

An Investigation into
MINERALOGICAL CHARACTERISTICS OF THE MOINA FLUORSPAR, TIN, TUNGSTEN,
AND BISMUTH DEPOSIT FOR THE PURPOSE OF METALURGICAL BENEFICIATION

prepared for

TNT MINES LTD. (FORMERLY MINEMAKERS LTD.)

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Executive Summary

One Composite sample, labelled **PO268 Modd Comp.**, was submitted to the Mineral Services group within SGS for mineralogical characterization using the QEMSCAN™ technology, chemical analysis, X-Ray Diffraction (XRD) and Scanning Electron Microscopy equipped with Energy Dispersive Detectors (SEM-EDS). This mineralogical characterization was recommended by Mr. Malcolm Crawford of Delta Minerals Limited, consultant for TNT Mines Ltd. for the purpose of examining the mineralogical characteristics of the Moina F-Sn-W-Bi Skarn (Wrigglite) deposit located in Tasmania Australia, and to explore the feasibility of this material for metallurgical beneficiation. Historical beneficiation and mineralogical testwork conducted in the late 1970's and early 1980s indicated complications with regards to the fluorine extraction but also Sn concentration. Since new technologies with regards to mineral processing have advanced, so the question arises if new techniques could be implemented into a flowsheet and drastically change the economics of the property. The head grades of the **PO268 Modd Comp** are listed below.

F	S	Sn	Bi	W	Zn	Mo	Fe
7.90%	0.20%	0.16%	0.05%	0.06%	0.02%	0.005%	18.50%

There were two main objectives to this study;

1. Characterize the sample by size fraction using the QEMSCAN to determine:
 - a. the mineral distributions;
 - b. deportment of F and Sn;
 - c. locking/association and grain size characteristics of the fluorite, cassiterite, Bi-Minerals, scheelite, sulphides (mainly pyrite) and Fe-Oxides; and
 - d. determinative mineralogical parameters such as mineral release and grade recovery.
2. Analyze coarse material (-10 mesh) and determine the “natural” grain size of the scheelite to establish if a gravity concentrate is feasible. This sample was analyzed with the SEM.

The sample preparation and the details of the results are discussed in the main body of the report, but some of the points of interest are discussed in this summary.

For the first objective, the QEMSCAN results determined the following:

- **Mineral Abundances**

- The sample consists mainly of various Ca-Silicate minerals such as vesuvianite/epidote (13.8%), garnet (5.6%), actinolite/cummingtonite (5.8%), Fe-Ca-Amphibole (~15%) and diopside (~2%). Moderate levels of Fe-Oxides (~18.5%), fluorite (~14%), biotite (~8%), plagioclase (~8%), and minor calcite (1.5%), chlorite (~1.1%) and a high F chlorite (~0.6%) were also detected. Pyrite was identified in trace levels (~0.5%), whereas other sulphides are scarce (0.03%).
- The trace phases of particular interest include scheelite (0.21%), Bi-Minerals (~0.1%) including predominately Bi-Sulphides, but Native bismuth was also observed during the

SEM investigation, cassiterite (0.07%) and the Sn-Fe Oxide (0.05%). Notably, these minerals occur mainly in the -20 µm size fraction.

- **SEM Investigation and Elemental Department**

- A SEM-EDS analysis was also conducted to aid the QEMSCAN interpretation. Historical studies have shown that fluorine can be a low level constituent in the various Ca-Silicate phases but also in micas. This was confirmed during the SEM-EDS. Sn is also present in trace amounts in various minerals. The historic data have shown that both garnet and sphene could also contain low levels of Sn (up to 0.7 wt%). During the SEM investigation, sphene was not analyzed but garnets, and, less commonly, vesuvianite contained Sn.
- The deportment of fluorine and Sn were calculated based on the QEMSCAN mineral distribution and the SEM investigation. The data show that ~92% of the fluorine is contained in the fluorite, while the remaining 8% is carried by the various Ca-silicates and micas. Approximately 37% of the Sn is contained in the garnet (non-recoverable Sn). Cassiterite and a Sn-Fe Oxide (or very fine grained cassiterite in Fe-Oxides) account for 48% and 15% of the Sn, respectively.

- **Liberation/Association and Grain Size of**

- **Fluorite:** Approximately 50% of the fluorite occurs as liberated particles (both the Free and Liberated categories combined), and increases from the +63 µm fraction to the -20 µm fraction (~19% liberated to ~70%). “Midds”, “Sub-Midds” and “Locked” grains represent 5%, 32% and 10%, respectively. The non-liberated fluorite mainly occurs as ternary particles with Fe-Oxides and silicates (~23%), and as binary particles with Ca-silicates (~9%) and complex particles (~6%). Fluorite in the “Midd”, “Sub-Midds” and “Locked” classes are generally <30 µm in size.
- **Cassiterite:** It is very poorly liberated (~11% for both the “Free” and “Liberated” categories). It most commonly occurs as ternary particles with Fe-Oxides and silicates (~27%), complex particles (~27%), and binary particles with Ca-silicates (~15%). Liberation increases moderately with decreasing size from ~nil in the +63 µm to ~30% in the -20 µm size fraction). Based on the grain size data roughly 50% of the cassiterite is <10 µm in size.
- **Bi-Minerals:** They are poorly to moderately liberated (~39% of the combined “Free” and “Liberated” classes). “Midds” represent ~6%, whereas “Sub-Midds” and “Locked” grains represent 24% and 30%, respectively. Bi-Minerals are commonly associated with ternary particles with Fe-Oxides and silicates (~14%) and complex particles (~30%). Liberation increases moderately with decreasing size from ~10% in the +63 µm to ~60% in the -20 µm size fraction. Based on the grain size data, approximately 90% of the Bi-Minerals are <12 µm in size.
- **Scheelite:** The scheelite is moderately liberated at 52%, while “Midds” account for ~6% and “Sub-Midds” for ~26%, and “Locked” for ~15%. Scheelite most commonly occurs as complex (~17%) and as ternary particles with Fe-Oxides and silicates (~10%), and as binary particles with fluorite. Liberation increases with decreasing size from ~16% in the +63 µm to ~70% in the -20 µm size fraction. Based on the grain size data roughly 80% of the scheelite is <30 µm.

- **Grade vs. Recovery**

Overall, the maximum achievable grade vs. recovery at this grind target indicates that for;

- Fluorite – ~100% CaF₂ grade with ~37% recovery,
- Cassiterite – ~77% Sn grade with ~13% recovery,
- Bi-Mineral – ~81% Bi grade with ~21% recovery,
- Scheelite – ~80% WO₃ grade with ~34% recovery are theoretically achievable.

For the second objective, the SEM investigation did not find coarse particles of scheelite. The largest particle found was ~80 µm.

Introduction

This report describes a test program using a combination of mineralogical techniques including the QEMSCAN™ technology (Quantitative Evaluation of Materials by Scanning Electron Microscopy), X-Ray Diffraction (XRD) and Scanning Electron Microscopy equipped with Energy Dispersive Detectors (SEM-EDS) on one sample labelled **PO268 Modd Comp.** from the Moina F-Sn-W-Bi Skarn (Wrigglite) deposit located in Tasmania Australia. This sample was submitted for analysis by Mr. Malcolm Crawford of Delta Minerals Limited, consultant for TNT Mines Ltd. for the purpose of exploring the mineralogical characteristics of this ore body for metallurgical beneficiation. Historical metallurgical testwork conducted in the late 1970's and early 1980's by AMDEL (Australian Mineral and Development Laboratories) has shown that extraction of the some of the elements, in particular the Sn, is difficult. Historical mineralogical data with regards the fluorspar indicates that a very fine grind would be required to make a quality concentrate (estimated target grind would be ~30 µm). Since then, new technologies with regards to the processing have advanced. Thus, the question arises if new processes could be implemented into a flowsheet to drastically change the economics of the property. This program was also conducted to reaffirm some of the initial historical mineralogical data and to also evaluate the tungsten, bismuth and sulphide minerals

This composite sample was received in four size fractions with an approximate K_{80} of 63 µm (+63µm, -63/+45 µm, -45/+20 µm, -20 µm) and as -10 mesh material. The QEMSCAN™ analysis was conducted to quantify the mineral abundances by size fraction and determine the liberation/association characteristics of the fluorspar, tin, tungsten and bismuth minerals, but also the related gangue minerals that could be problematic (i.e., pyrite). XRD analysis was conducted to validate the QEMSCAN™ data.

An aliquot of the -10 mesh material was also submitted for an SEM investigation. The historic mineralogical work indicated that a portion of the tungsten minerals were much coarser than the other economic minerals of interest. Thus, examination of the -10 mesh was conducted to confirm if coarse scheelite was present and determine its "natural" grain size. This would indicate if a gravity separation technique could be implemented early in the process stream.



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Testwork Summary

1. Sample Preparation & QEMSCAN Analysis Mode

The **PO268 Modd Comp.** was received as four size fractions (+63 μm , -63/+45 μm , -45/+20 μm , -20 μm) but also, a -10 mesh sample was provided. Each size fraction was micro-riffled to generate representative splits for polished section preparation, chemical analysis for Whole Rock Analysis, F, Bi, Mo, Zn, Sn, W, S and CO_3 . Graphite impregnated polished epoxy grain mounts were prepared from each size fraction. Each polished section was submitted for mineralogical analyses using the QEMSCAN™ Particle Map Analysis (PMA) and Specific Mineral Search (SMS) mode of measurement. The PMA generates valuable mineral liberation and association data for all particles and collects the modal abundance of each mineral phase, as well as provides overall mineral distribution. The SMS searches for “bright phase” minerals. For Moina, the Sn minerals (cassiterite), W-minerals (scheelite), Bi-Minerals, and sulphides such as pyrite and sphalerite were mapped to generate an ample statistical population of particles for these lower grade mineral constituents. Similarly to the PMA, liberation and association data can be provided with this mode of measurement.

The complete QEMSCAN™ data is presented in Appendix A.

The QEMSCAN™ calculated assay and the direct chemical assays from the WRA, F, Bi, Sn, W and S assays were compared as a quality control for each of the size fractions, as presented in Figure 1 and in Appendix A. The overall correlation coefficient is 0.98. The Chemical Certificate of Analysis (CofA) is presented in Appendix B.

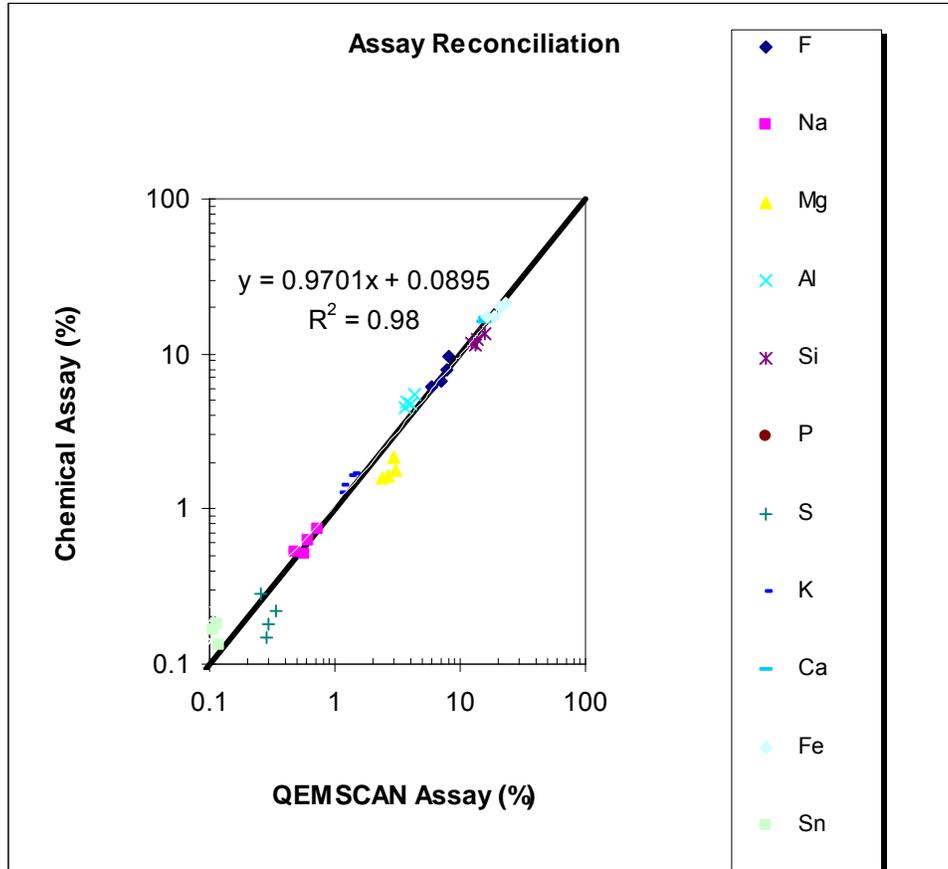


Figure 1: QEMSCAN™ Calculated Assay vs. Chemical Assay for the PO268 Modd Comp.

2. X-Ray Diffraction (XRD) Analysis

Each of the size fractions were also subjected to an X-Ray Diffraction analysis which is summarized in Table 1. The full XRD report including patterns and working conditions are presented in Appendix C. Each fraction is mainly composed of magnetite and fluorite, and minor amounts of vesuvianite, pyroxene, amphiboles, garnet, micas, feldspars and quartz. This analysis was used to help develop the QEMSCAN™ SIP (Species Identification Program) and confirm the speciation of specific minerals.

