6 kV and 12 kV
Clinopyroxene

Element	Acclerating Voltage: 6 kV	Acclerating Voltage: 12 kV
Mg	Mg K – 1.254	Mg K – 1.254
Si	Si K – 1.740	Si K – 1.740
Ca	Ca K – 3.691	Ca K – 3.691
Fe	Fe L – 0.705	Fe K – 6.401

Voltage: 6 kV
Analytical Time: Exhaustive



Voltage: 12 kV
Analytical Time: Exhaustive



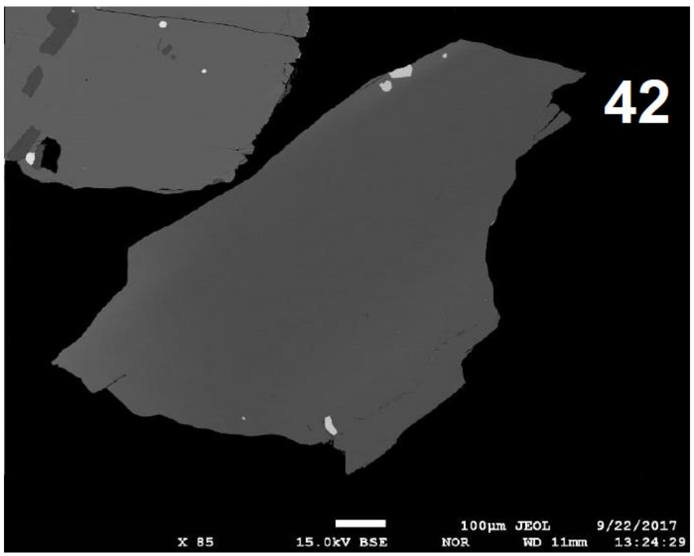
Solid Line is 1:1
Dashed Lines are +/- 10%

FlatQUAD: Standard Based Analysis

Voltage: 12 kV
Clinopyroxene: Repeatability

20 Repeat Analyses

Clinopyroxene

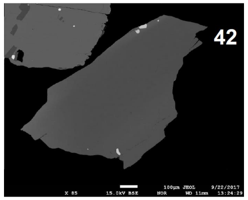


	SiO2 (%)	TiO2 (%)	Al2O3 (%)	Cr2O3 (%)	FeO (%)	MnO (%)	MgO (%)	CaO (%)
Spectra_CVO-CPX-42 61	55.98	0.19	2.13	0.50	9.90	0.26	30.99	1.23
Spectra_CVO-CPX-42 62	55.94	0.17	2.19	0.56	9.76	0.19	30.83	1.32
Spectra_CVO-CPX-42 63	55.78	0.18	2.19	0.61	9.53	0.22	30.96	1.18
Spectra_CVO-CPX-42 64	55.94	0.12	1.90	0.50	9.88	0.28	30.79	1.31
Spectra_CVO-CPX-42 65	55.81	0.19	2.18	0.55	9.80	0.19	30.97	1.26
Spectra_CVO-CPX-42 66	55.71	0.16	2.15	0.53	9.80	0.17	31.02	1.24
Spectra_CVO-CPX-42 67	56.03	0.18	2.00	0.55	9.52	0.24	30.93	1.15
Spectra_CVO-CPX-42 68	55.36	0.18	2.09	0.49	10.41	0.29	30.13	1.32
Spectra_CVO-CPX-42 69	55.53	0.15	2.10	0.59	9.97	0.25	30.54	1.18
Spectra_CVO-CPX-42 70	55.35	0.20	2.10	0.55	9.71	0.25	30.81	1.23
Spectra_CVO-CPX-42 71	55.98	0.13	2.02	0.52	9.89	0.27	30.98	1.28
Spectra_CVO-CPX-42 72	55.06	0.23	2.53	0.52	10.97	0.27	29.49	1.33
Spectra_CVO-CPX-42 73	55.61	0.23	2.09	0.56	10.27	0.26	30.63	1.28
Spectra_CVO-CPX-42 74	55.84	0.18	2.12	0.57	9.76	0.16	30.89	1.27
Spectra_CVO-CPX-42 75	55.62	0.16	2.12	0.56	10.27	0.25	30.13	1.38
Spectra_CVO-CPX-42 76	55.16	0.19	2.20	0.33	11.69	0.26	29.58	1.34
Spectra_CVO-CPX-42 77	55.61	0.14	2.08	0.59	10.82	0.22	30.26	1.23
Spectra_CVO-CPX-42 78	56.05	0.20	1.87	0.48	9.97	0.20	30.89	1.22
Spectra_CVO-CPX-42 79	55.31	0.21	2.46	0.47	10.83	0.21	29.99	1.46
Spectra_CVO-CPX-42 80	55.39	0.14	2.13	0.41	11.44	0.29	29.64	1.16

FlatQUAD: Standard Based Analysis
Voltage: 12 kV
Clinopyroxene: Repeatability

20 Repeat Analyses: Clinopyroxene

All major and minor elements within error

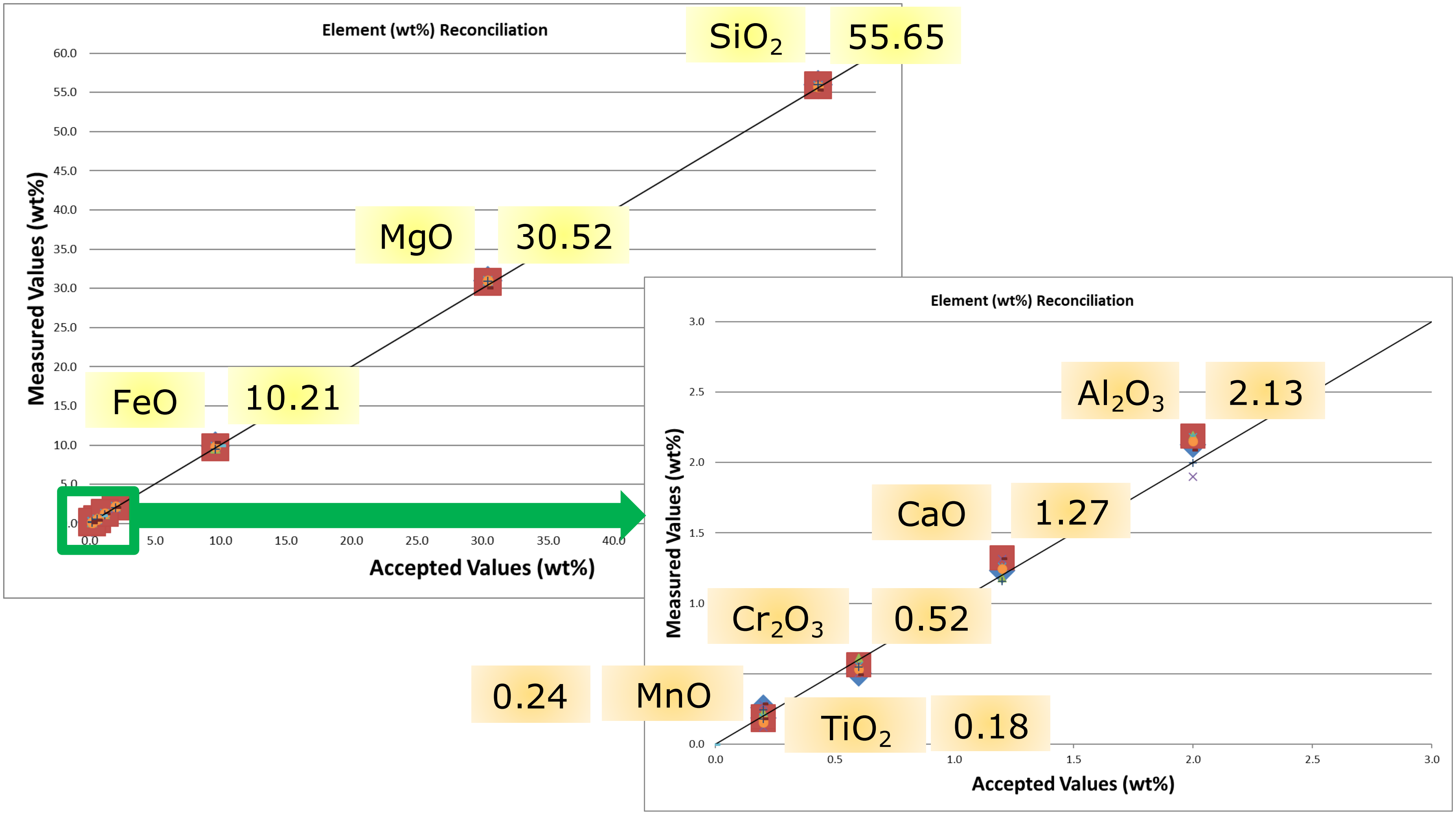


Element	Accepted Values	FlatQUAD Average	FlatQUAD Std Dev	FlatQUAD Maximum	FlatQUAD Minimum	FlatQUAD Range
SiO_2	55.60	55.65	0.30	56.05	55.06	0.99
TiO_2	0.20	0.18	0.03	0.23	0.12	0.11
Al_2O_3	2.00	2.13	0.15	2.53	1.87	0.66
Cr_2O_3	0.60	0.52	0.07	0.61	0.33	0.28
FeO	9.60	10.21	0.63	11.69	9.52	2.17
MnO	0.20	0.24	0.04	0.29	0.16	0.13
MgO	30.40	30.52	0.52	31.02	29.49	1.53
CaO	1.20	1.27	0.08	1.46	1.15	0.30