Table 1: Summary of the X-Ray Diffraction Analysis

Sample	Major	Moderate	Minor	Trace
(1) PO268 Modd Comp +63 μm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, potassium feldspar, mica, garnet, quartz	*chlorite, *kaolinite, *epidote, *calcite
(2) PO268 Modd Comp - 63/+45 μm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, garnet, quartz	*chlorite, *epidote, *potassium feldspar, *calcite
(3) PO268 Modd Comp - 45/20 μm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, garnet, quartz	*chlorite, *epidote, *calcite
(4) PO268 Modd Comp - 20 μm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, quartz	*chlorite, *kaolinite, *epidote, *calcite, *garnet

3. Discussion of Certain Mineral Phases and the Mineral List Generated with iExplorer Software

Mineralogical results include:

- mineral abundances by size fraction;
- deportment of F and Sn
- liberation and association characteristics of fluorite, cassiterite, Bi-Mineral, scheelite, pyrite and Fe-Oxides;
- grain size distribution by liberation class of the minerals mentioned above;
- cumulative grain size distribution; and
- determinative mineralogical parameters such and mineral release curves and mineralogical limiting grade - recovery curves,

and are discussed separately. However, details from the Scanning Electron Microscope equipped with energy dispersive spectrometer (SEM-EDS) for developing the minerals list for the size by size characterization is discussed in this section. A mineral list was developed with the QEMSCAN™ processing software iExplorer and theoretical chemistries of each mineral phase are also presented in Table 2.

Table 2: Mineral List Created with the iExplorer Software

Fluorite	CaF_2
Scheelite	CaWO_4
Bi-Minerals	<i>Bismuthinite - Bi_2S_3</i>
	<i>Native Bi</i>
Cassiterite	SnO_2
Sn-Fe Oxide	<i>Variable Ratio of Sn and Fe with O_2</i>
Vesuvianite/Epidote	$\text{Ca}_{10}\text{Mg}_2\text{Al}_4(\text{SiO}_4)_5(\text{Si}_2\text{O}_7)_2(\text{OH})_4$
Garnet	<i>Andradite - $\text{Ca}_3\text{Fe}_2(\text{SiO}_4)_3$</i>
Actinolite/Cummingtonite	$\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
Fe-Ca-Amphibole(LowAl&K)	$(\text{Ca,Na})_{2-3}(\text{Mg,Fe,Al})_5\text{Si}_6(\text{Si,Al})_2\text{O}_{22}(\text{OH})_2$
Diopside/Salite	$\text{K}(\text{Mg,Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$
Biotite	$\text{K}(\text{Mg,Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$
Sericite/Muscovite	$\text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$
Chlorite	$(\text{Fe,}(\text{Mg,Mn})_5,\text{Al})(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$
Chlorite(F)	$(\text{Fe,}(\text{Mg,Mn})_5,\text{Al})(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$ with low concentrations of F
K-Feldspar	KAlSi_3O_8
Plagioclase	$(\text{Na,Ca})(\text{Si,Al})_4\text{O}_8,$
Quartz	SiO_2
Sphene	CaTiSiO_5
Fe-Oxides	<i>Magnetite - Fe_3O_4</i>
	<i>Hematite - Fe_2O_3</i>
	<i>Goethite - $\alpha\text{FeO}\cdot\text{OH}$</i>
Clays (General Clay Compositions)	
<i>Cu-Clay</i>	$(\text{Al,Mg})_8(\text{Si}_4\text{O}_{10})_3(\text{OH})_{10}\cdot 12\text{H}_2\text{O}$
<i>Al-Clay/Mica</i>	
<i>Al-Fe-Silicate</i>	$\text{Fe}_2(\text{Al,Si})_4\text{O}_{10}(\text{OH})_2\text{Na}_{0.3}(\text{H}_2\text{O})_4$
Calcite	CaCO_3
Pyrite	FeS_2
Other Sulphides	<i>Sphalerite - ZnS</i>

It should be noted that the energy dispersive X-ray characteristics for magnetite, hematite and goethite are nearly identical. Therefore, these minerals cannot be distinguished by QEMSCAN™ and only a total Fe-Oxide abundance can be calculated. Distinction between vesuvianite and epidote is also very difficult due to their similar chemistry and thus, they have been treated as one phase. However, from the XRD analysis (discussed in section 2), vesuvianite is the predominant mineral among the two.

The initial reconciliation of QEMSCAN™ and chemical assays showed minor discrepancies with regards to fluorine, and a significant difference for Sn. The QEMSCAN™ calculated Sn assay was significantly lower than that of the chemical assay. Therefore, Sn in solid solution in certain minerals was suspected. Using the paper from *Economic Geology (Geology and Genesis of the F-Sn-W (be-Zn) Skarn (Wrigglite) at Moina Tasmania)* as reference, electron microprobe analysis were conducted on numerous phases of the various Ca silicates, garnets, micas and other phases. Fluorine was consistently detected as a low level constituent in the minerals mentioned above, but most notably in vesuvianite and the various amphibole/pyroxene phases, which account for a minor proportion of the **PO268 Modd Comp.** (discussed in more detail in Section 4.1). Sn can also occur in solid solution in garnet (reported up to 0.70 wt%) and sphene.

Further investigation with a Scanning Electron Microscope equipped with Energy Dispersive Spectrometers (SEM-EDS) at SGS confirmed that fluorine ranges from nil to nearly 5% in a number of Ca-Silicate phases. Sn was also detected in various silicates mainly in Garnet and Vesuvianite. Sn ranges from nil to ~4% in these minerals.

It also should be noted that these EDS are normalized, standardless semi-quantitative analyses and electron microprobe (EMPA) analyses are necessary to accurately determine the mineral chemistry.

Based on the EDS results and the EMPA data provided in the Economic Geology paper, an F content of 1% to 1.5% F has been applied to the following phases: **Vesuvianite/Epidote, Actinolite/Cummingtonite, Fe-Ca-Amphibole(LowAl&K), Diopside/Salite, Biotite, Sericite/Muscovite** and **Chlorite**. A high fluorine chlorite (~6% F - denoted as Chlorite(F in the QEMSCAN mineral distributions) was also detected. A summary of the EDS analysis for the various Ca-Silicates and vesuvianite are presented in Table 3 and Table 4. The Tabulated results are presented Appendix D.

SEM-EDS investigation identified a number of silicate grains that contain Sn (mainly garnet and, less commonly, vesuvianite).. Similarly to F, the range of Sn in these phases is from nil to ~4%. The average Sn content of garnet is 0.7% as provided by the reference paper from **Economic Geology**.

These applied chemistries are important for calculating the Elemental Deportment (discussed in greater detail in section 4.2).

Table 3: Summary of the SEM-EDS results for the Ca- Silicates Phases

Spectrum	O	F	Al	Si	Ca	Fe	Mg	Cl	Mn	Ti
<i>Average</i>	44.93	1.20	7.36	17.03	23.04	4.11	1.70	0.44	0.72	0.48
<i>Stdev</i>	1.33	1.79	0.79	0.40	0.39	1.12	0.41	0.07	0.10	0.10
<i>Min</i>	41.73	0.00	5.59	16.57	22.39	2.77	0.87	0.37	0.58	0.39
<i>Max</i>	46.56	4.36	8.91	18.32	23.91	7.27	2.55	0.59	0.91	0.62

Table 4: Summary of the EMPA results for the Vesuvianite in the XCELL Tails Samples

Spectrum	O	F	Al	Si	Ca	Fe	Mg	Mn
<i>Average</i>	42.51	1.38	5.37	16.83	21.40	10.10	1.02	1.19
<i>Stdev</i>	1.27	2.13	2.64	0.86	0.88	4.91	0.42	0.58
<i>Min</i>	38.73	0.00	1.04	14.18	19.52	3.43	0.40	0.59
<i>Max</i>	45.23	5.00	9.29	18.53	22.37	17.25	1.54	3.14

The mineral list includes a phase described as a Sn-Fe Oxide. This generally occurs as very fine grained (2 µm to 5 µm) and it is likely cassiterite locked in Fe-Oxides. During the analysis, QEMSCAN™ detects mixed spectra of Sn and Fe. However, visual observations show that this is not a true Sn-Fe oxide but very fine grained cassiterite locked in the Fe-Oxides.

Figure 2 displays the QEMSCAN™ pseudo images and the very fine-grained nature of the Sn-Fe phase as illustrated by the dark green color in the particle maps. The SEM-BSE image shows disseminated Sn-Fe Oxide (bright phase) locked in Fe-Oxides (darker grey phase).

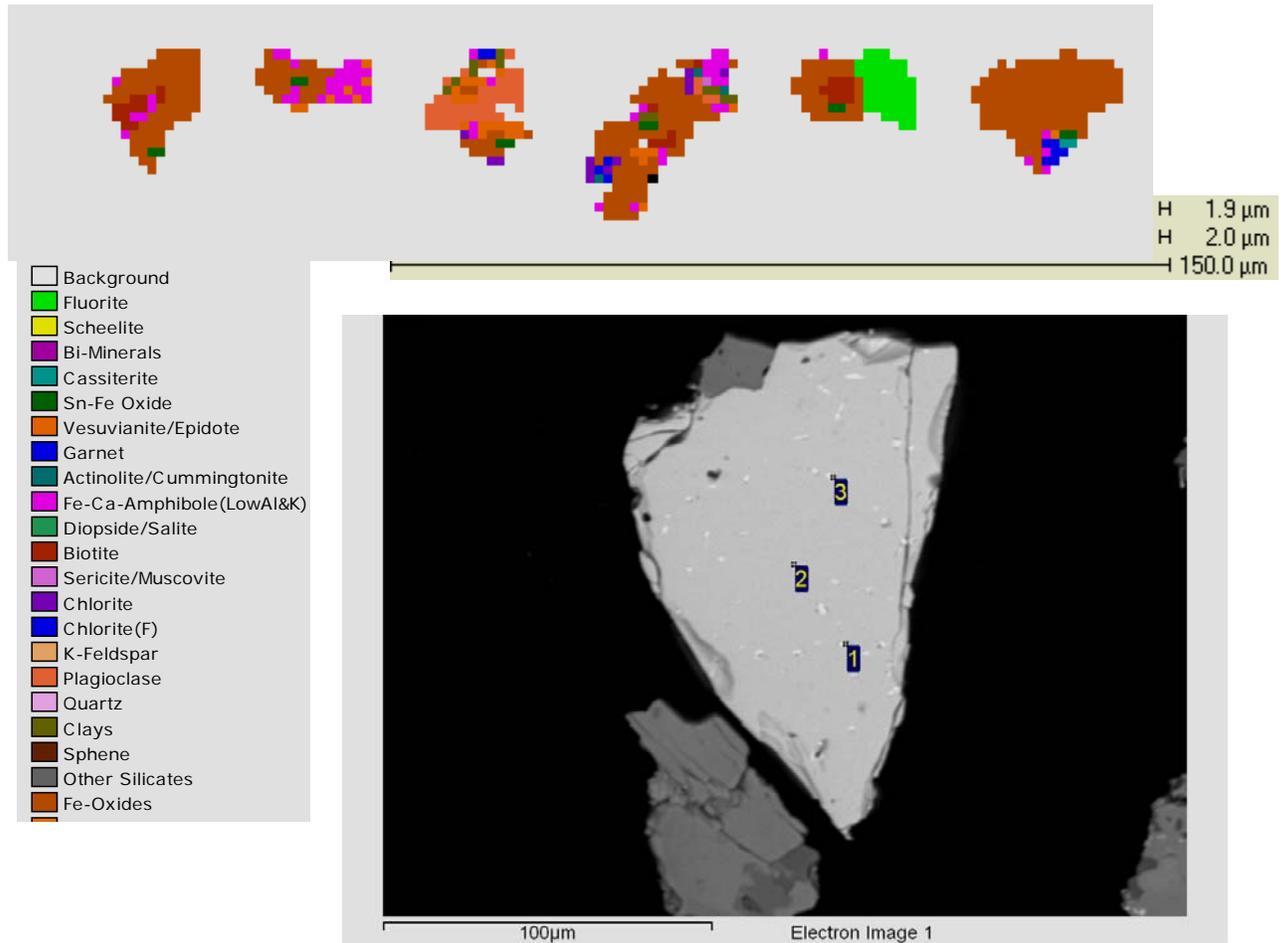


Figure 2: QEMSCAN™ Pseudo Images and a SEM-BSE Image Displaying the Sn-Fe Oxide phase.

In the QEMSCAN™ pseudo images, note the very fine grained nature (denoted by the dark green) of generally <math>< 4 \mu\text{m}</math> in size locked in the Fe-Oxide (darker brown phase). This is also displayed in the SEM-BSE images where numerous “bright phases” that are very fine grained (commonly <math>< 5 \mu\text{m}</math>) are locked in the Fe-Oxide.

4. Mineralogical Details on the *PO268 Modd Comp.*

4.1. Mineral Abundances

Table 5 and Figure 3 present the mineral distributions by size fraction and the combined head. The sample consists mainly of various Ca-Silicate minerals including vesuvianite/epidote (13.8%), garnet (5.6%), actinolite/cummingtonite (5.8%), Fe-Ca-Amphibole (~15%) and diopside (~2%). Moderate levels of Fe-Oxides (~18.5%), fluorite (~14%), biotite (~8%), plagioclase (~8%) with minor levels of calcite (1.5%), chlorite (~1.1%) and a high F chlorite (~0.6%) were also detected. Pyrite was also detected in trace levels (0.48%), whereas other sulphides (0.03%) were negligible in comparison (this includes both sphalerite and molybdenite).

By size fraction, there is an increase in fluorite content from 11% in the +63 μm to 15.3% in the -20 μm size fraction.

The trace phases of particular interest include scheelite (0.21%), Bi-Minerals (which account for 0.09% and include mainly Bi-Sulphides but also Native bismuth (also observed during the SEM investigation), cassiterite (0.07%) and the Sn-Fe Oxide (0.05%). Notably, these phases occur mainly in the -20 μm (Figure 4).

Table 5: Mineral Distribution of the PO268 Modd Comp by Size Fraction

Survey		Minemakers								
Project		12547-001 / MI5031-OCT10								
Sample		PO268 Modd Comp								
Fraction		Combined	+63um	-63/+45um	-45/+20um			-20um		
Mass Size Distribution (%)			29.8	12.9	19.0			38.4		
Particle Size			56	32	21			8		
Mineral	Mass (%)	Sample	Sample	Fraction	Sample	Fraction	Sample	Fraction	Sample	Fraction
	Fluorite	13.74	3.28	11.02	1.71	13.31	2.85	15.05	5.90	15.36
	Scheelite	0.21	0.04	0.12	0.03	0.23	0.03	0.15	0.12	0.30
	Bi-Minerals	0.09	0.02	0.06	0.01	0.07	0.01	0.05	0.06	0.14
	Cassiterite	0.07	0.02	0.05	0.01	0.05	0.00	0.02	0.04	0.10
	Sn-Fe Oxide	0.05	0.02	0.05	0.01	0.07	0.01	0.05	0.01	0.03
	Vesuvianite/Epidote	13.83	5.07	17.03	1.98	15.36	2.21	11.63	4.58	11.92
	Garnet	5.64	2.30	7.73	0.78	6.02	1.10	5.78	1.47	3.82
	Actinolite/Cummingtonite	5.84	2.24	7.53	0.86	6.67	0.95	4.99	1.79	4.66
	Fe-Ca-Amphibole(LowAl&K)	15.04	4.05	13.61	1.48	11.51	2.38	12.52	7.14	18.58
	Diopside/Salite	1.99	0.59	1.97	0.28	2.16	0.50	2.62	0.63	1.64
	Biotite	8.25	2.28	7.67	0.84	6.55	1.18	6.22	3.94	10.26
	Sericite/Muscovite	1.72	0.34	1.14	0.14	1.12	0.33	1.73	0.91	2.37
	Chlorite	1.10	0.15	0.50	0.08	0.61	0.15	0.78	0.72	1.87
	Chlorite(F)	0.64	0.27	0.89	0.11	0.83	0.16	0.86	0.11	0.29
	K-Feldspar	1.98	0.84	2.82	0.32	2.47	0.40	2.12	0.42	1.09
	Plagioclase	7.09	2.59	8.69	0.95	7.40	1.29	6.82	2.26	5.88
	Quartz	0.72	0.26	0.86	0.09	0.72	0.13	0.68	0.24	0.62
	Clays	0.31	0.14	0.48	0.04	0.34	0.06	0.31	0.07	0.18
	Sphene	0.13	0.04	0.14	0.02	0.13	0.03	0.14	0.04	0.12
	Other Silicates	0.36	0.05	0.16	0.01	0.09	0.05	0.26	0.25	0.65
	Fe-Oxides	18.56	4.51	15.14	2.84	22.05	4.67	24.64	6.54	17.02
	Other_Oxides	0.02	0.01	0.03	0.00	0.03	0.00	0.02	0.00	0.01
	Calcite	1.51	0.25	0.84	0.10	0.75	0.26	1.35	0.91	2.36
	Ca-Fe Carb/Ox	0.49	0.26	0.88	0.09	0.71	0.10	0.52	0.04	0.10
	Other Carbonates	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
	Pyrite	0.48	0.13	0.44	0.08	0.59	0.10	0.51	0.18	0.46
	Other_Sulphides	0.03	0.01	0.03	0.00	0.02	0.01	0.03	0.01	0.03
	Other	0.11	0.03	0.09	0.02	0.12	0.02	0.13	0.05	0.12
	Total	100.00	29.76	100.0	12.87	100.0	18.97	100.0	38.41	100.0

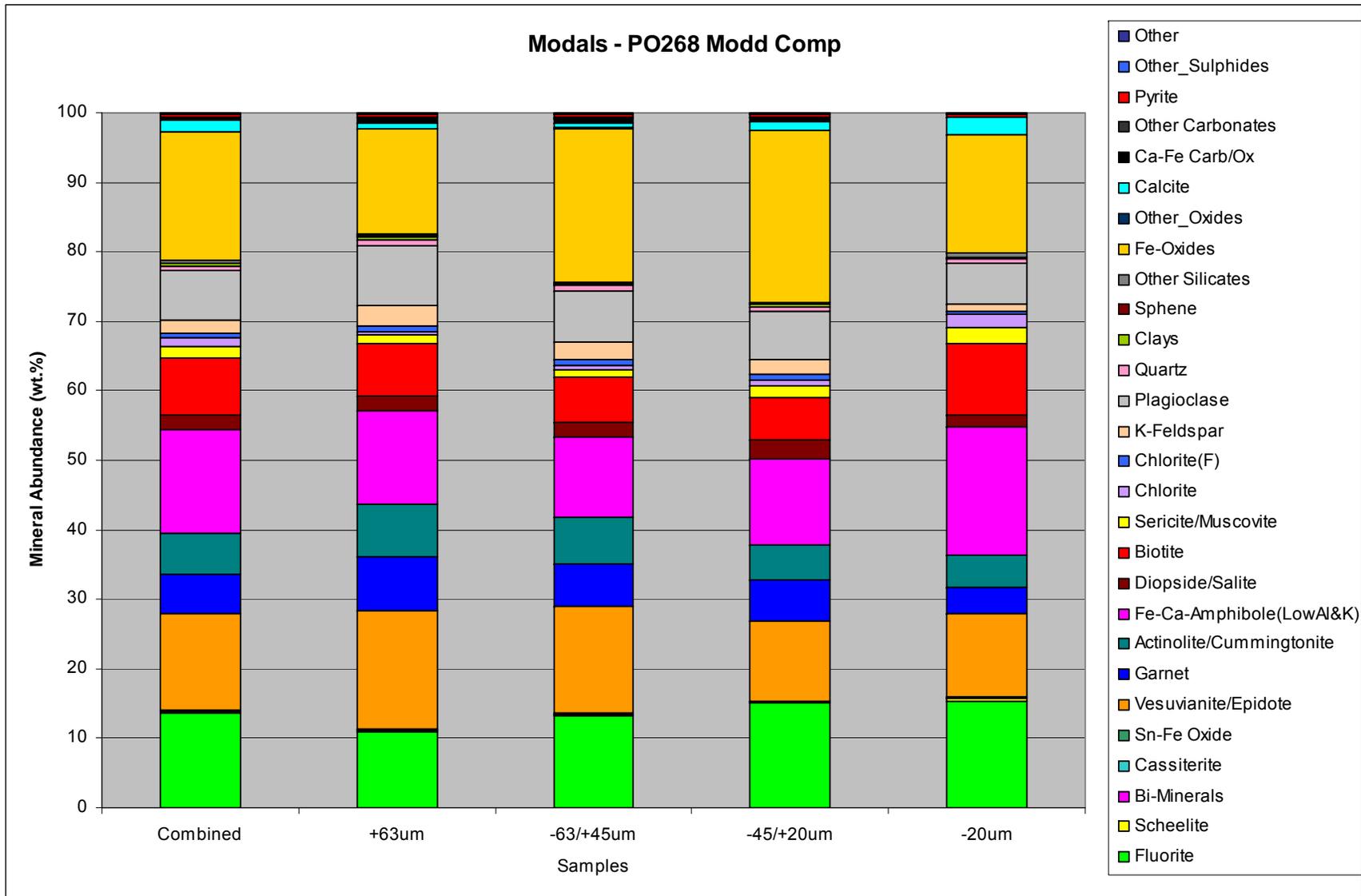


Figure 3: Graphic Presentation of the Mineral Abundances by Size Fraction

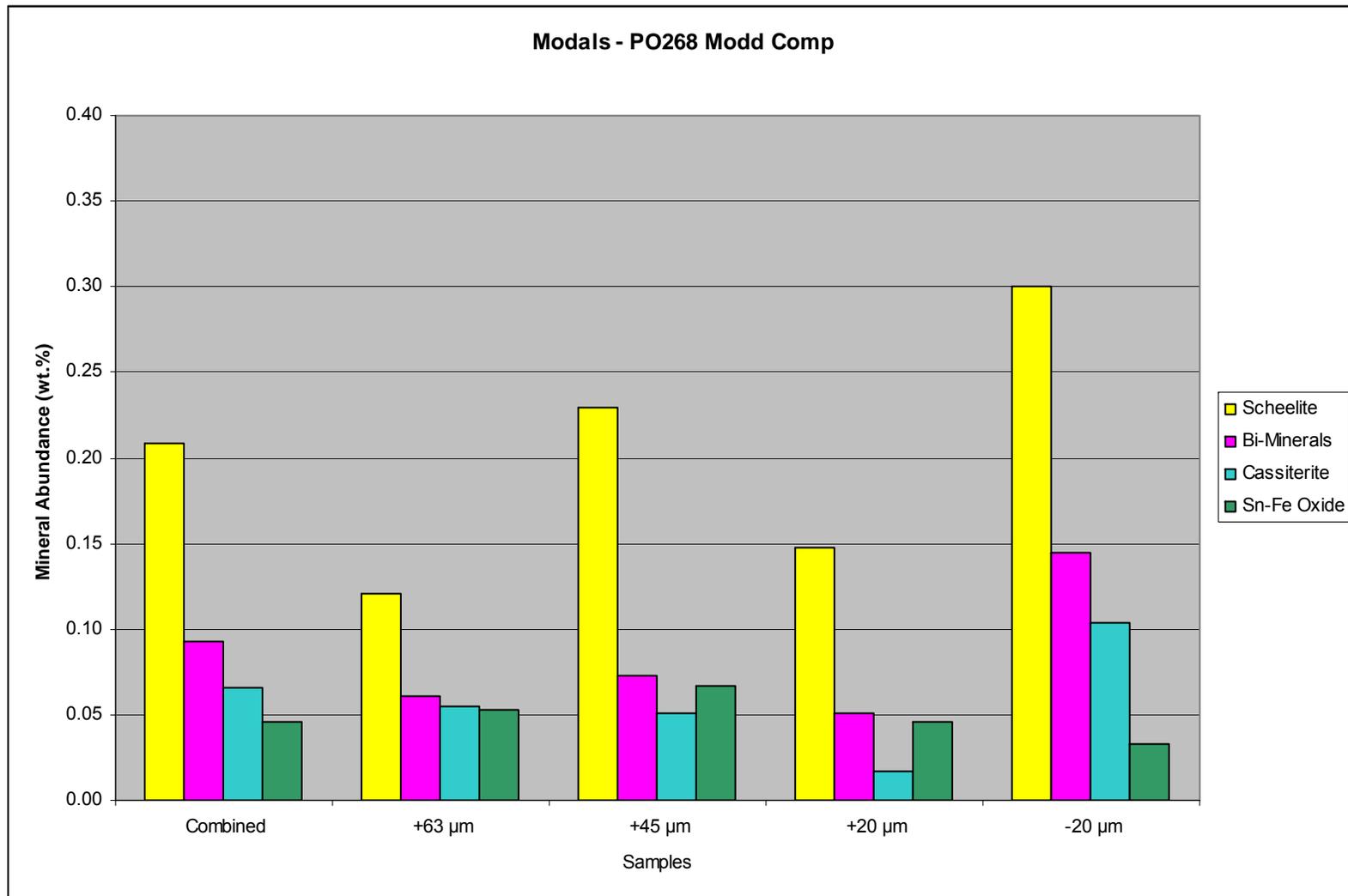


Figure 4: Graphic Presentation of the Normalized Mineral Abundance of Scheelite, Bi-Minerals, Cassiterite and the Sn-Fe Oxide) by Size Fraction

4.2. Department

4.2.1. Fluorine Department

As mentioned in the SEM portion of this report (Section 3), fluorine can be contained in many of the Ca-Silicate phases and range from nil to nearly 5%. Thus, the F distribution is calculated based on SEM values and the QEMSCAN data (Figure 5). Approximately 92% of the F is contained in fluorite, but the various silicates account for the balance. Essentially ~8% of the F grade should be considered non-recoverable.