FlatQUAD: Standard Based Analysis

Voltage: 12 kV

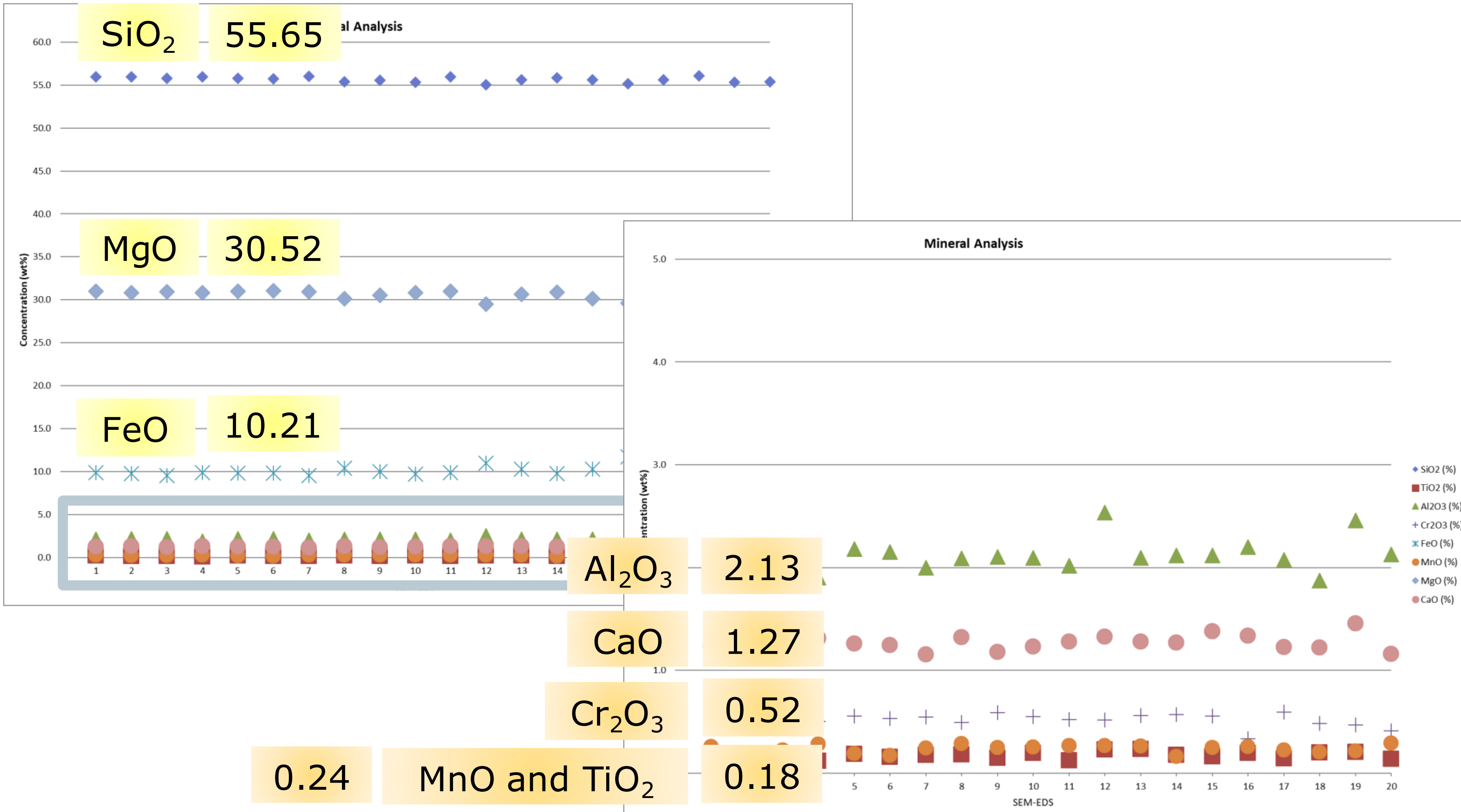
Clinopyroxene: Repeatability



FlatQUAD: Standard Based Analysis

Voltage: 12 kV

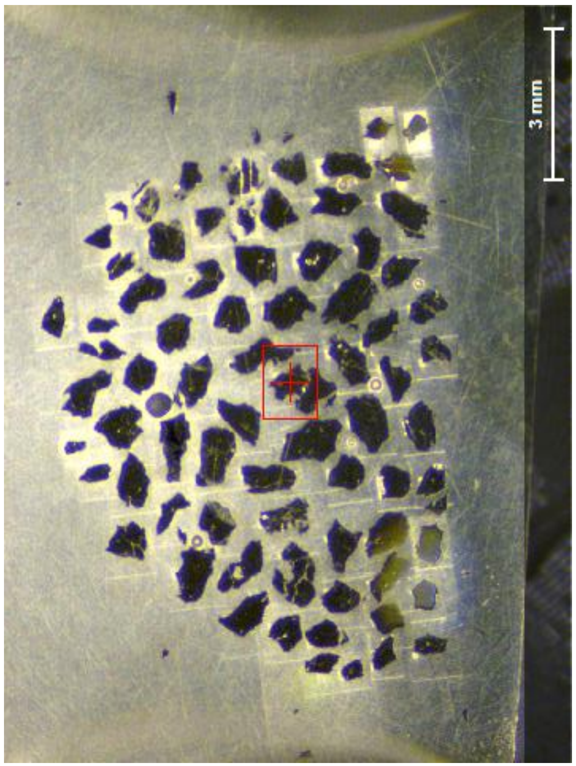
Clinopyroxene: Repeatability

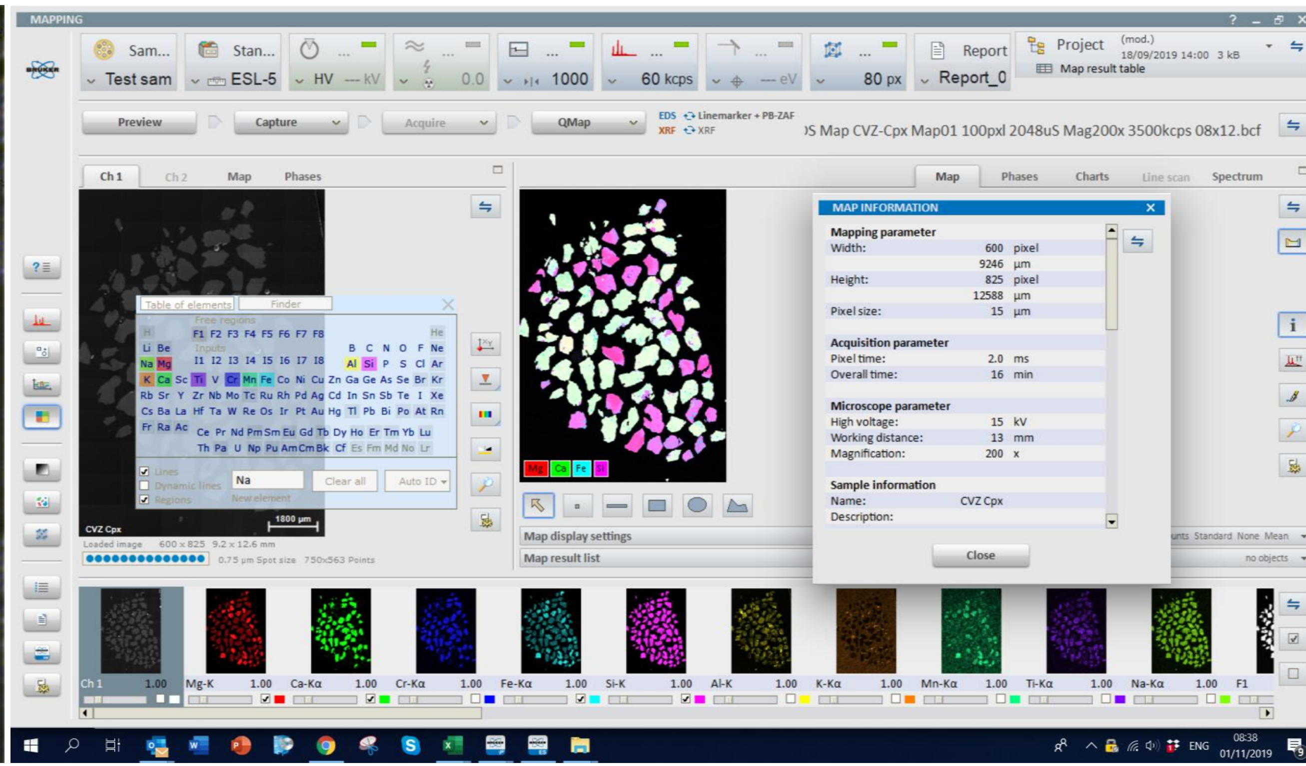


FlatQUAD: Hypermapping
Volcanic Grain Mounts

Quickly identify various mineral phases: **Pixel Dwell Time: 2048 µS**

Different Clinopyroxene Compositions

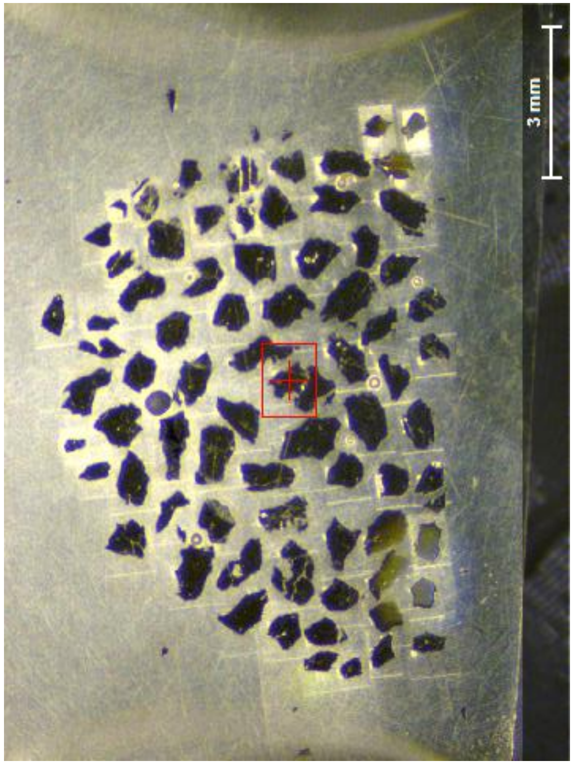




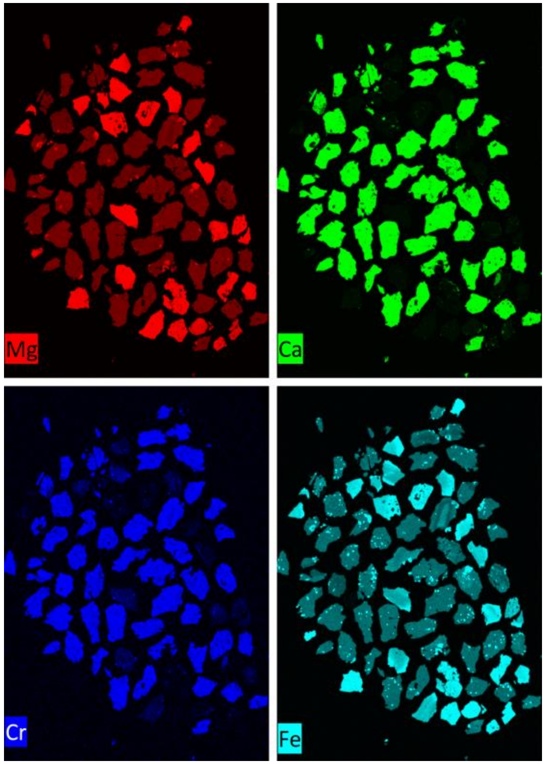
FlatQUAD: Hypermapping
Volcanic Grain Mounts

Quickly identify various mineral phases:
Different Clinopyroxene Compositions

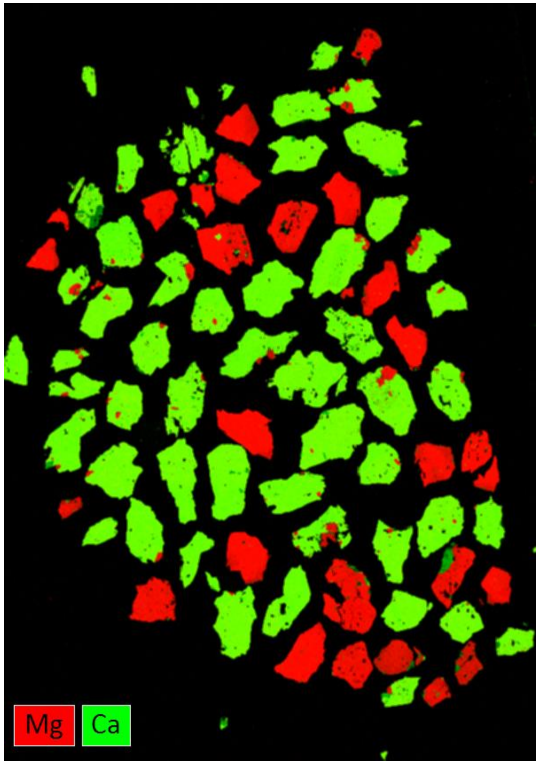
Pixel Dwell Time: 2048 µS
Input Count Rate (ICR): 2,100,000 cps



Optical Image



Individual Element Intensity Maps



Mixed Element Intensity Maps

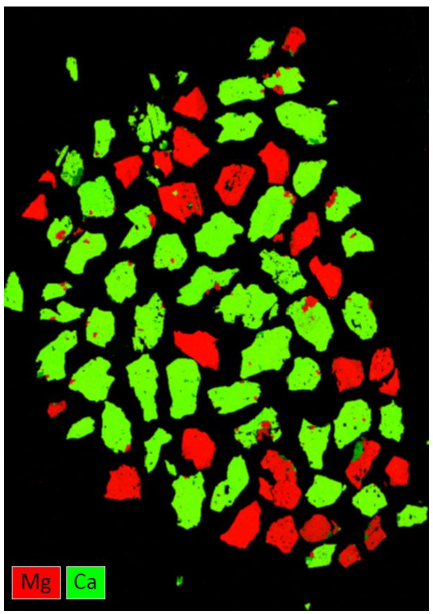
FlatQUAD: Hypermapping
Volcanic Grain Mounts

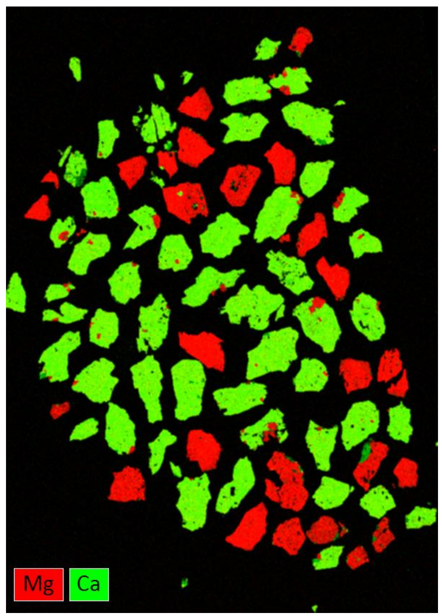
Quickly identify different clinopyroxene compositions

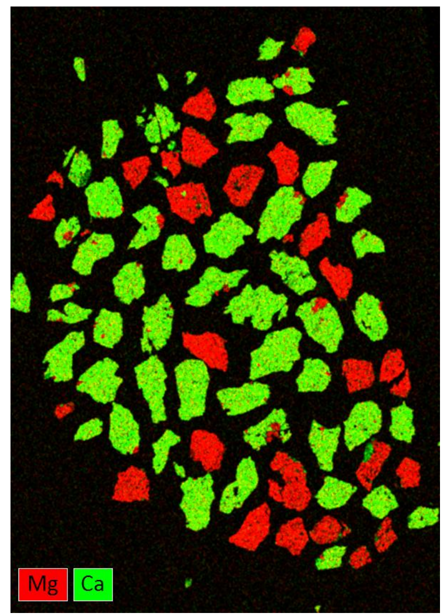
Input Count Rate (ICR): 2,100,000 cps

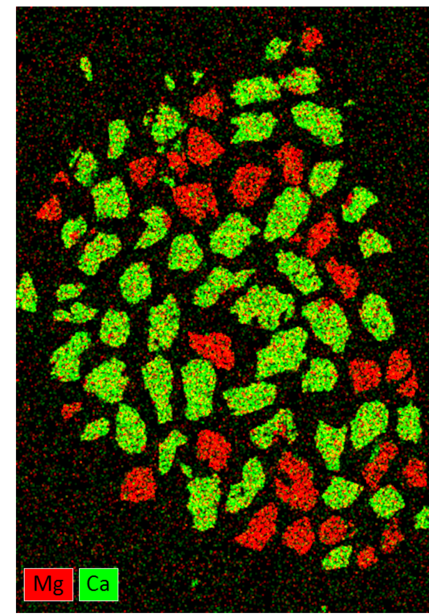
Pixel Dwell Time: Decreasing by order of magnitude

2048 µS	**256 µS**	**32 µS**	**4 µS**







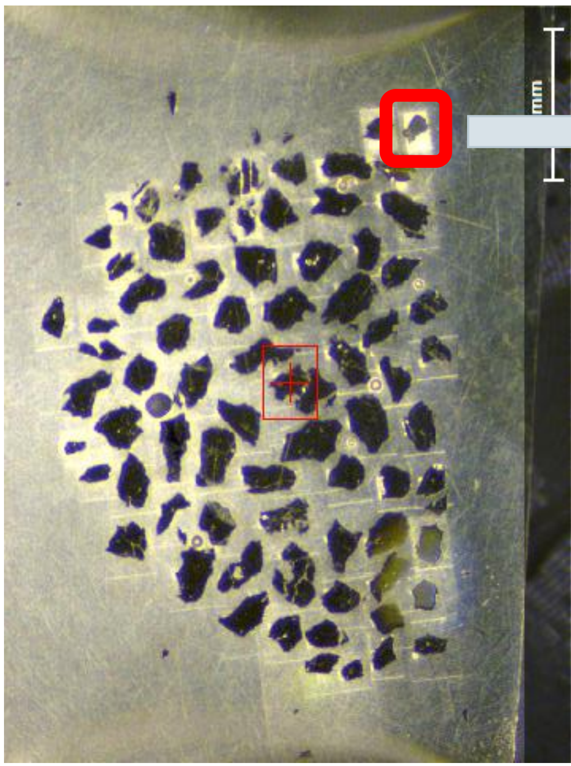


Total Analytical Time: Decreasing

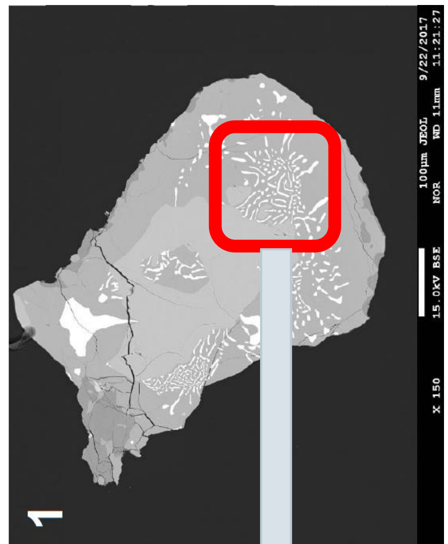
16 minutes	**126 seconds**	**15 seconds**	**2 seconds**

FlatQUAD: Hypermapping
Volcanic Grains

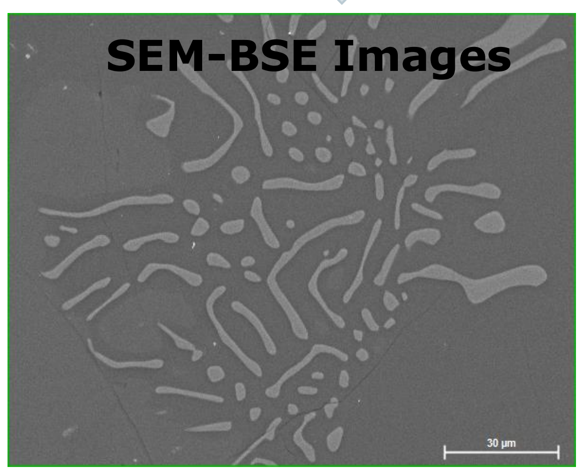
Titanomagnetite symplectic textures in volcanic grains



Optical Image

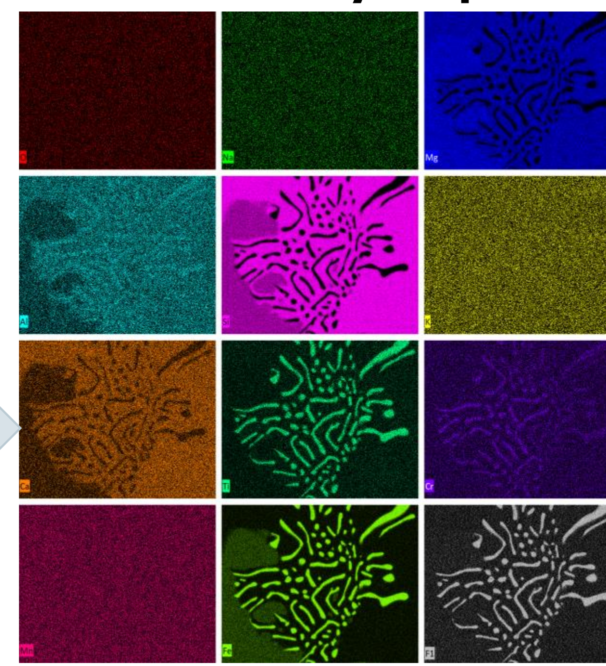


Pixel Size:	**250 nm**
Dwell Time:	**256 µS**
ICR:	**1,800,000 cps**



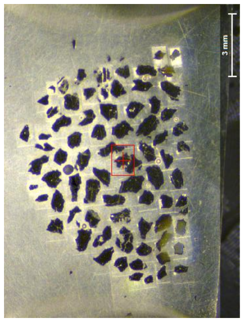
SEM-BSE Images

Individual Element Intensity Maps

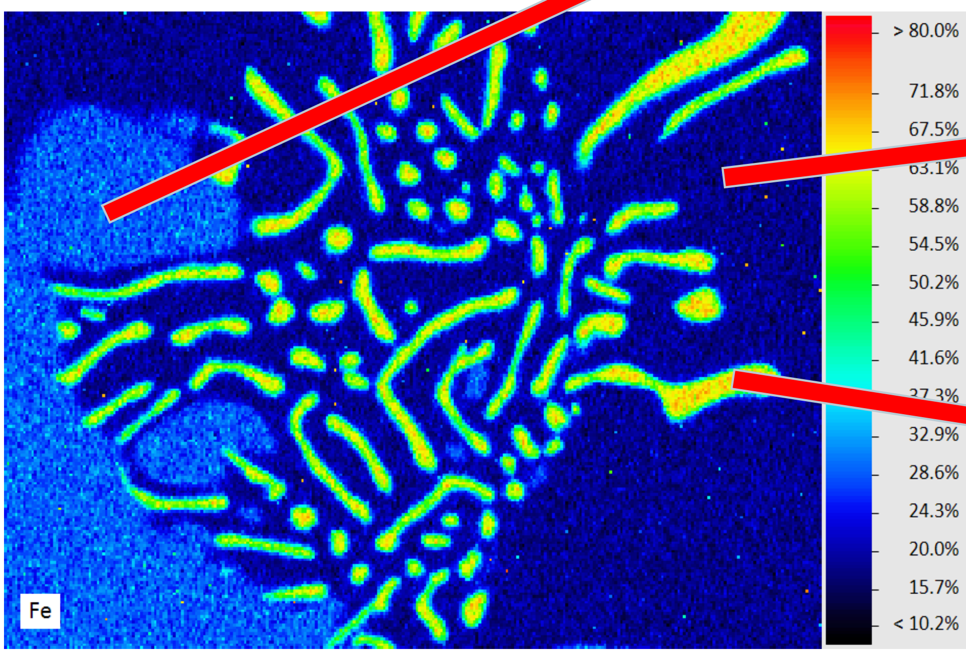


FlatQUAD: Hypermapping
Volcanic Grains

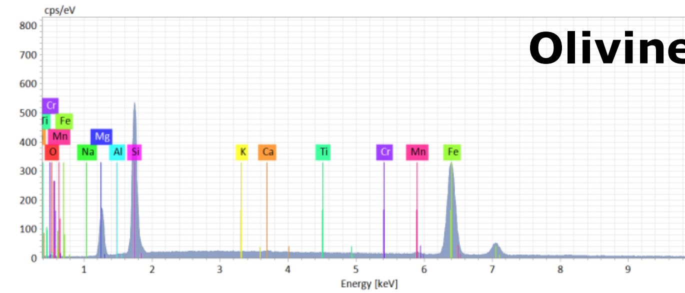
Titanomagnetite symplectic textures in volcanic grains