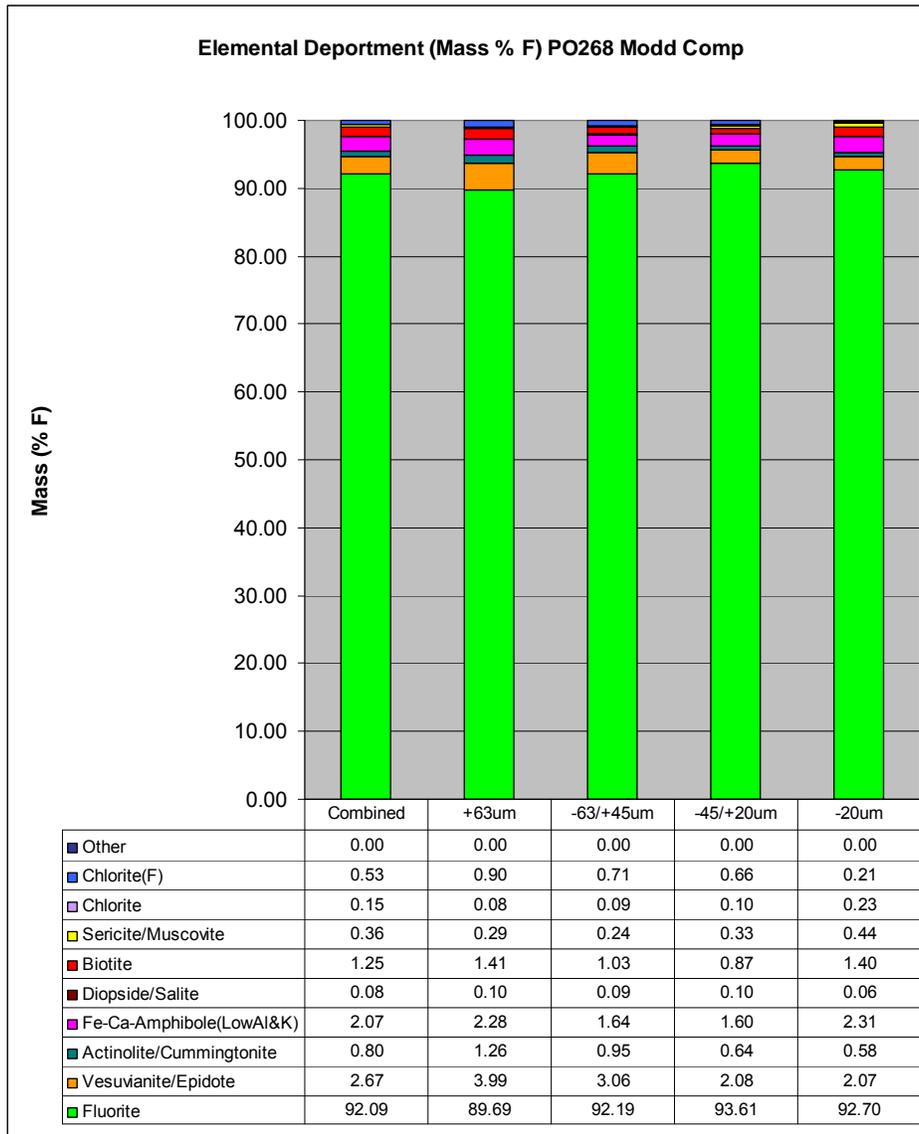


Figure 5: Fluorine Department of the PO268 Modd Comp. by Size Fraction

4.2.2. Sn-Department

As discussed in the SEM-EDS portion of this report (Section 3), a variety of silicate minerals contain Sn (mainly garnets, but also vesuvianite). Sn ranges in these phases from nil to ~4%, while a 0.7% Sn grade has been applied to the garnet (as referred in Economic Geology). A mixed composition to the Sn-Fe Oxides has also been applied, which has a 35% Sn grade. Based on applied chemistries and mineral distributions, cassiterite accounts for ~50% of the overall Sn distribution where Sn-Fe Oxides for ~ 15%. Approximately 35% of the Sn occurs in solid solution in the silicates and is considered non-recoverable.

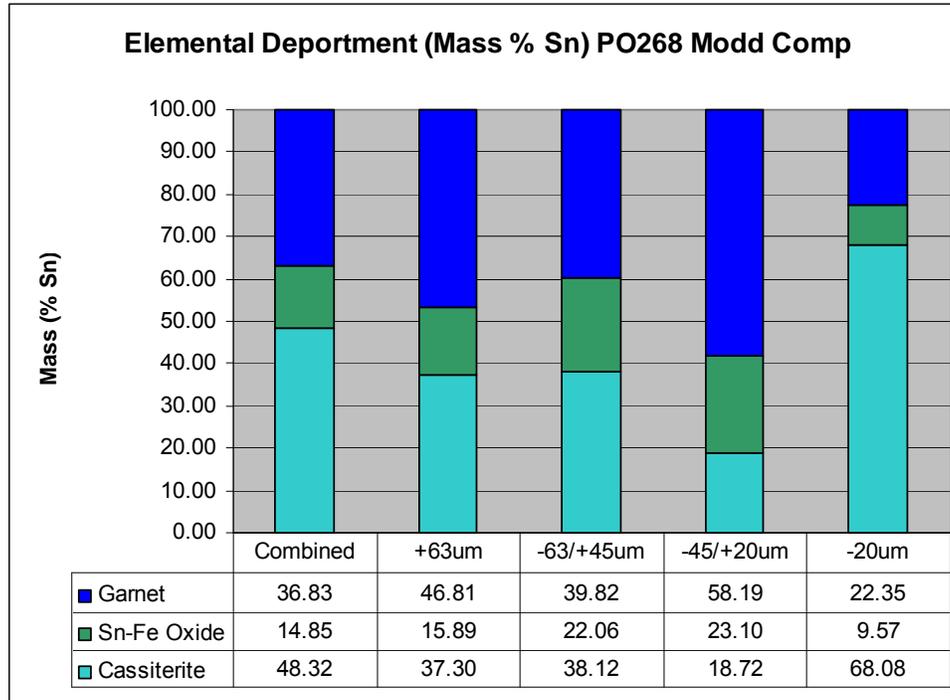


Figure 6: Sn-Department of the PO268 Modd Comp.

4.3. Liberation and Association

For the purpose of these analyses, particle liberation is defined based on 2D particle area percent. Particles are classified in the following groups (in descending order) based on **mineral-of-interest** (for example fluorite) area percent: free (=100% area percent) and liberated ($\geq 95\%$ area percent), middling ($< 95\%$ but $> 90\%$ area percent) sub-middling ($< 90\%$ but $> 20\%$ area percent) and locked ($< 20\%$ area percent). The non-liberated grains have been classified according to association characteristics, where binary association groups refer to particle area percent greater than or equal to 95% of the two minerals or mineral groups (for example Fluorite and Fe-Oxides combined account for $> 95\%$ area percent). The complex groups refer to particles with ternary, quaternary and greater mineral associations including the mineral of interest. The barren group refers to minerals that do not contain the mineral of interest within

that group. For example, the particles that do not contain fluorite within this class and are thus not included in the presented data. A more detailed summary of the terminology is presented in Appendix D. It should be noted that the liberation categories were created for this program because the fluorspar industry requires very low impurity grades within a concentrate. These liberation categories are flexible and can be converted to less stringent requirements. For the purpose of benchmarking, the same liberation categories were applied to the other presented mineral phases as well. This terminology for liberation and association is also presented in Appendix F.

4.3.1. Liberation and Association Fluorite

Liberation and association graphs of fluorite are presented in Figure 7 and Figure 8, respectively. Approximately 50% of the fluorite occurs as liberated particles (both the Free and Liberated categories combined). Liberation steadily increases from the +63 μm fraction to the -20 μm fraction (~19% to ~70%). “Mids”, “Sub-Mids” and “Locked” grains represent 5%, 32% and 10%, respectively. The non-liberated fluorite mainly occurs as ternary particles with Fe-Oxides and silicates (~23%), as binary particles with Ca-silicates (~9%) and complex particles (~6%).

Figure 9 displays the grain size distribution of each liberation class. The graph illustrates that most of the fluorite in the “mid”, “sub-mids” and “locked” classes is generally <30 μm in size. An image grid, displaying the liberation characteristic of these particles, is presented in Figure 10.

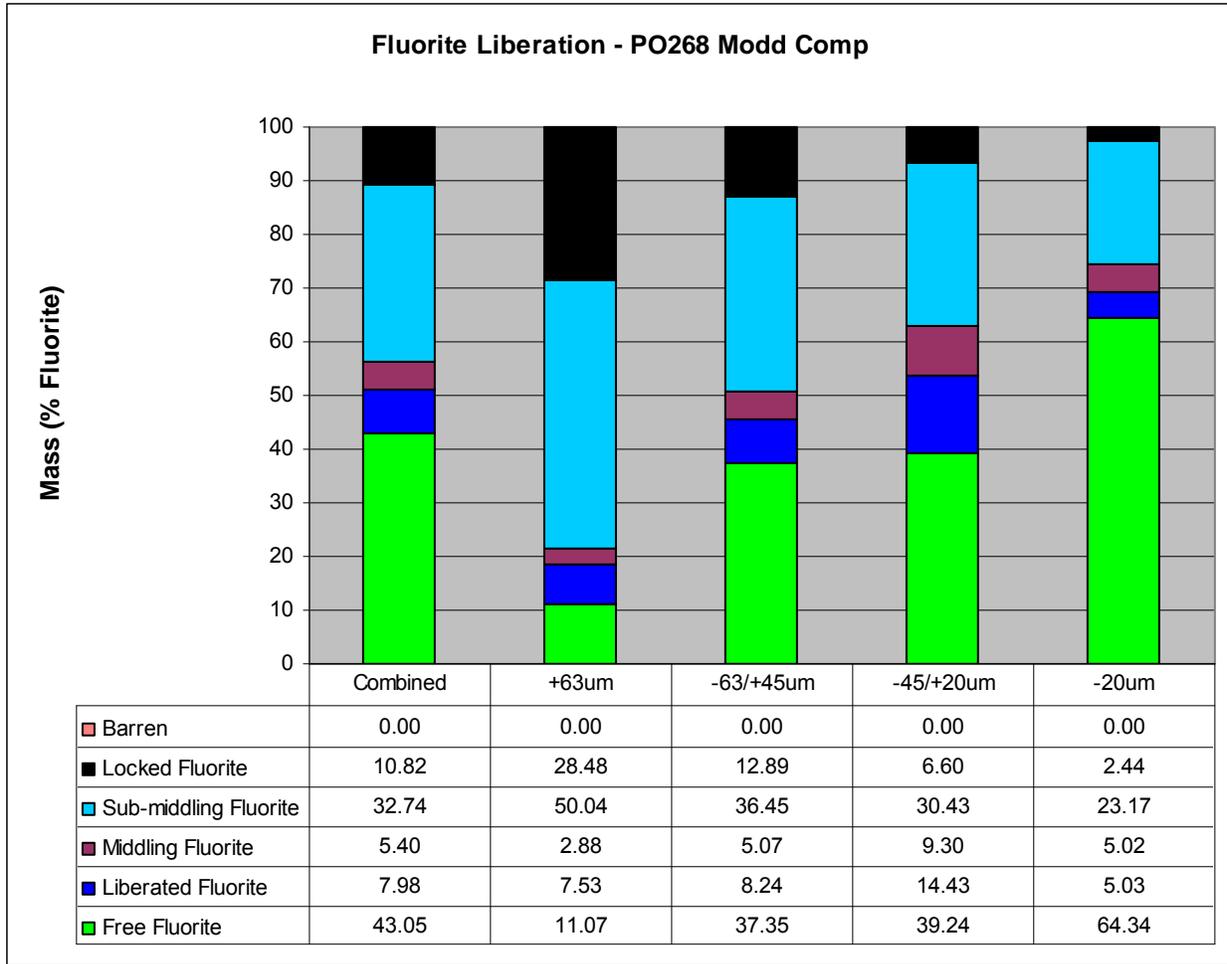


Figure 7: Fluorite Liberation by Size Fraction for the PO268 Modd Comp.

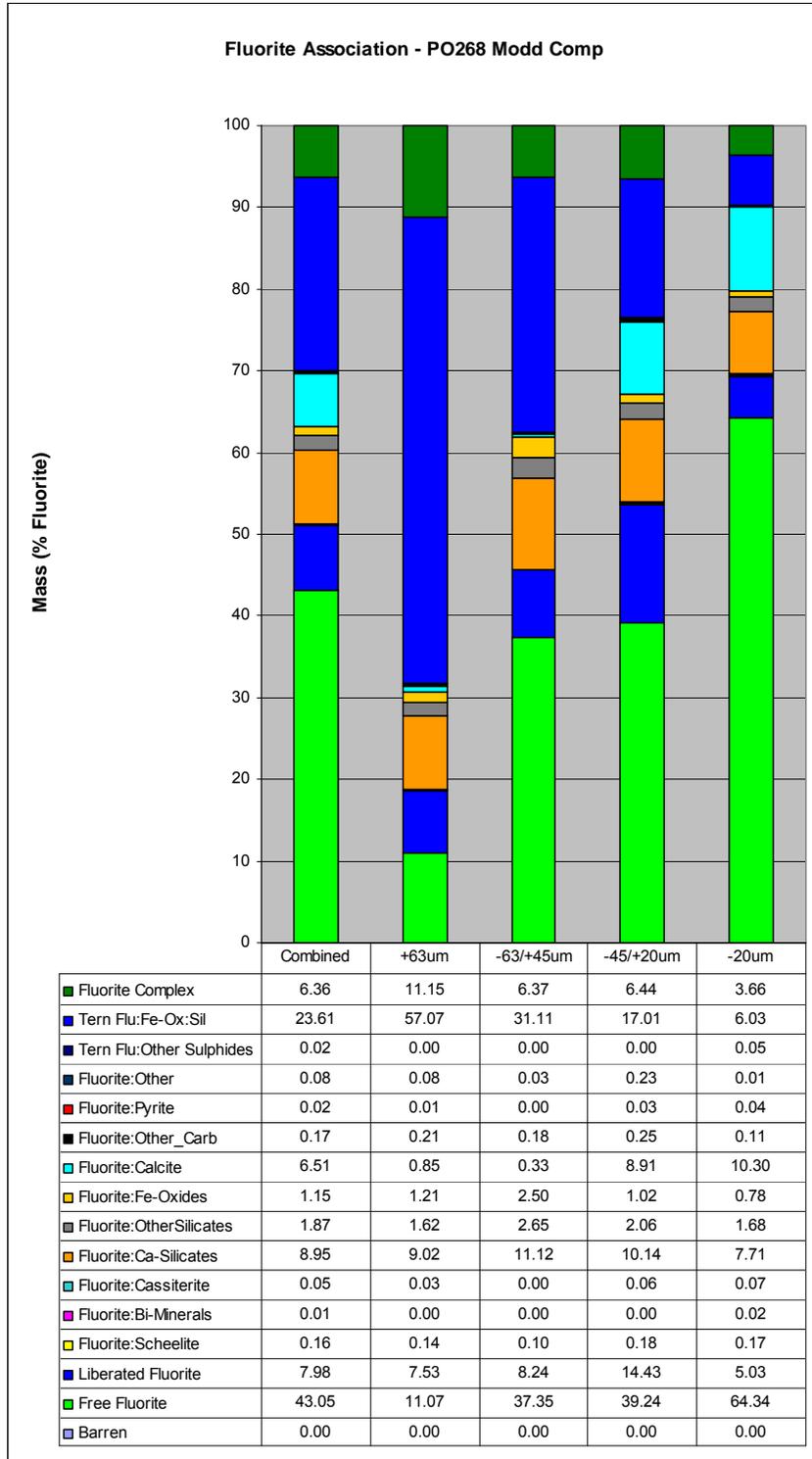


Figure 8: Fluorite Association by Size Fraction for the PO268 Modd Comp.