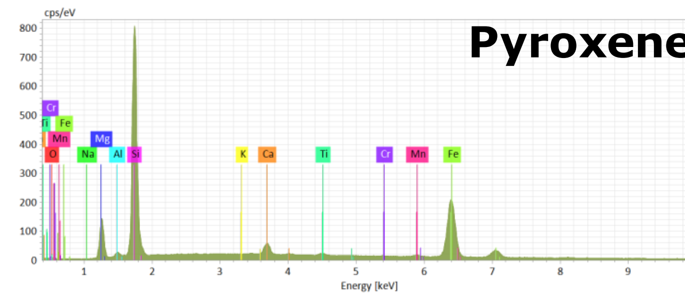


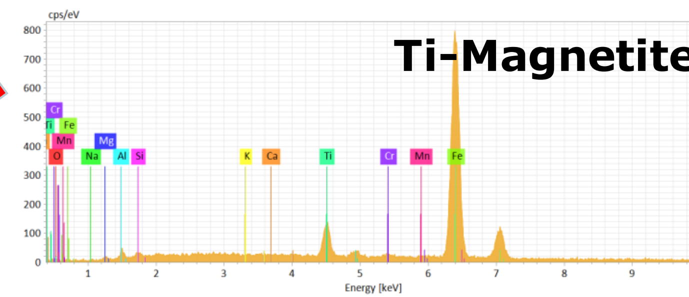
Mineral Identification and Composition



Fe Quant Map

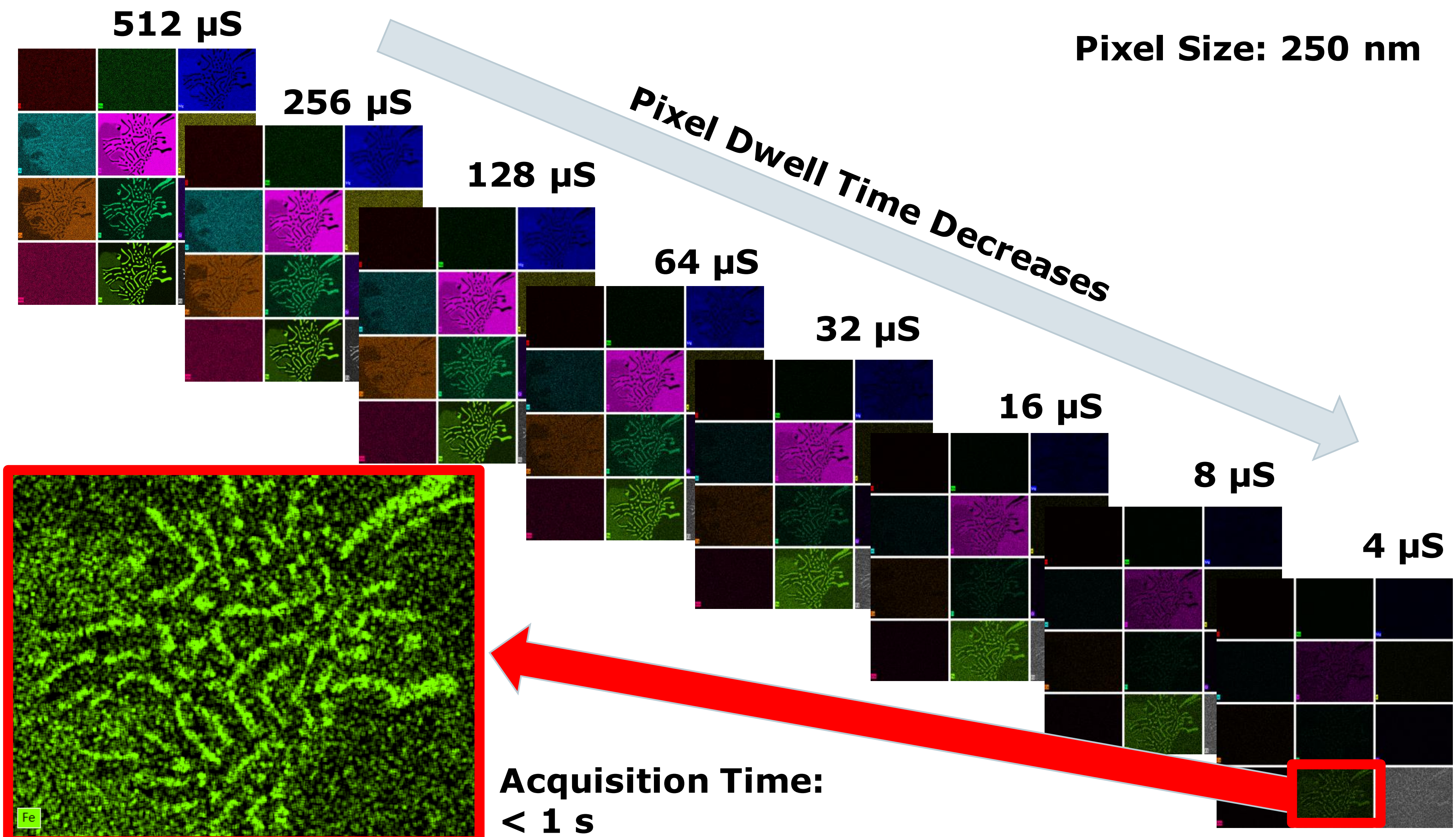






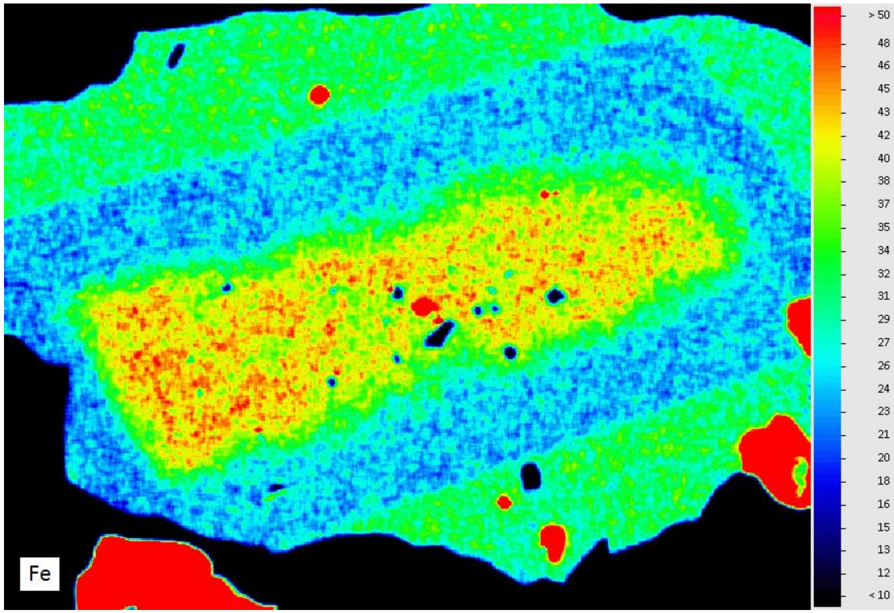
SEM-EDS: Hypermapping
Volcanic Grains

Titanomagnetite symplectic textures in volcanic grains



FlatQUAD: Hypermapping
Volcanic Grains

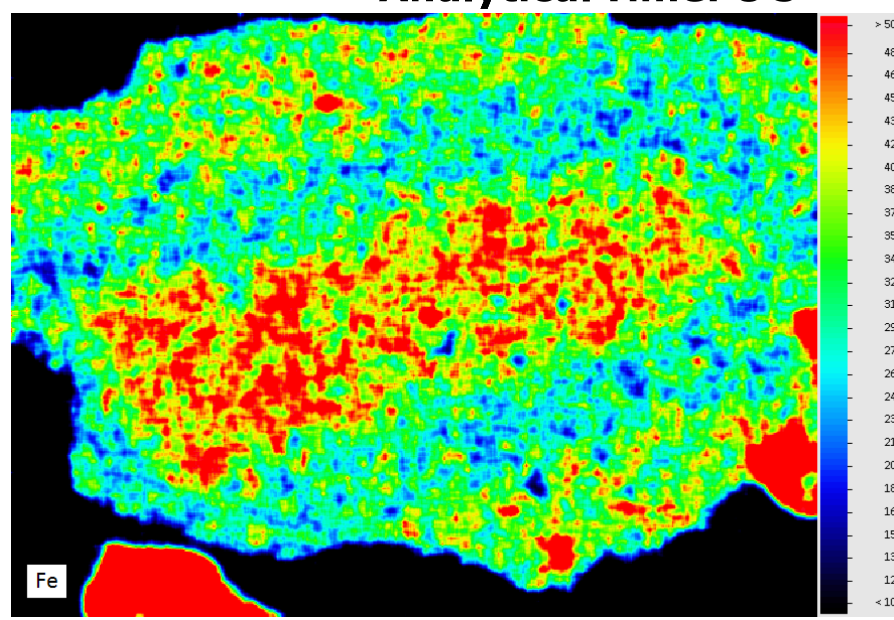
Zonation in clinopyroxene grain

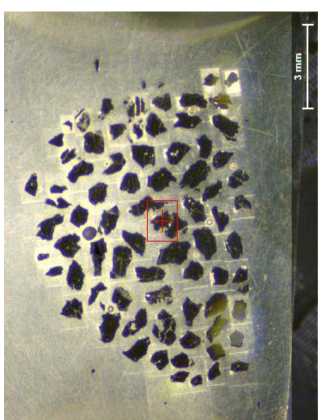


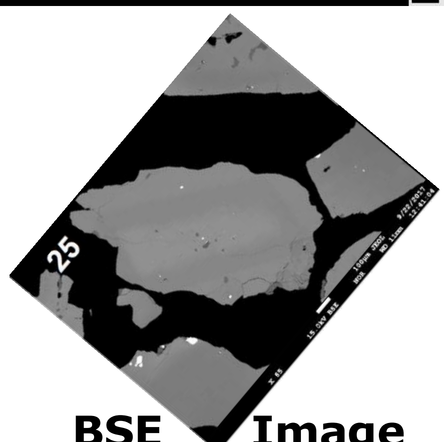
Pixel Size: 1.7 µm
Dwell Time: 1024 µS
Analytical Time: 256 s

ICR:
2,050,000 cps

Pixel Size: 1.7 µm
Dwell Time: 32 µS
Analytical Time: 8 s

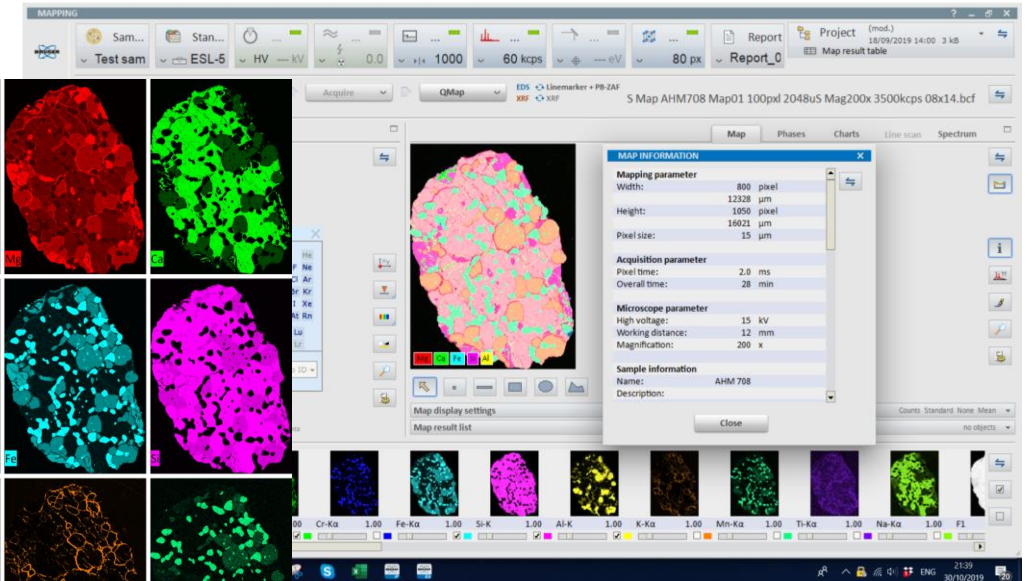


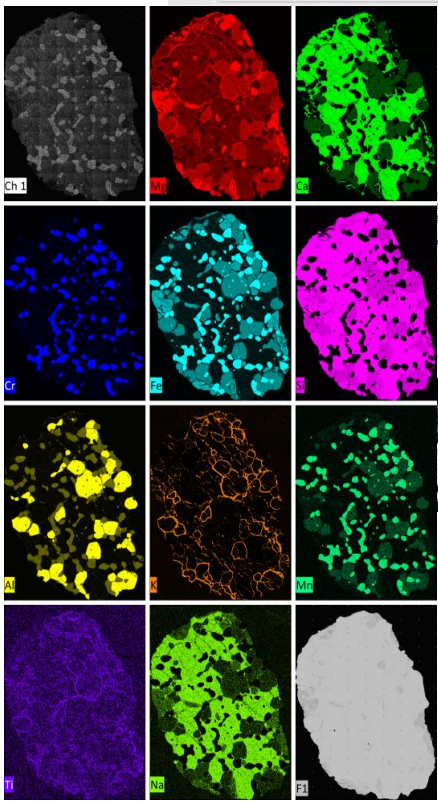




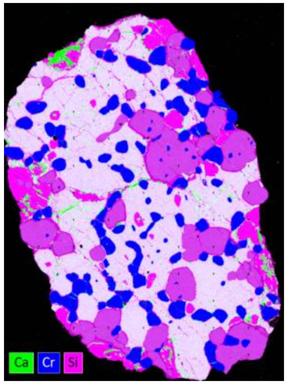
BSE Image

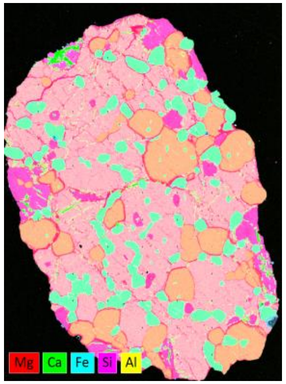
FlatQUAD: Hypermap Results
Phase Identification