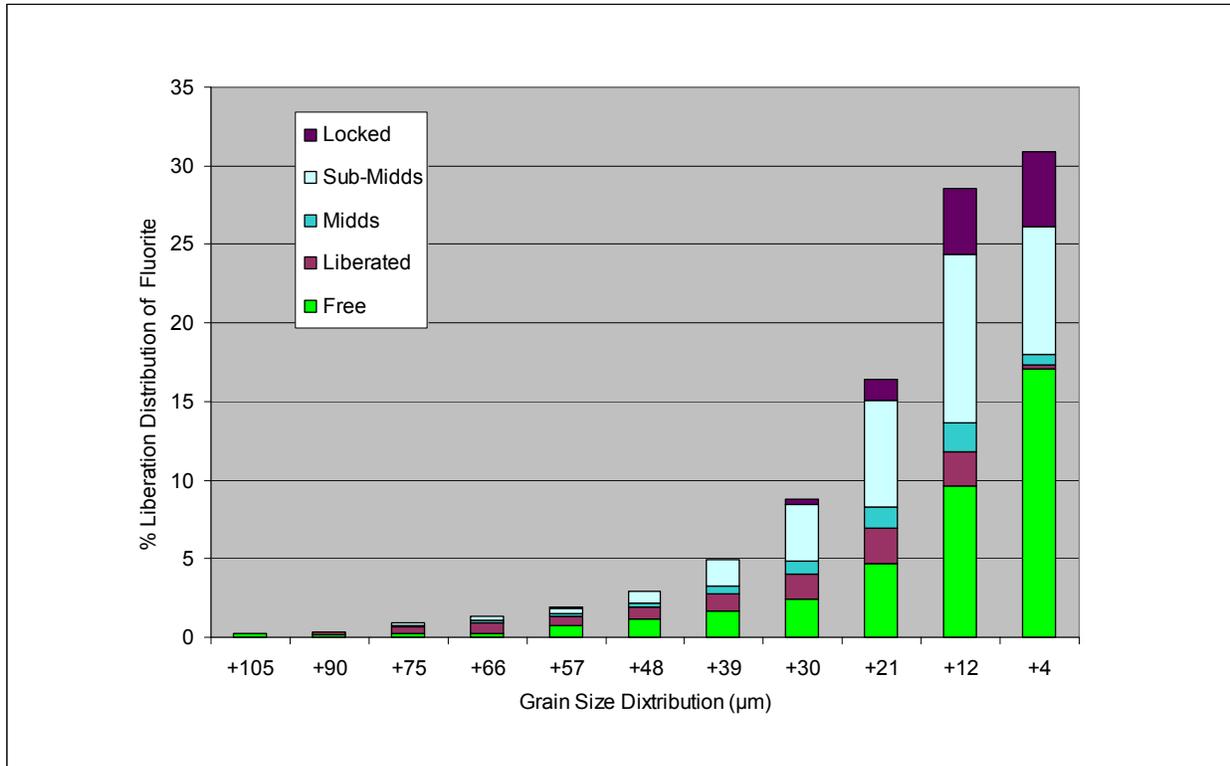


Figure 9: Fluorite Liberation Profile by Grain Size in the PO268 Modd Comp.

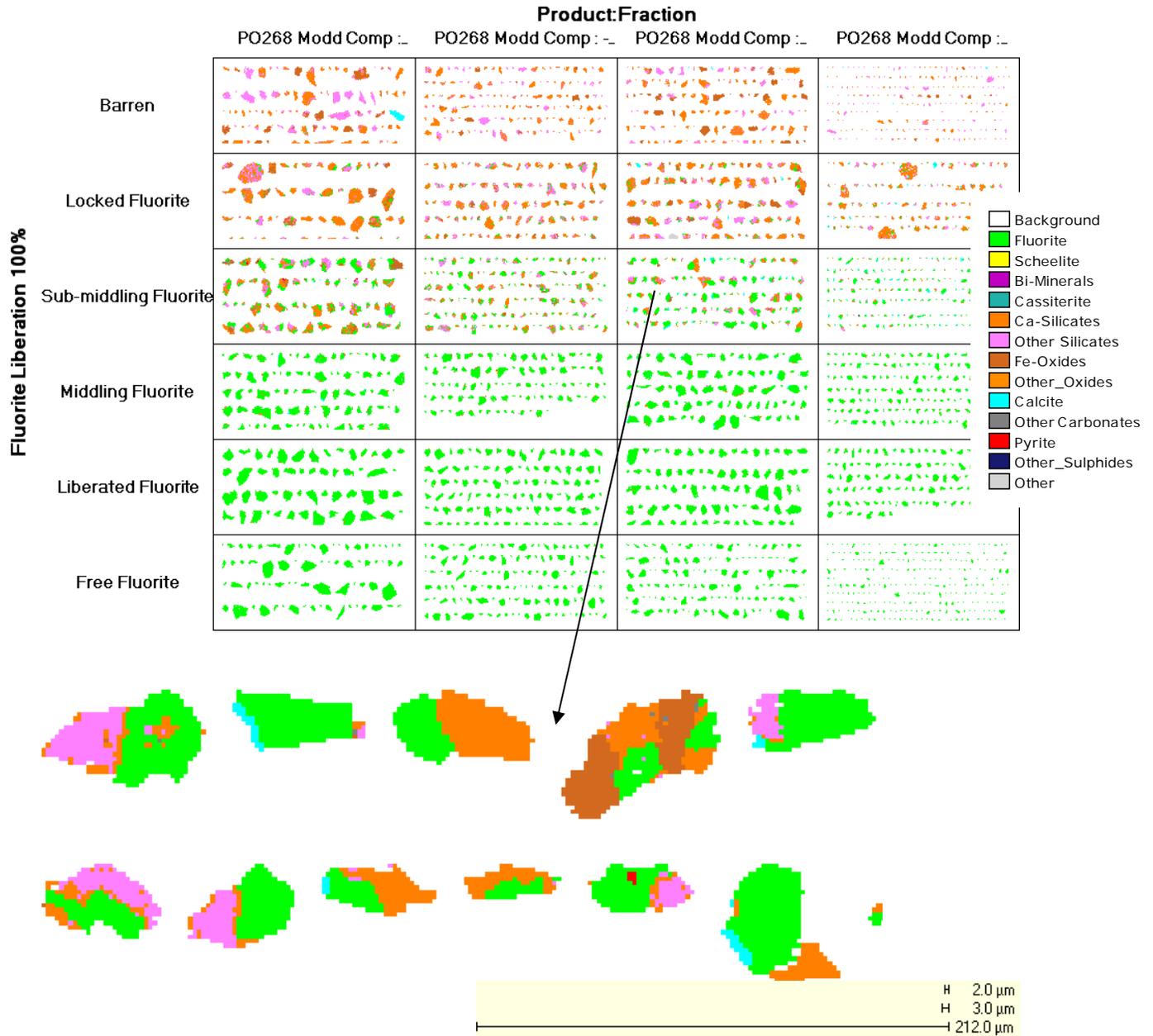


Figure 10: Image Grid of the Fluorite Liberation and an Enlarged View of the +20 µm Size Fraction Sub-Middling Class for the PO268 Modd Comp.

4.3.2. Liberation and Association Cassiterite

Cassiterite liberation and association data (which also includes the Sn-Fe Oxide phase) are presented in Figure 11 and Figure 12, respectively. Cassiterite is very poorly liberated (~17.5% for both the “Free” and “Liberated” categories). It most commonly occurs as ternary particles with Fe-Oxides and silicates (~27%), complex particles (~27%) and binary particles with Ca-silicates (~15%). Liberation increases moderately with decreasing size from ~7% in the +63 µm to ~30% in the -20 µm size fraction. Based on the grain size data (Figure 13), roughly 50% of the cassiterite grains is <10 µm in size. An image grid displaying the liberation characteristic of these particles is presented in Figure 14.

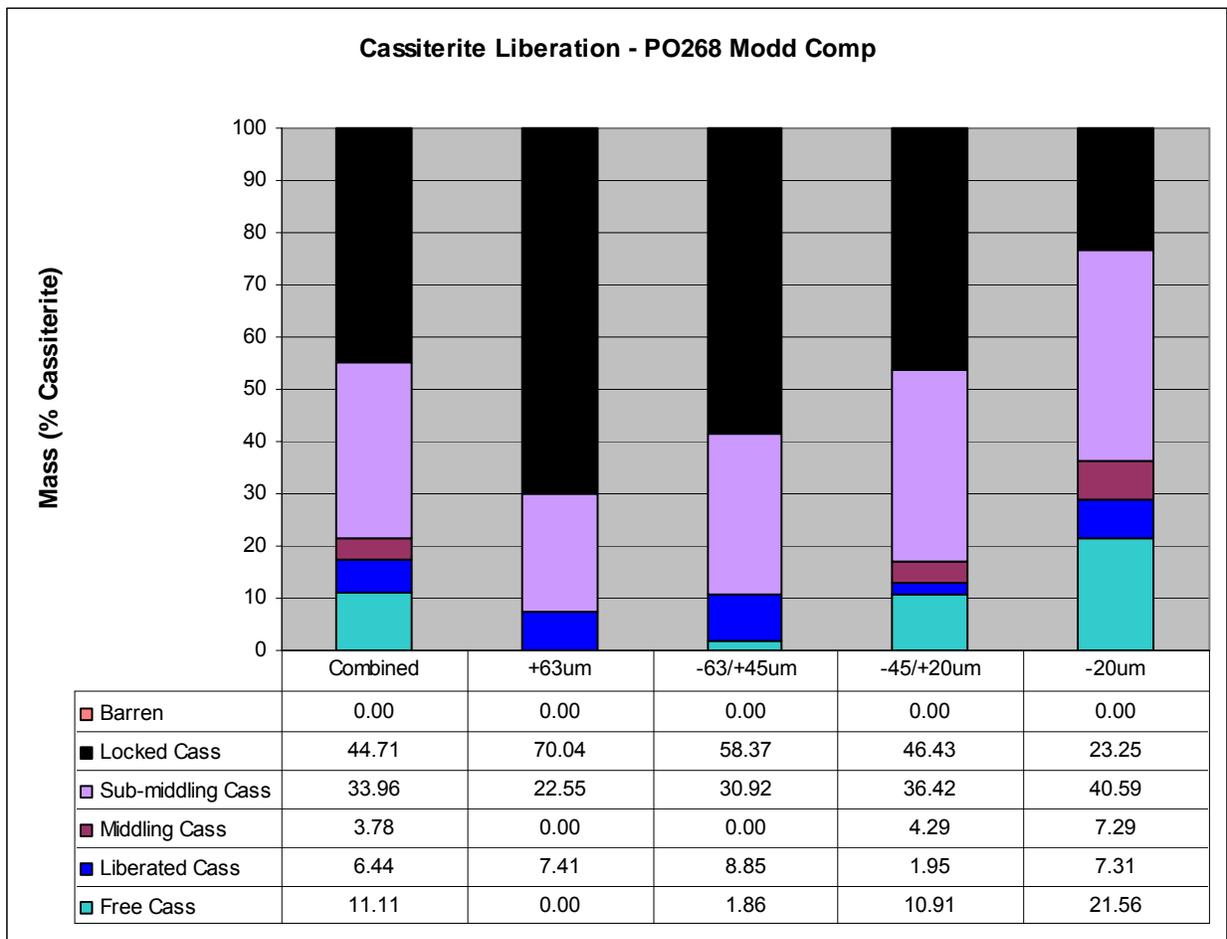


Figure 11: Liberation of Cassiterite by Size Fraction for the PO268 Modd Comp.

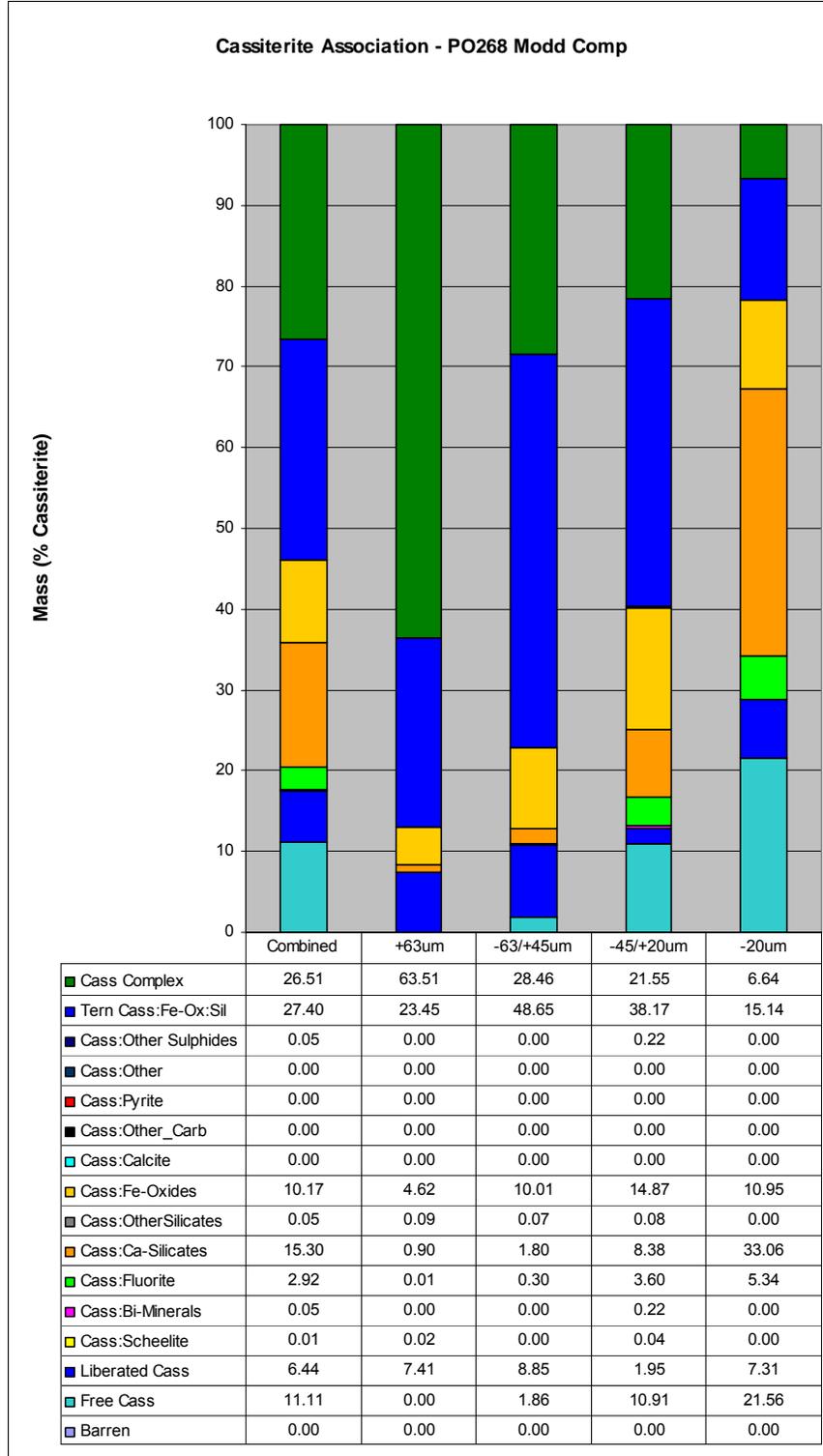


Figure 12: Association of Cassiterite by Size Fraction of the PO268 Modd Comp.

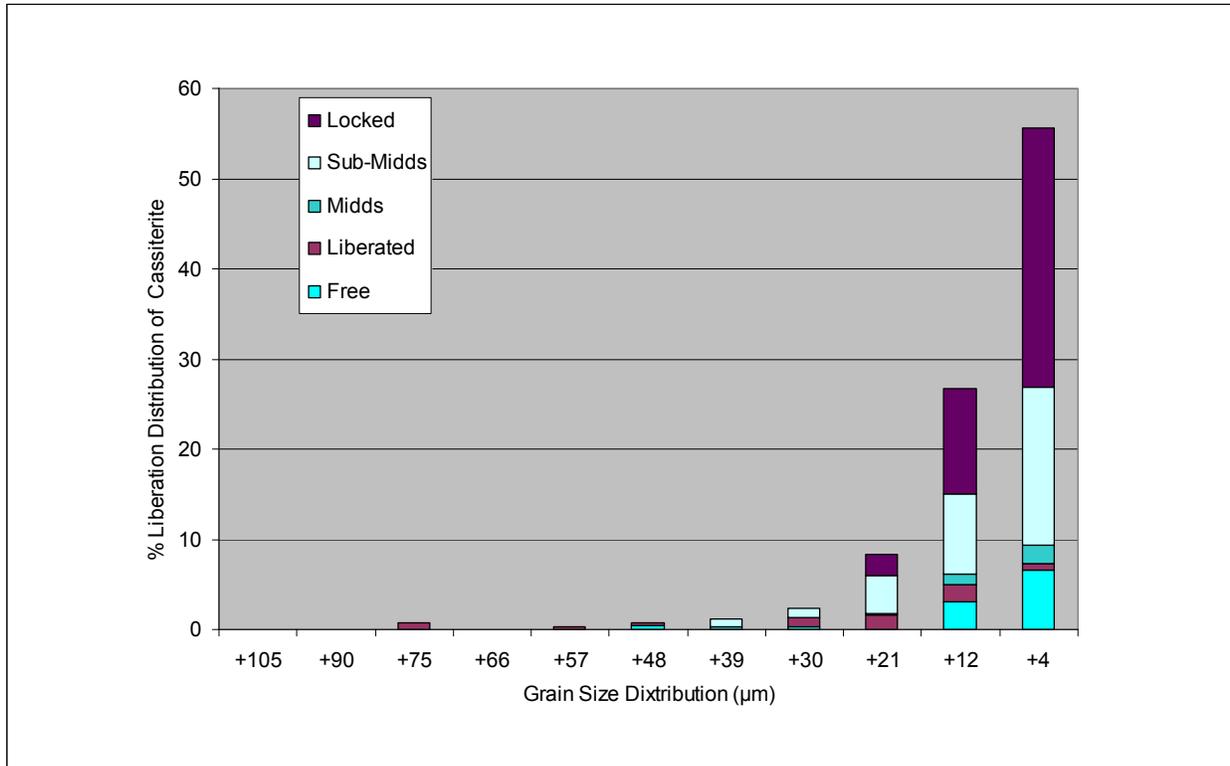


Figure 13: Liberation Profile by Size Class of the Cassiterite in the PO268 Modd Comp.

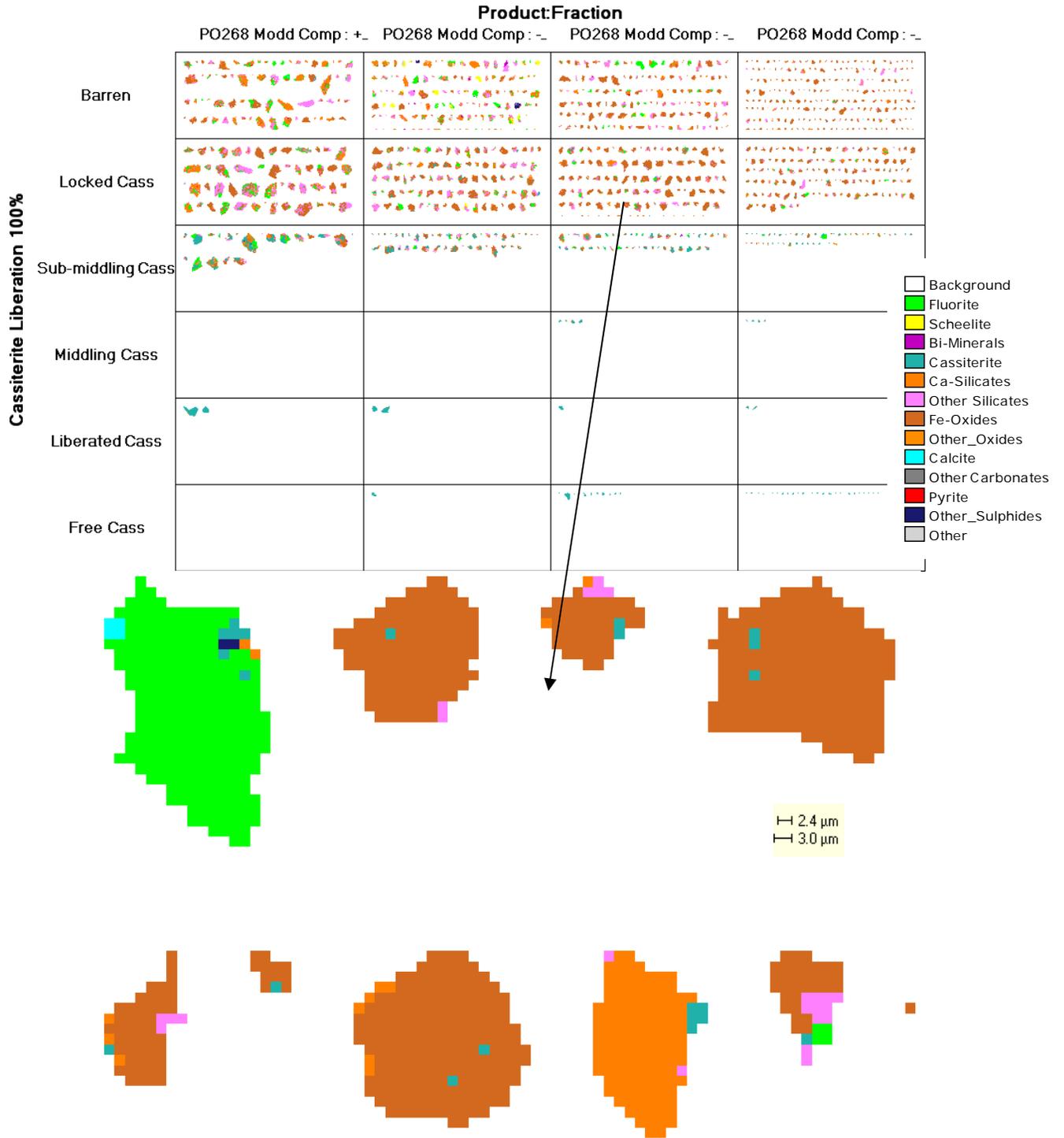


Figure 14: Image Grid of the Cassiterite Liberation

The enlarged view is from the +20 μm size fraction showing the Locked Class for the **PO268 Modd Comp.** Note the very fine grained nature (<4 μm) of cassiterite in the Fe-Oxides.

4.3.3. Liberation and Association of Bi-Minerals

Bi-Mineral liberation and association data are presented in Figure 15 and Figure 16, respectively, and display that they are poorly to moderately liberated (~39% of the combined “Free” and “Liberated” classes). “Mids” account for ~6%, “Sub-Mids” for 24% and “Locked” grains for 30%. Bi-Minerals commonly form ternary particles with Fe-Oxides and silicates (~14%) and complex particles (~30%). Liberation increases moderately with decreasing size from 10% in the +63 µm to ~60% in the -20 µm size fraction. Based on the grain size data (Figure 17), roughly 90% of the Bi-Minerals are <12 µm in size. An image grid displaying the liberation characteristic of these particles is presented in Figure 17.

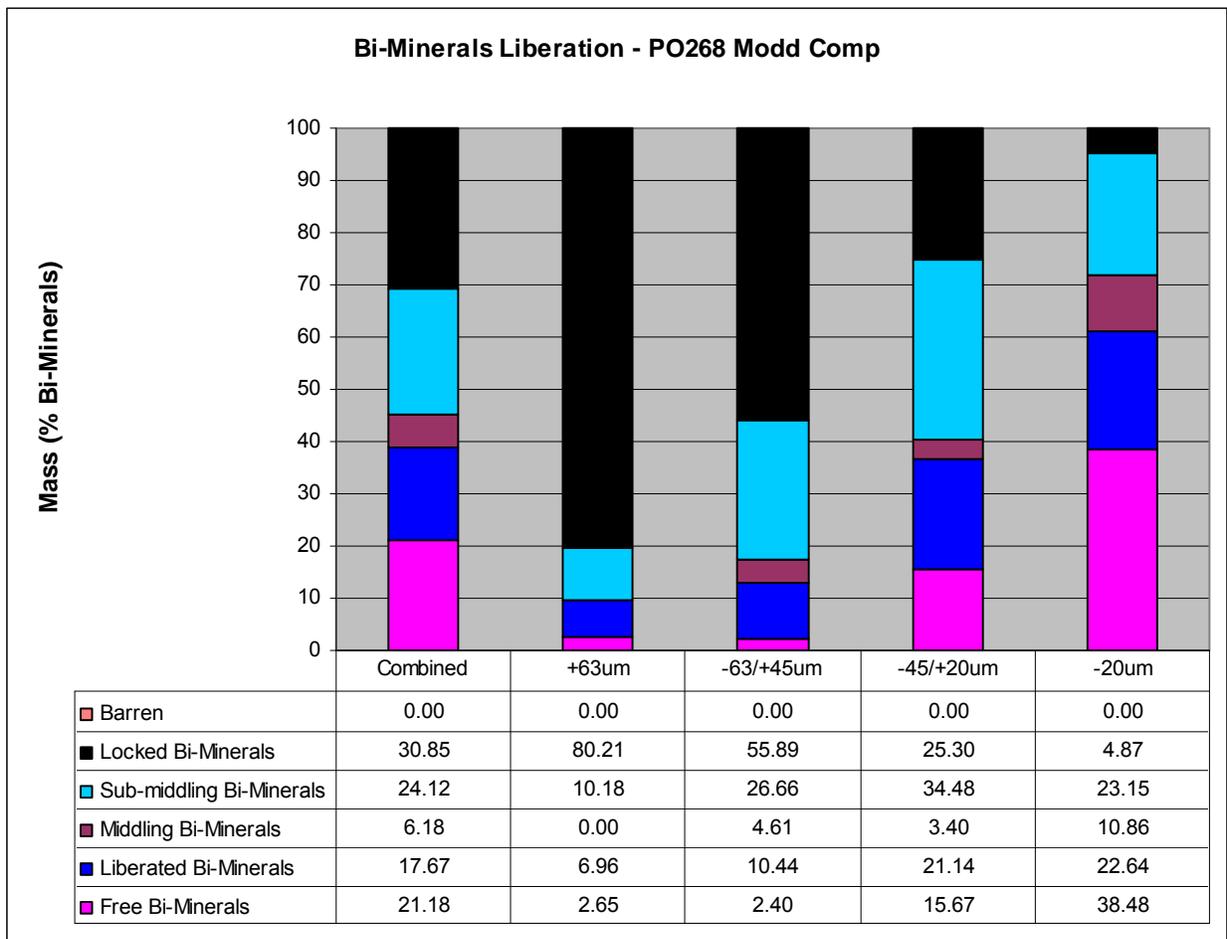


Figure 15: Liberation of Bi-Minerals by Size Fraction of the PO268 Modd Comp.