Individual Element Intensity Maps





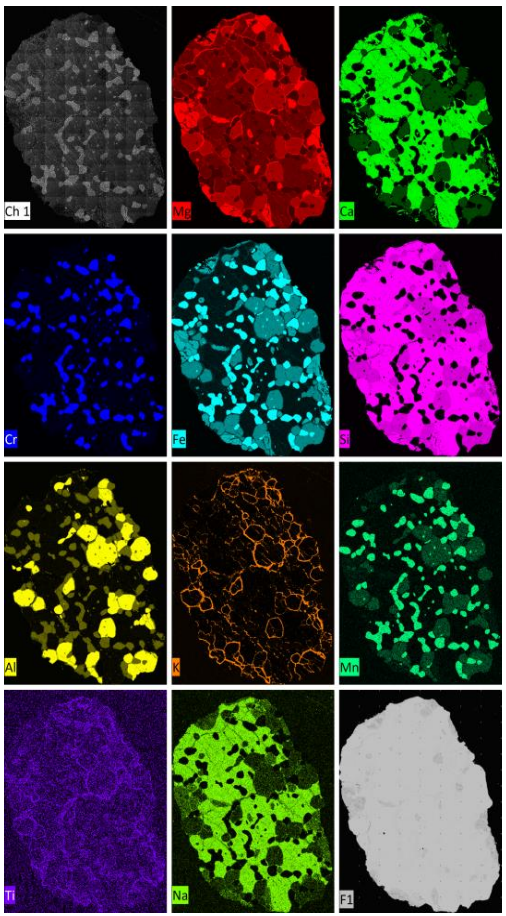
Mixed Element Intensity Maps

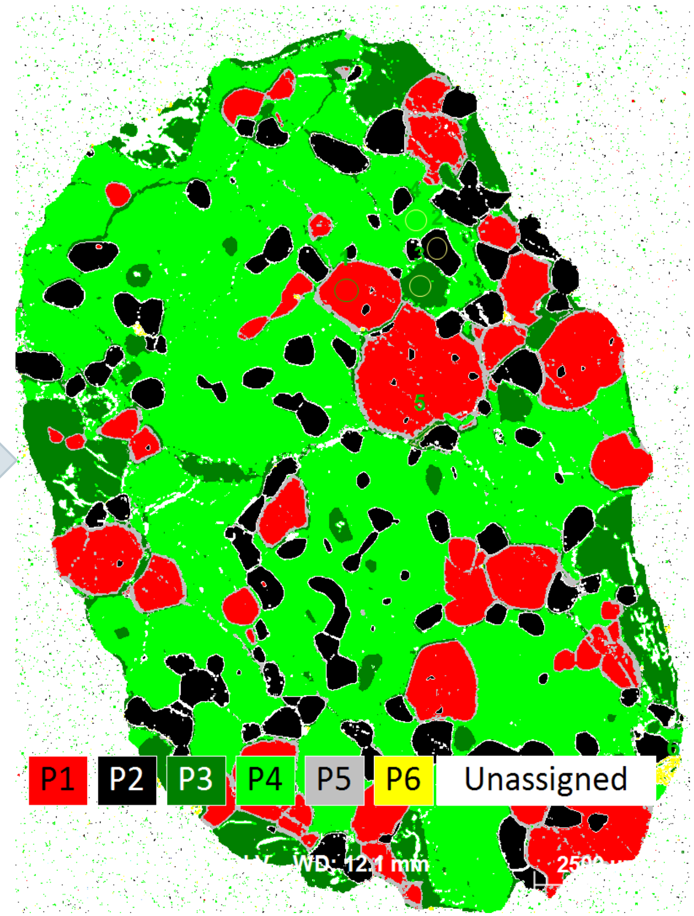
Measurement Conditions

High Voltage:	15 kV
Pixels:	800 x 1050
Measurment Time:	28 min
SDD:	4 x 60 mm^2
Dwell time:	2048 µs
FOV:	16 mm
Pixel size:	15 µm
Fields:	8 x 14 (112)
Magnification:	200x
ICR:	2,200,000 cps

FlatQUAD: Hypermap Results
Feature: Phase Identification

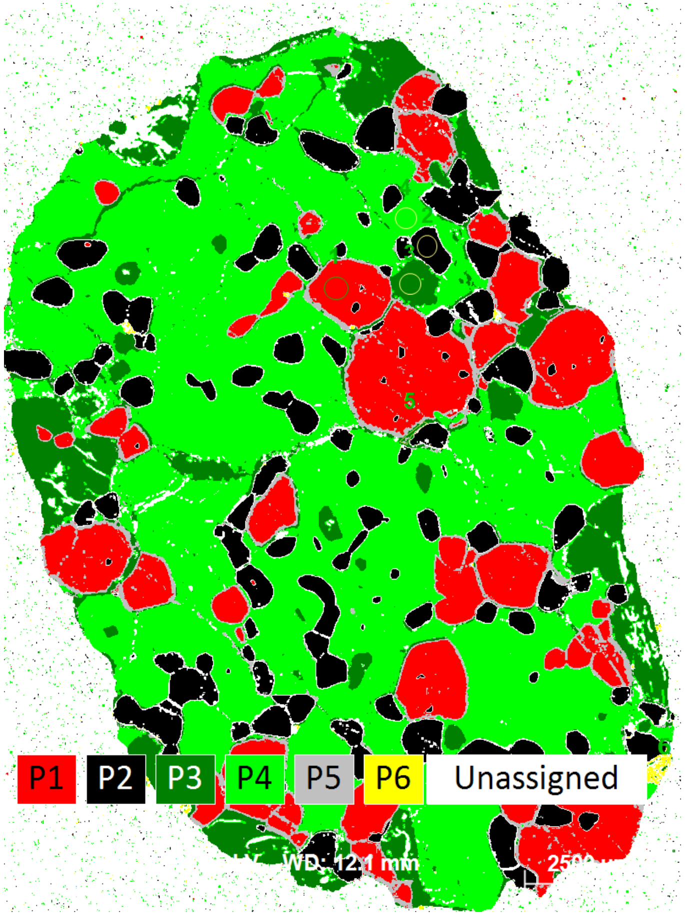
Phases Based on selected elements: Mg, Al, Si, Fe, Ca





FlatQUAD: Hypermap Results
Feature: Phase Identification

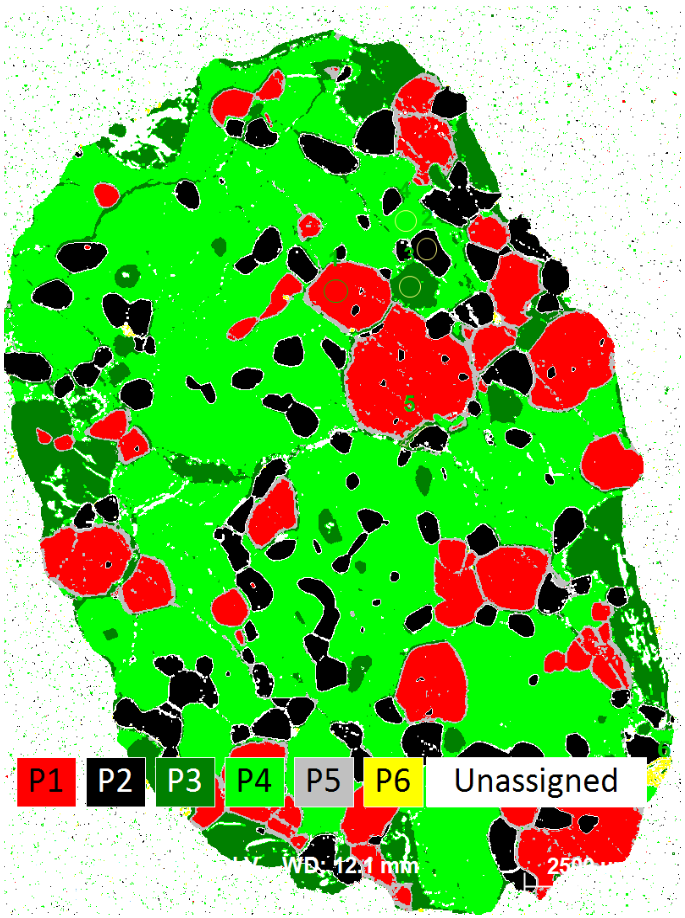
Phases Based on selected elements: Mg, Al, Si, Fe, Ca

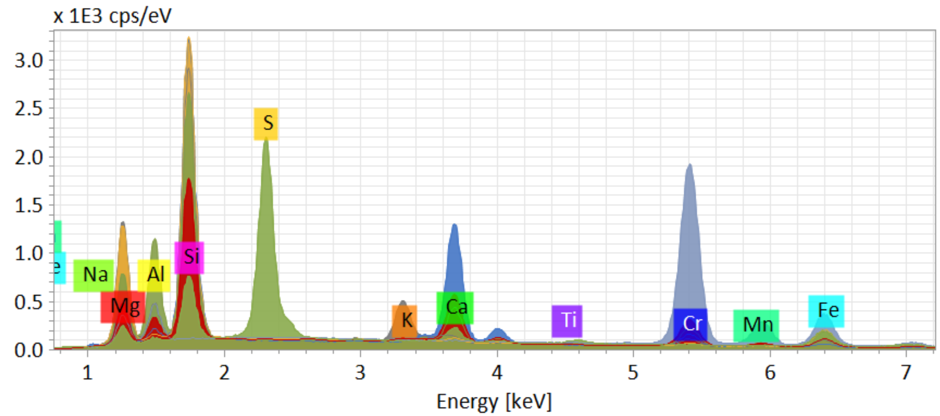


Phase	Area %
P1	12.3
P2	9.5
P3	7.7
P4	34.4
P5	3.2
P6	0.2
Unassigned	32.8

FlatQUAD: Hypermap Results
Feature: Phase Identification

Phases Based on selected elements: Mg, Al, Si, Fe, Ca

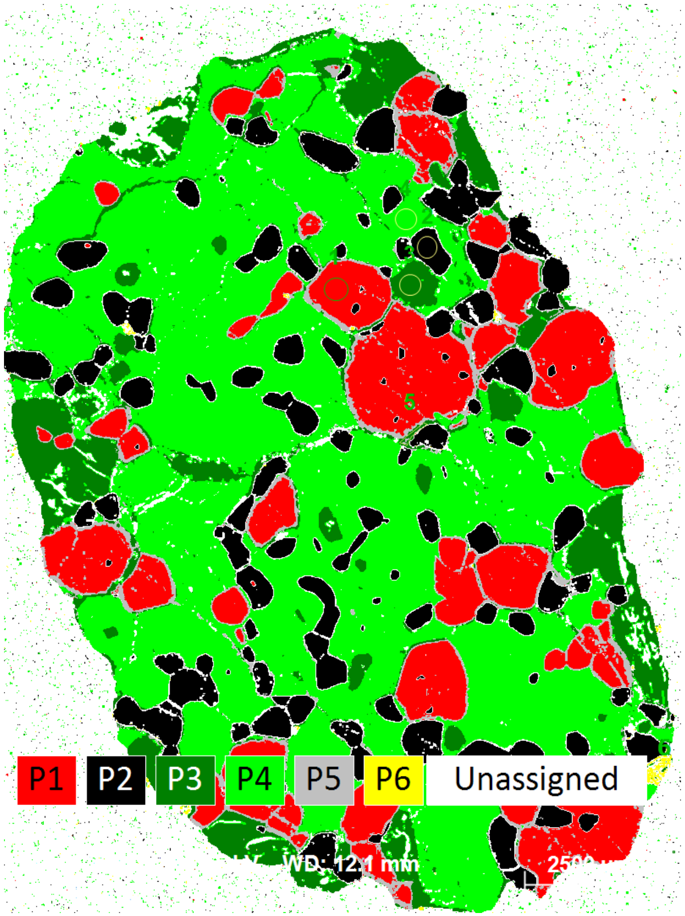




Spectrum	Oxygen	MgO	CaO	Cr2O3	FeO	SiO2	Al2O3	K2O	MnO	TiO2
P1	0.00	20.67	4.63	4.95	6.38	40.09	20.35	0.21	0.37	0.00
P2	0.00	14.62	0.08	54.93	14.20	1.34	10.70	0.02	0.58	0.00
P3	0.00	33.46	1.38	1.07	6.78	49.09	3.39	0.88	0.19	0.19
P4	0.00	16.89	18.38	3.87	1.73	50.41	3.48	0.46	0.00	0.00
P5	0.00	25.24	2.34	3.30	4.40	41.25	15.39	4.91	0.10	0.20