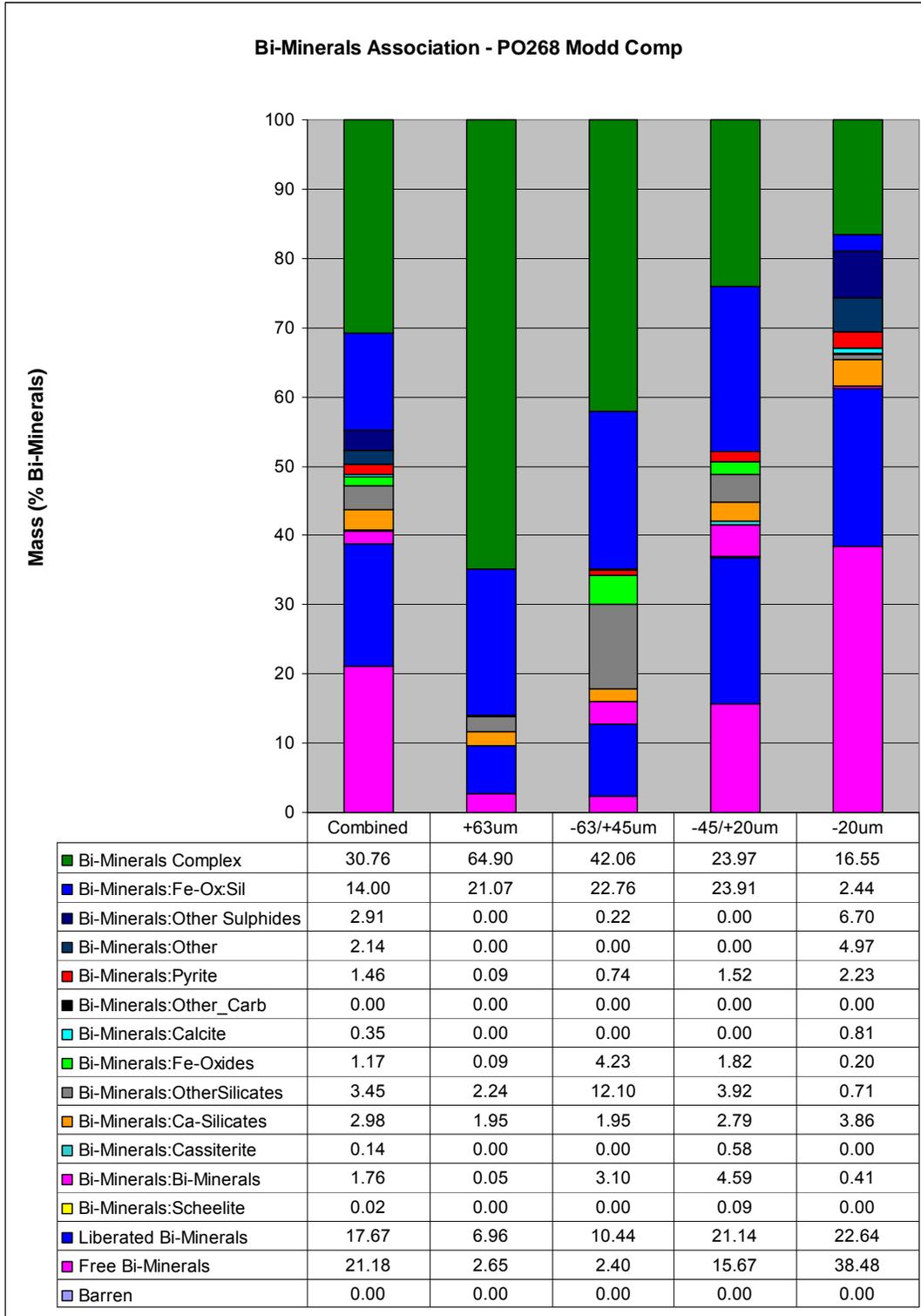


Figure 16: Association of Bi-Minerals by Size fraction in the PO268 Modd Comp.

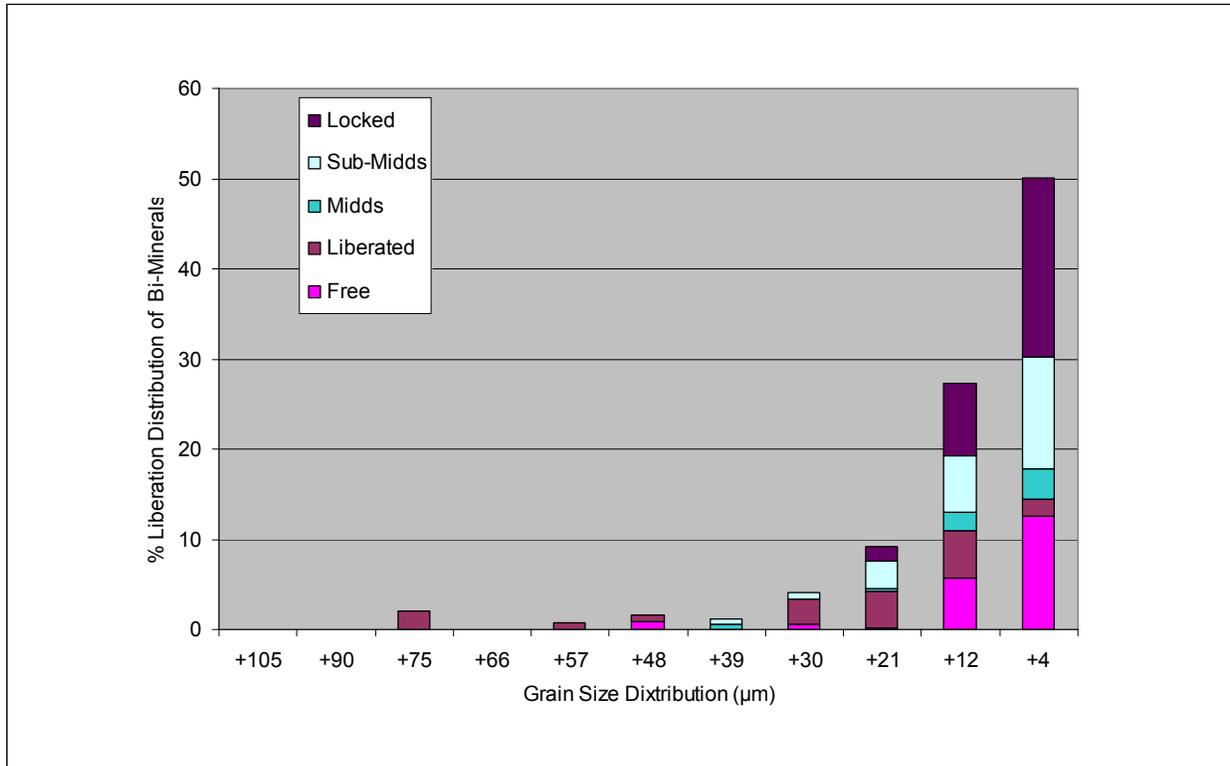


Figure 17: Liberation Profile by Size Class of the Bi-Minerals in the PO268 Modd Comp.

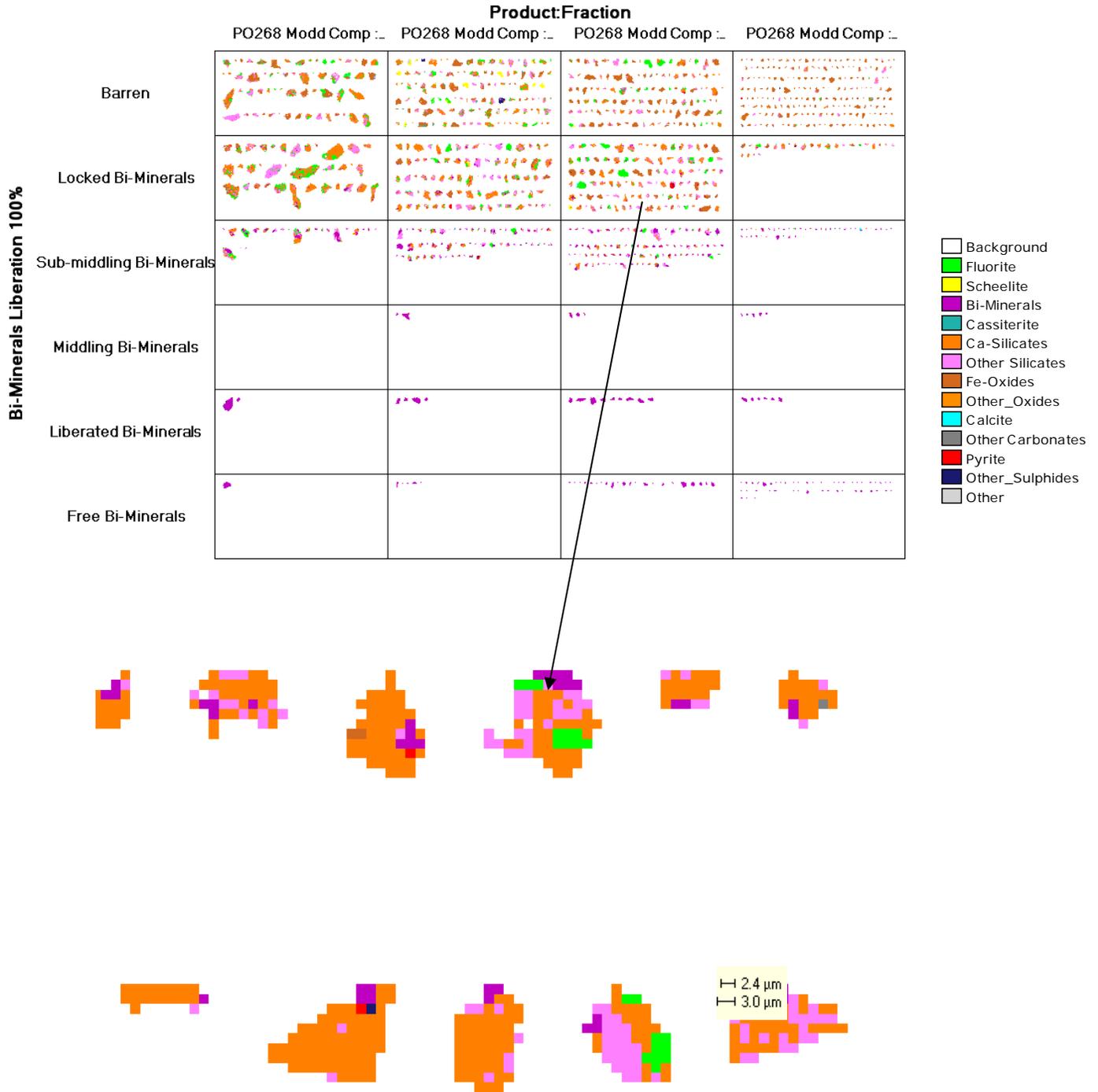


Figure 18: Image Grid of the Bi-Mineral Liberation

The enlarged view is from the +20 μm size fraction Locked Class for the **PO268 Modd Comp.** Note the very fine grained nature (<6 μm) of the Bi-Minerals in the Ca-Silicates.

4.3.4. Scheelite Liberation and Association

Scheelite liberation and association are presented in Figure 19 and Figure 20, respectively. The scheelite is moderately liberated at 52%, while “Midds” account for ~6% and “Sub-Midds” for ~26%, and “Locked” for ~15%. Scheelite is most commonly present as complex particles (~17%), as ternary particles with Fe-Oxides and silicates (~10%), and as binary grains with fluorite (~8%). Liberation increases with decreasing size from ~16% in the +63 µm to ~70% in the -20 µm size fraction. Based on the grain size data (Figure 21), roughly 80% of the scheelite is <30 µm in size. An image grid displaying the liberation characteristic of these particles is presented in Figure 21.