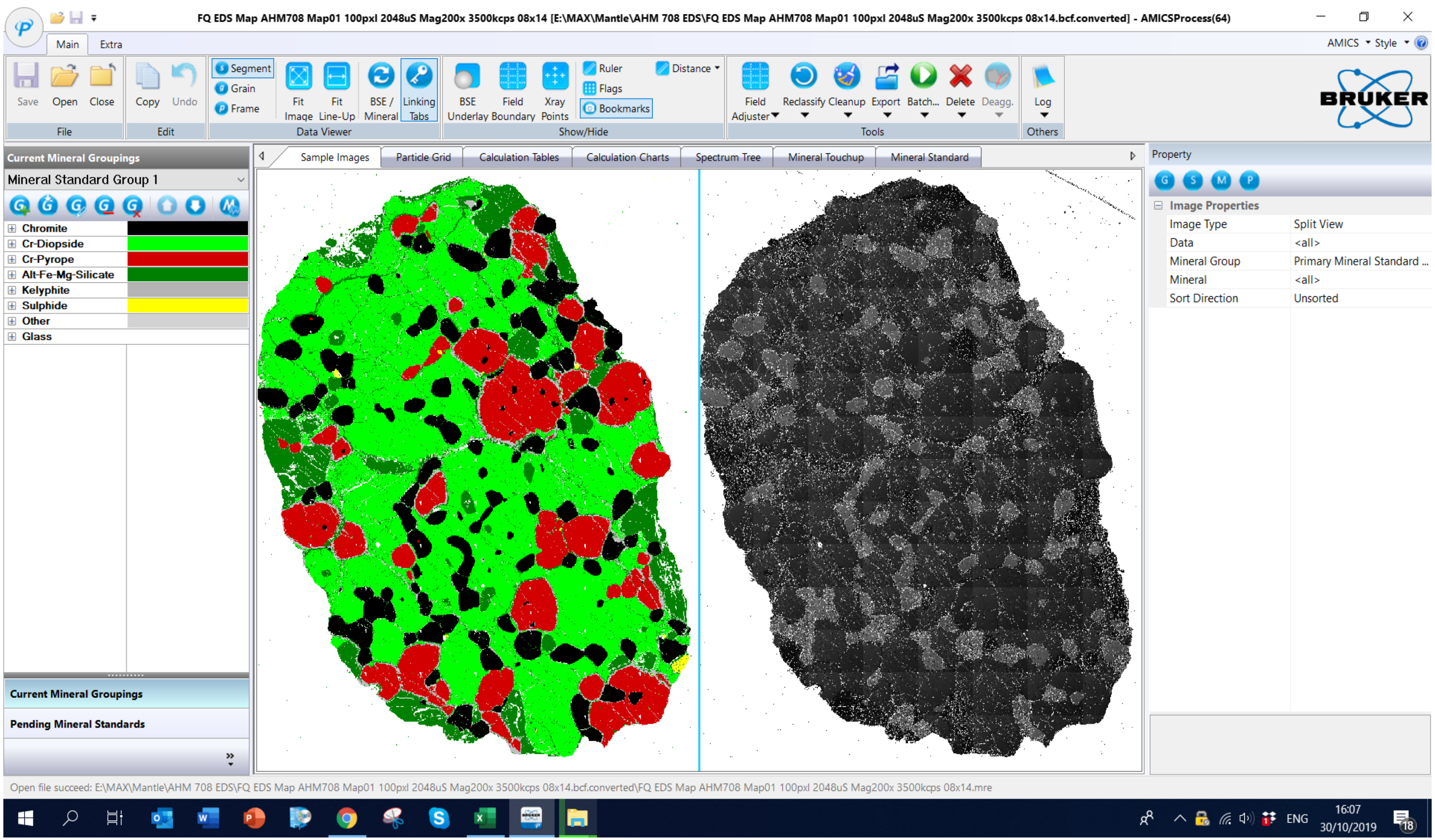
FlatQUAD: Hypermap Results
Feature: Phase Identification

Phases Based on selected elements: Mg, Al, Si, Fe, Ca

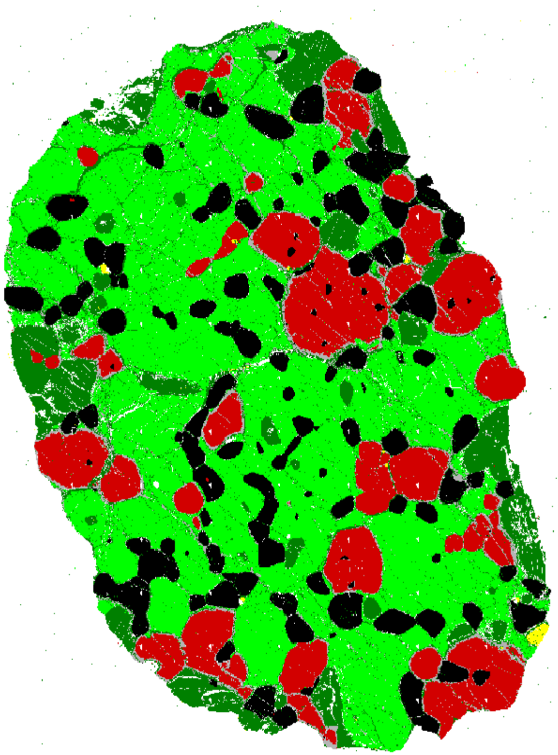


Phase	Area %	Mineral
P1	12.3	Garnet
P2	9.5	Chromite
P3	7.7	Olivine
P4	34.4	Clinopyroxene
P5	3.2	Metasomatism
P6	0.2	Sulphide
Unassigned	32.8	Glass Slide

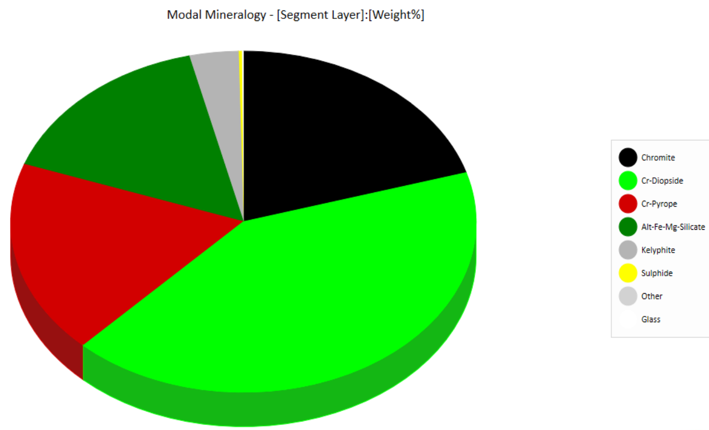
FlatQUAD: Hypermap Results
AMICS: Automated Mineralogy

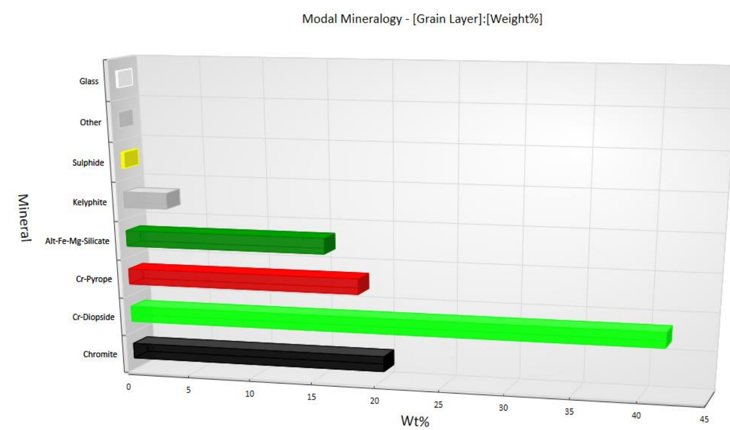


FlatQUAD: Hypermap Results
AMICS: Chromite



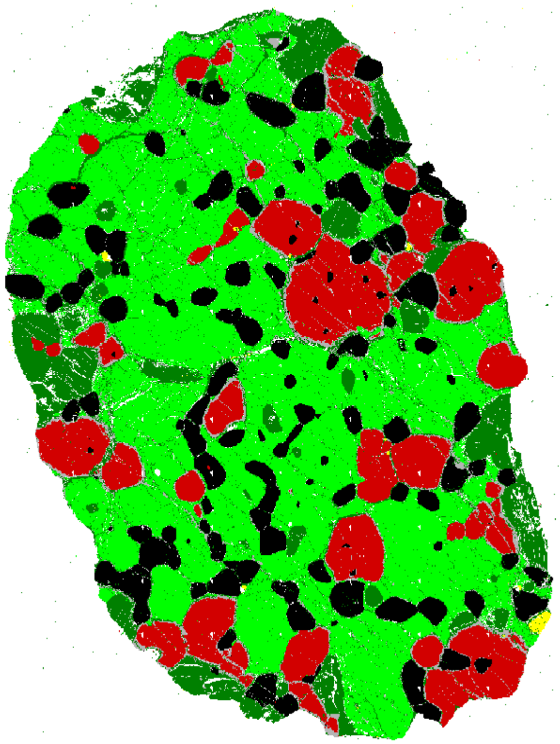
Mineralogical Map:
All phases shown



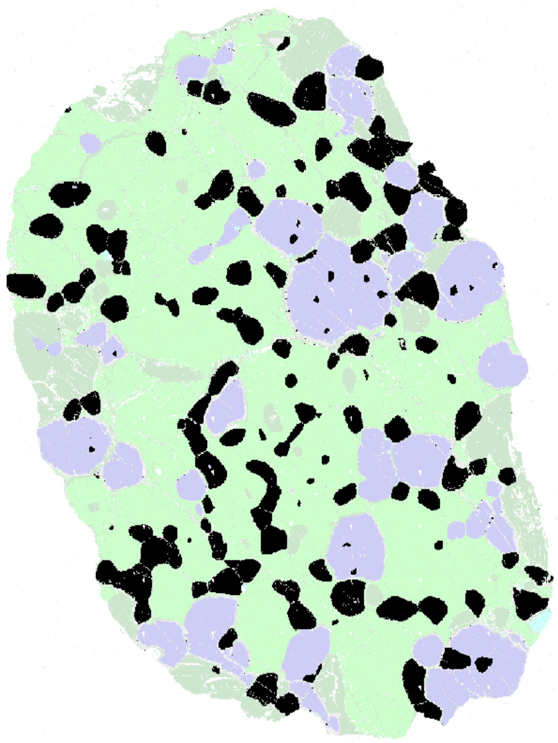


Modal Mineralogy:
Quantification

FlatQUAD: Hypermap Results
AMICS: Chromite



Mineralogical Map:
All phases shown



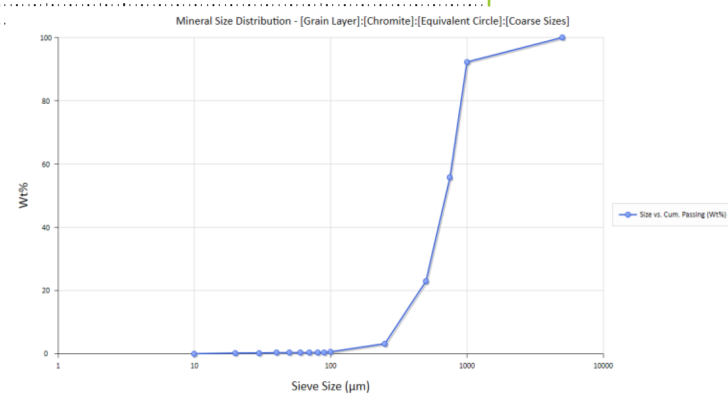
Mineralogical Map:
Chromite Mineral enhanced
Other Minerals faded

Chromite Mineral Map:
Relative Positions

FlatQUAD: Hypermap Results
AMICS: Chromite

Chromite Mineral Map:
Relative Positions

Chromite Mineral Grains:
Sorted by Size



Chromite Mineral Grains Size Distribution

AMICS:
Relevant Mineralogical Information

Modal Mineralogy: How much of each mineral is present.

Elemental Assay: How much of each element is present (Whole Rock).

Elemental Distribution: How is the element of interest (EOI) distributed in each mineral? E.g. Cr in Chromite vs Pyrope Garnet.

Mineral Association: Identify how the minerals are associated with each-other, e.g. Chromite and Garnet and Clinopyroxene etc.

Grain Shape Factor: The shape of the grain, i.e. euhedral, elongated.

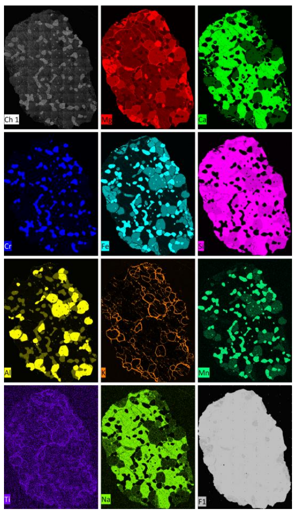
Mineral Density Distribution: Classify densities of minerals. Identify how the minerals are distributed among the densities.

Grade Recovery Curves: What % of minerals of interest (MOI) or element of interest (EOI) is recovered at what grade?

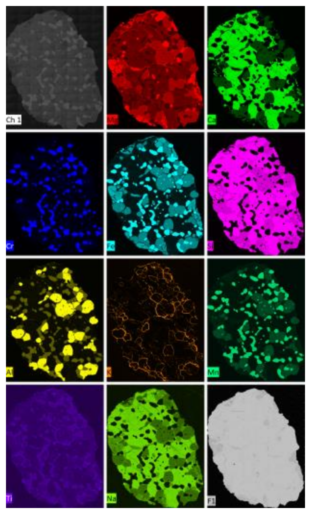
FlatQUAD: Hypermap Results

Analytical Time

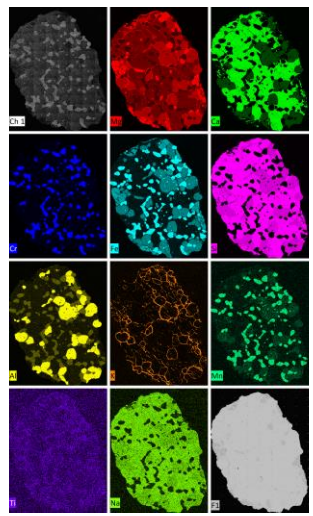
800 px
512 µS
462 min



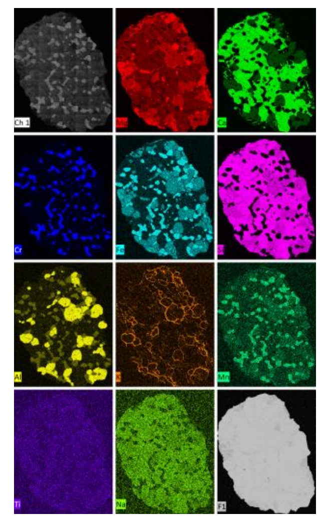
100 px
048 µS
28 min



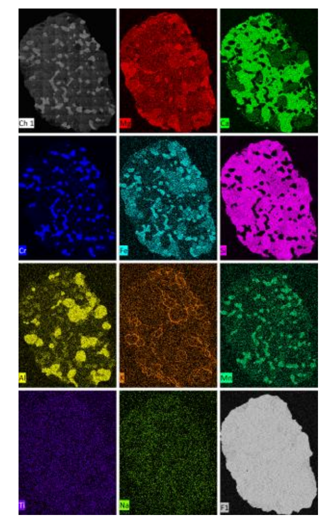
100 px
256 µS
4 min

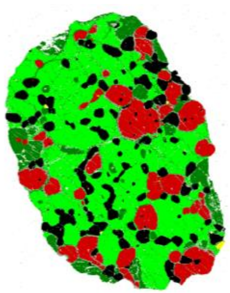


100 px
32 µS
26 sec



100 px
4 µS
3 sec



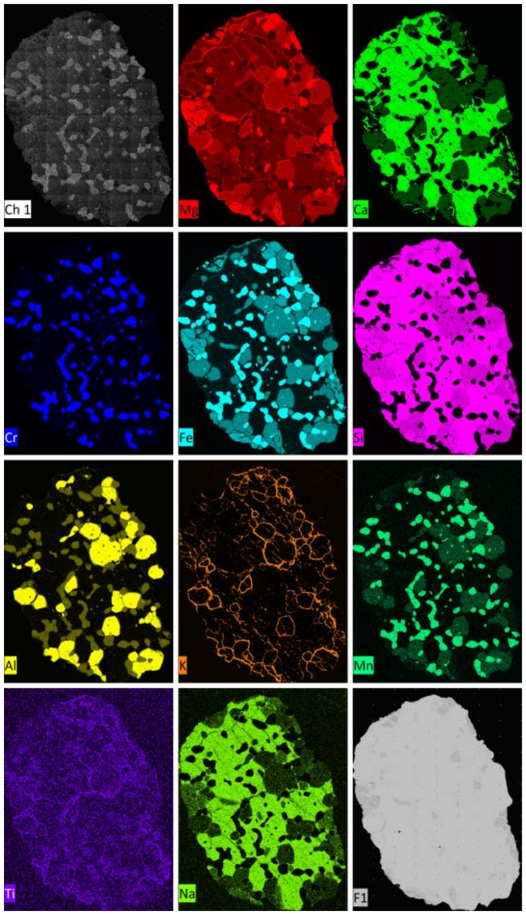


Pixel Dwell Time: Decreases

Analytical Time: Decreases

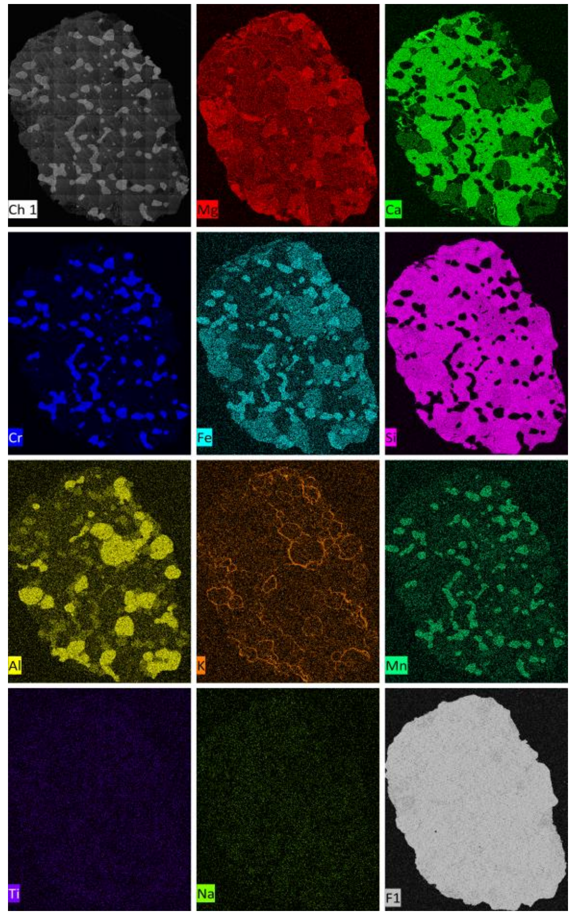
Note: Does not include stage movement time

FlatQUAD: Hypermap Results
High count map vs. low count map



High Count Map,

(28 min), 8x14 fields (112)



Low Count Map

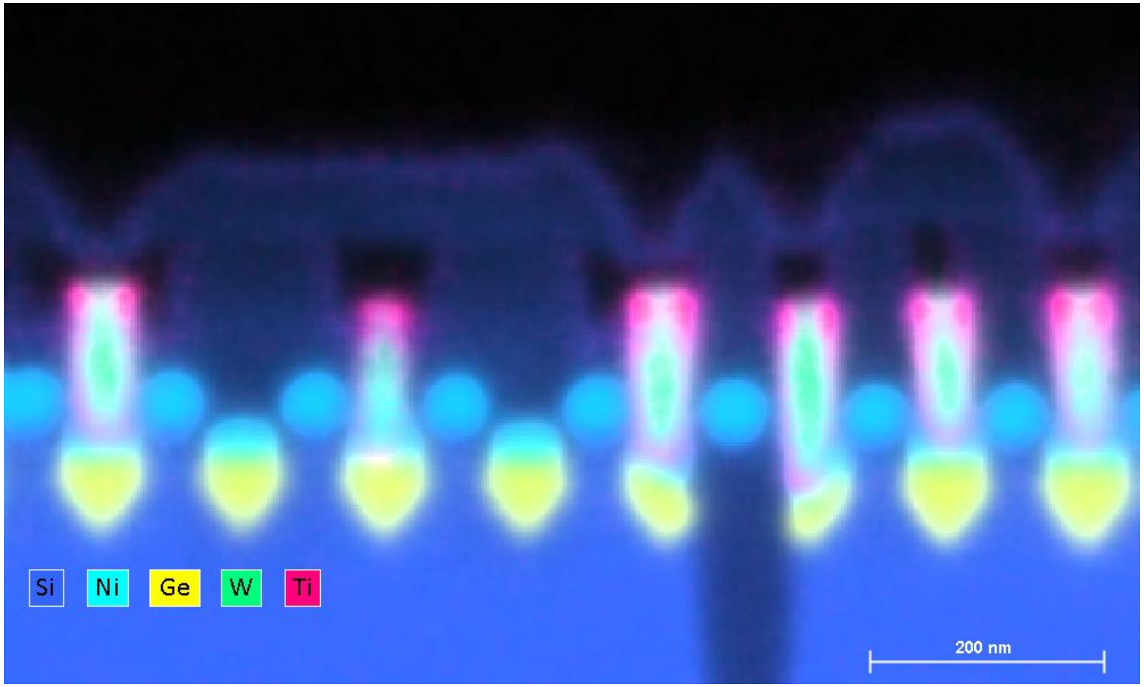
(3 sec), 8x14 fields (112)

Major element distribution is visible in both maps

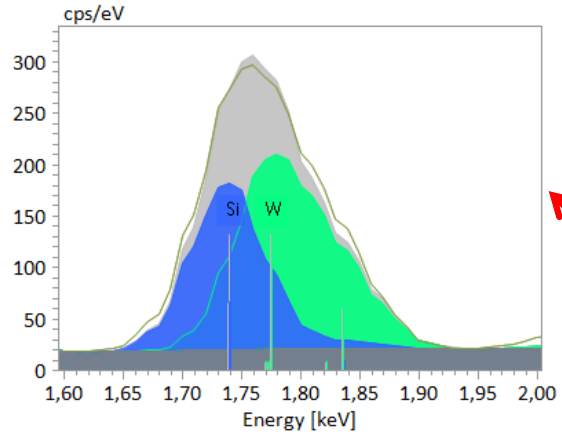
Due to background noise, minor elements are identified better in the high count map

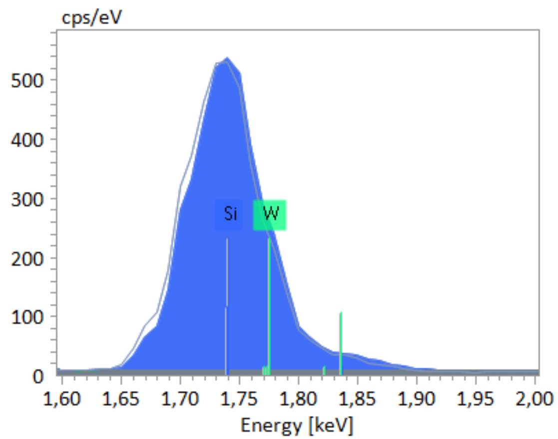
Mapping of nano structures - Semiconductor

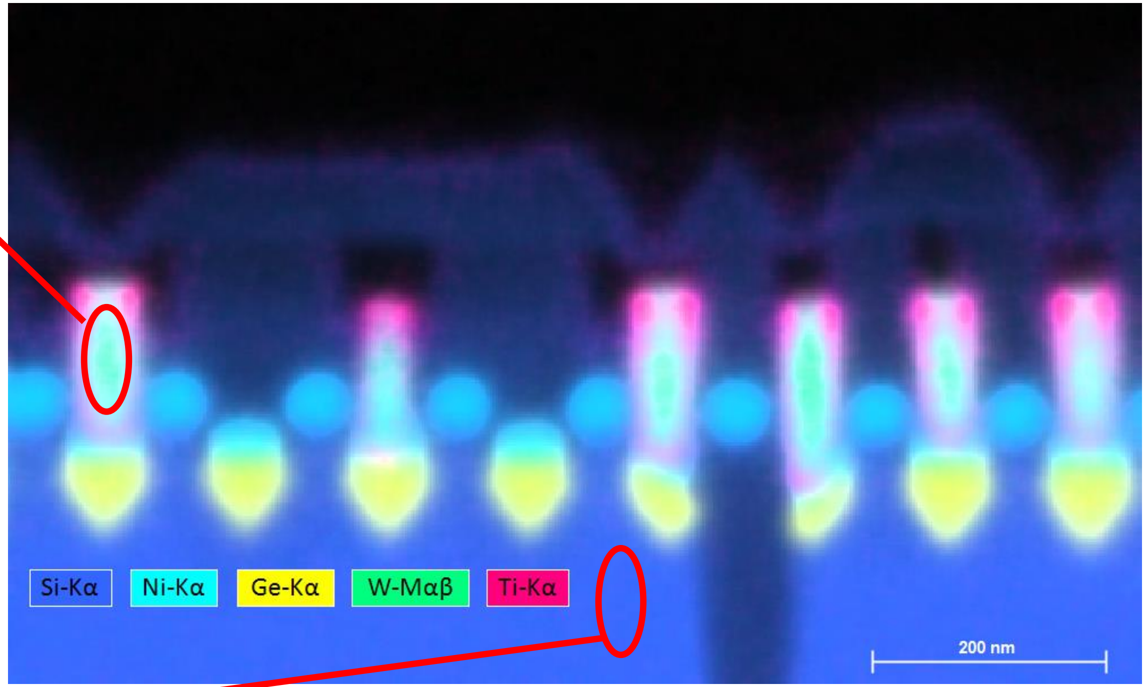
EDS Measurement parameters	
Map size	400 x 240 px
Measurement time	60 minutes
HV	20 kV
Input count rate	380 kcps
WD	14 mm
Dead time	20%



Mapping of nano structures – Semiconductor
Peak overlaps – online deconvolution





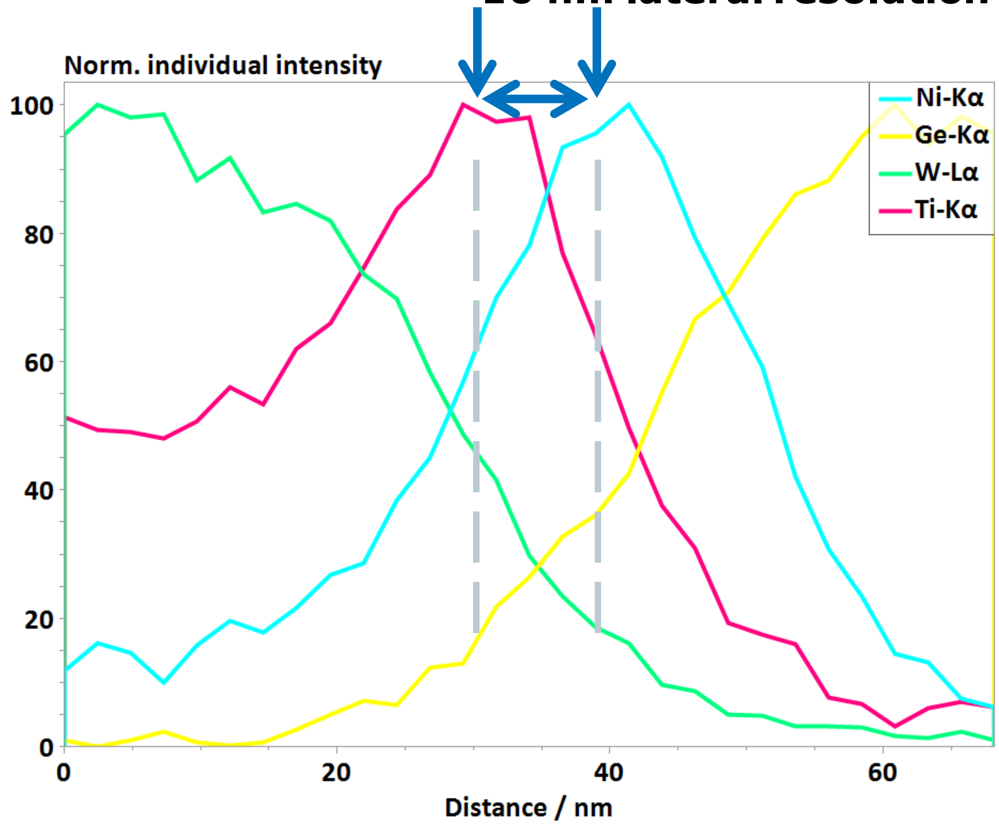


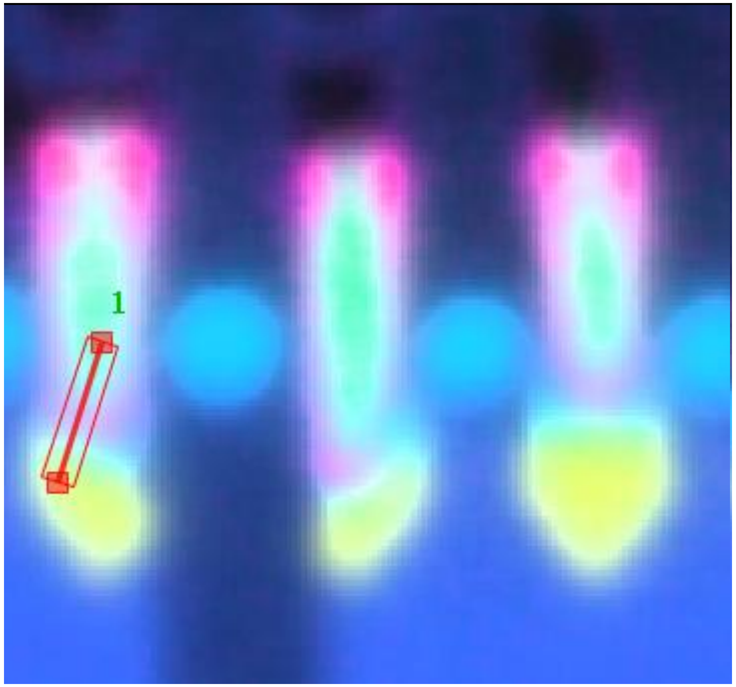
Extracted area spectra from the map

Mapping of nano structures – Semiconductor

Lateral resolution of 10 nm

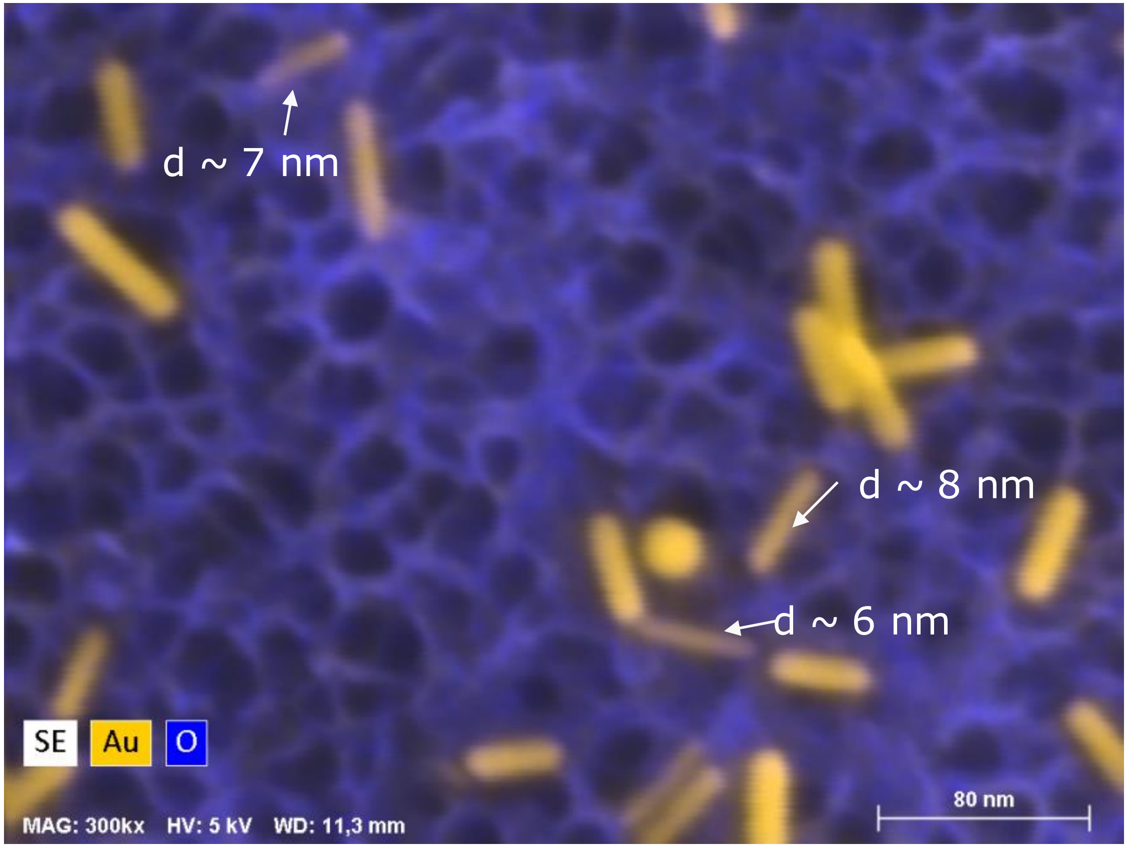
10 nm lateral resolution of Ni and Ti distribution maxima





Extracted linescan from the map data

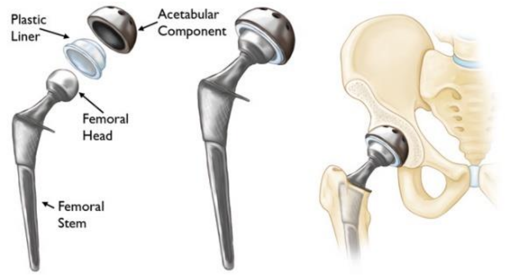
Mapping of nano structures – Au NP
Lateral resolution of under 10 nm



Au-NP on TiO_2 Sponge-like coating for implants

T. Yang et al., Colloids and Surfaces B: 145, 597 (2016).

Ralf Terborg et al., Microscopy Today, 2017, 3: 35



- Au-nano particles (NP) to avoid implant inflamation
- NP change surface potential
- Settling bacteria get „electricuted".
- For successful tissue growth it is very important to judge the distribution of the NP and compare it to fluorescence light microscopy.

FlatQUAD:
Summary and conclusions

- The FlatQUAD gives fast, accurate and precise quantification results. This can be standard-based or standardless.
- Ideally suited for beam sensitive samples and/or samples were sample preparation like coating is impractical.
- Avoids shadow effects.
- Ultra high speed mapping over entire thin sections (40 x 30 mm) in less then 3 minutes are possible with stage movment.
- Smallest particles can be observed and analyzed with low beam currents.
- Superior to standard SDD in speed and count-rate.

Acknowledgements

Dr Osvaldo Gonzales

Dr Petrus le Roux

Dr Valentin Troll

Dr Frances Deegan

Dr Nils Schlüter

Q&A

Are There Any Questions?

Please type in the questions you might have

in the Q&A box and press *Send*.

More Information

For more information, please contact us:

info.bna@bruker.com

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