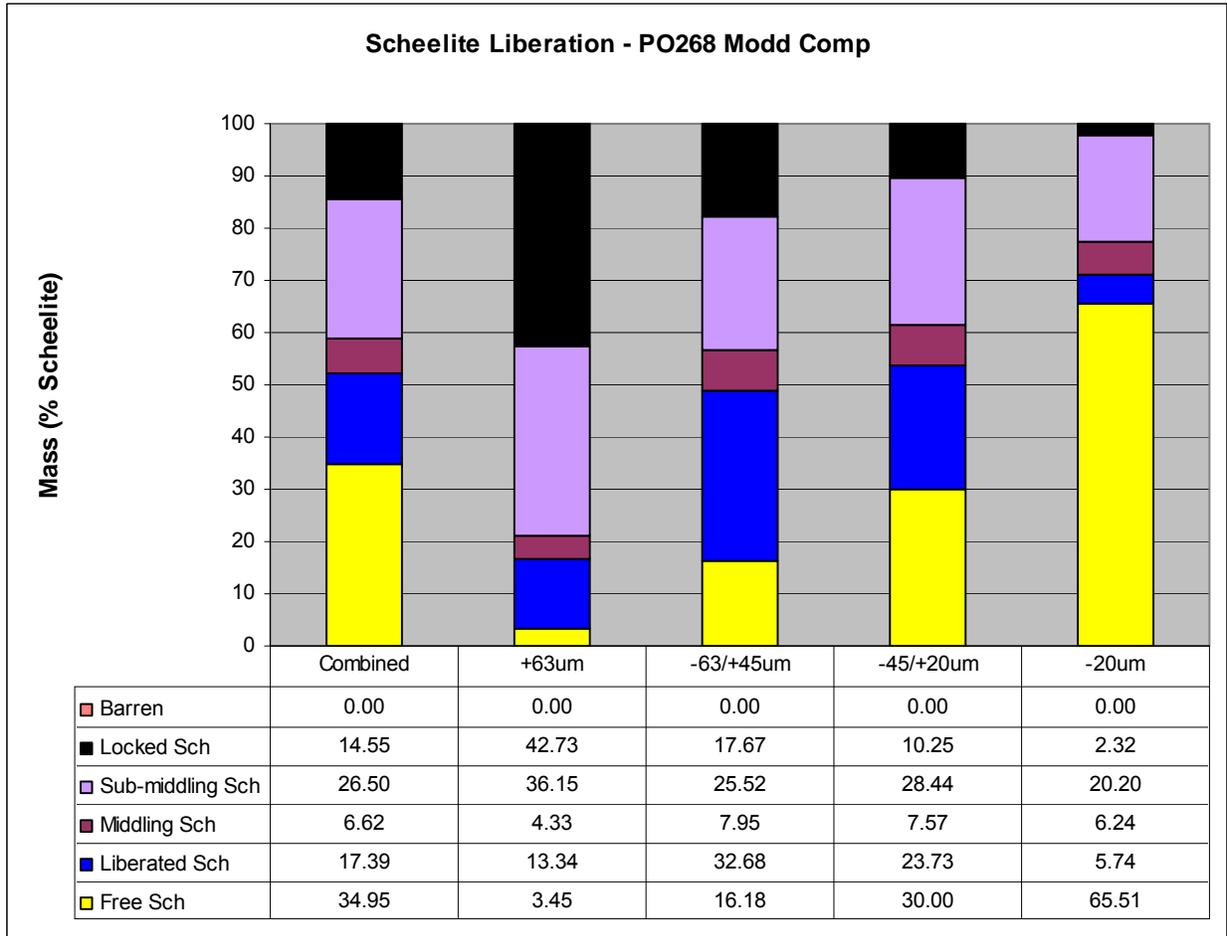


Figure 19: Liberation of Scheelite by Size Fraction for the PO268 Modd Comp.

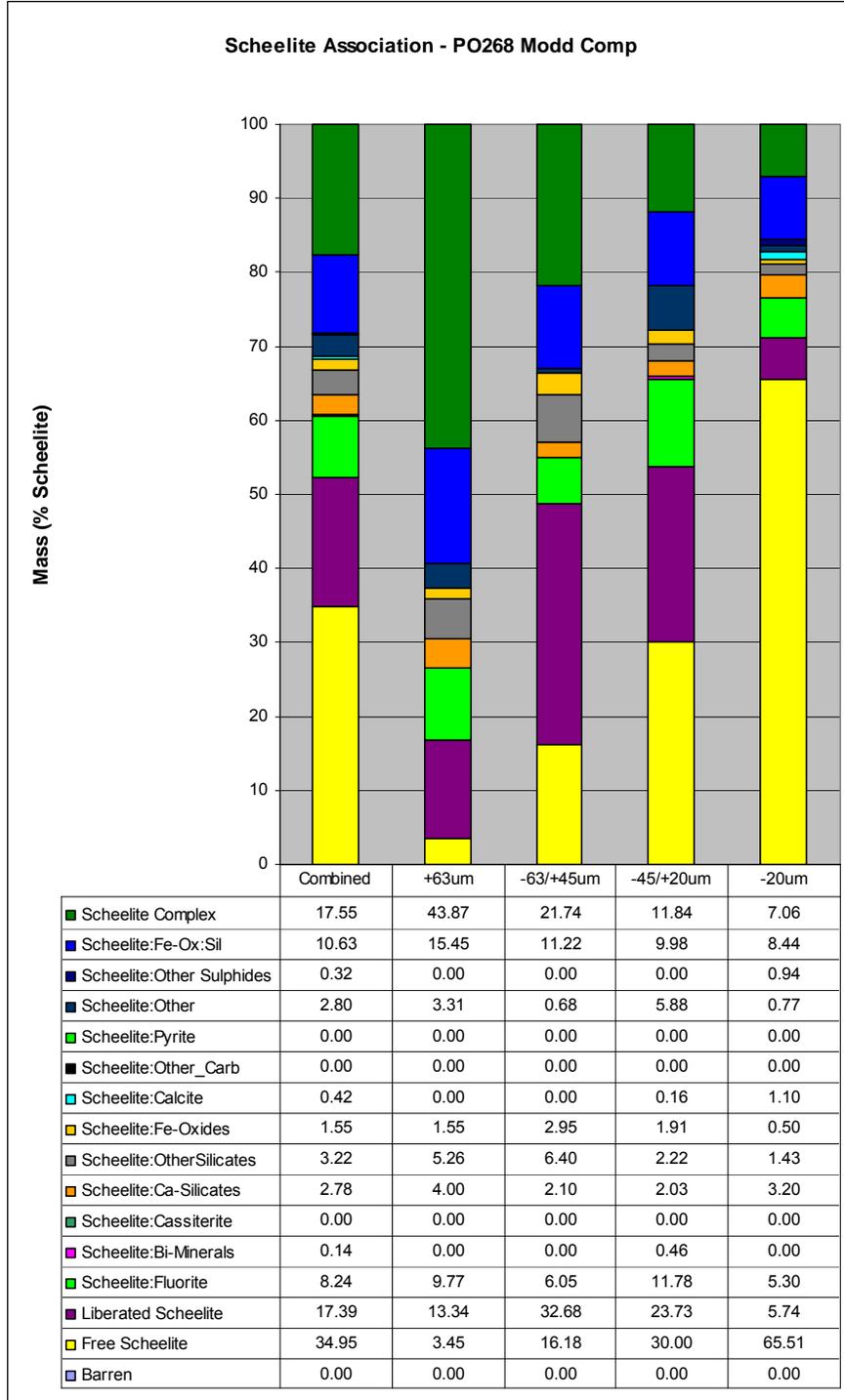


Figure 20: Association of Scheelite by Size Fraction of the PO268 Modd Comp.

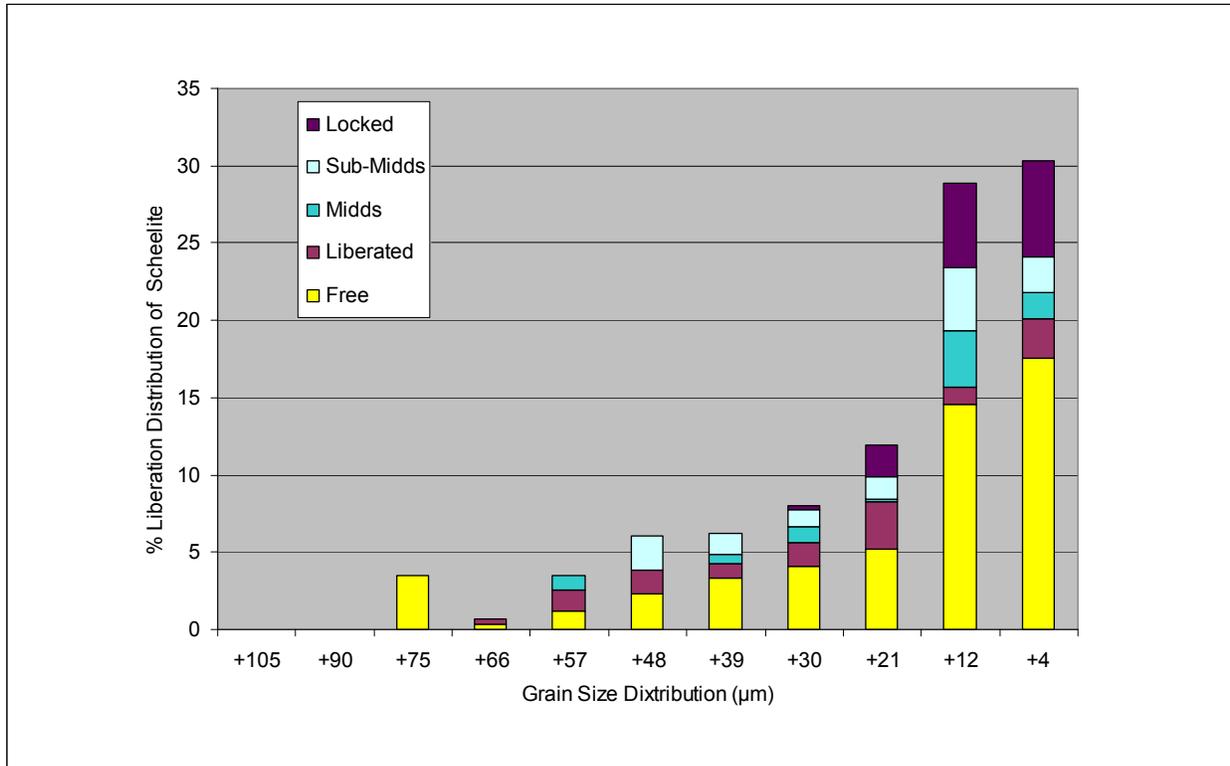


Figure 21: Liberation Profile by Size Class of the Scheelite in the PO268 Modd Comp.

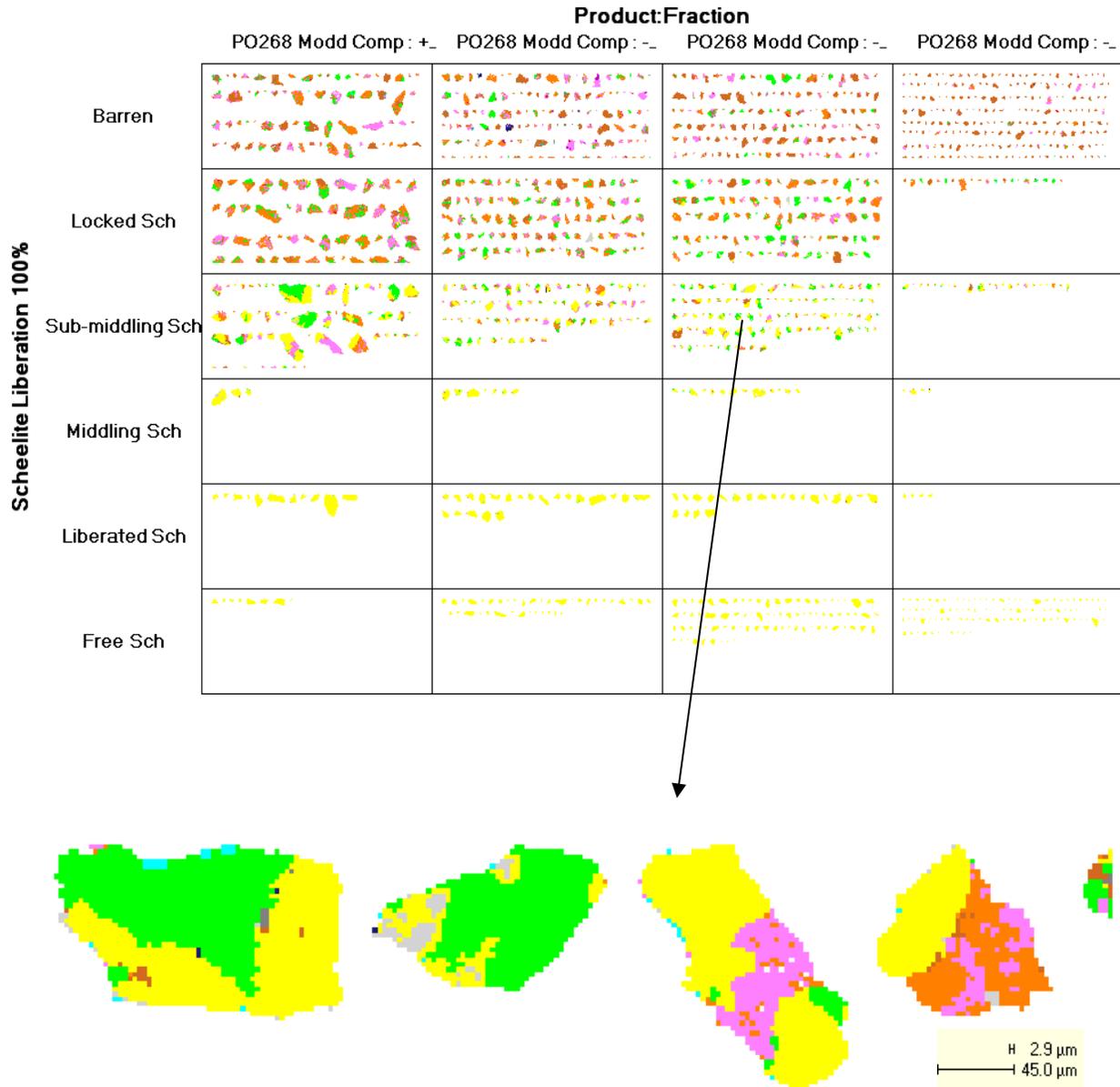


Figure 22: Image Grid of the Scheelite Liberation

The enlarged view is from the +20 μm size fraction Sub-Middling Class in the PO268 Modd Comp. Note that most of the scheelite particles have fluorite attachments.

4.3.5. Pyrite Liberation and Association

Pyrite liberation and association data are presented in Figure 23 and Figure 24, respectively. Pyrite is moderately liberated at 50%, while “Midds” account for ~10% and “Sub-Midds” for ~29% and “Locked” grains for 11%. Pyrite is commonly present as complex particles (~17%), ternary particles with Fe-Oxides and silicates (~10%), and as binary grains with other silicates (12%), and, less generally, with fluorite (1%).

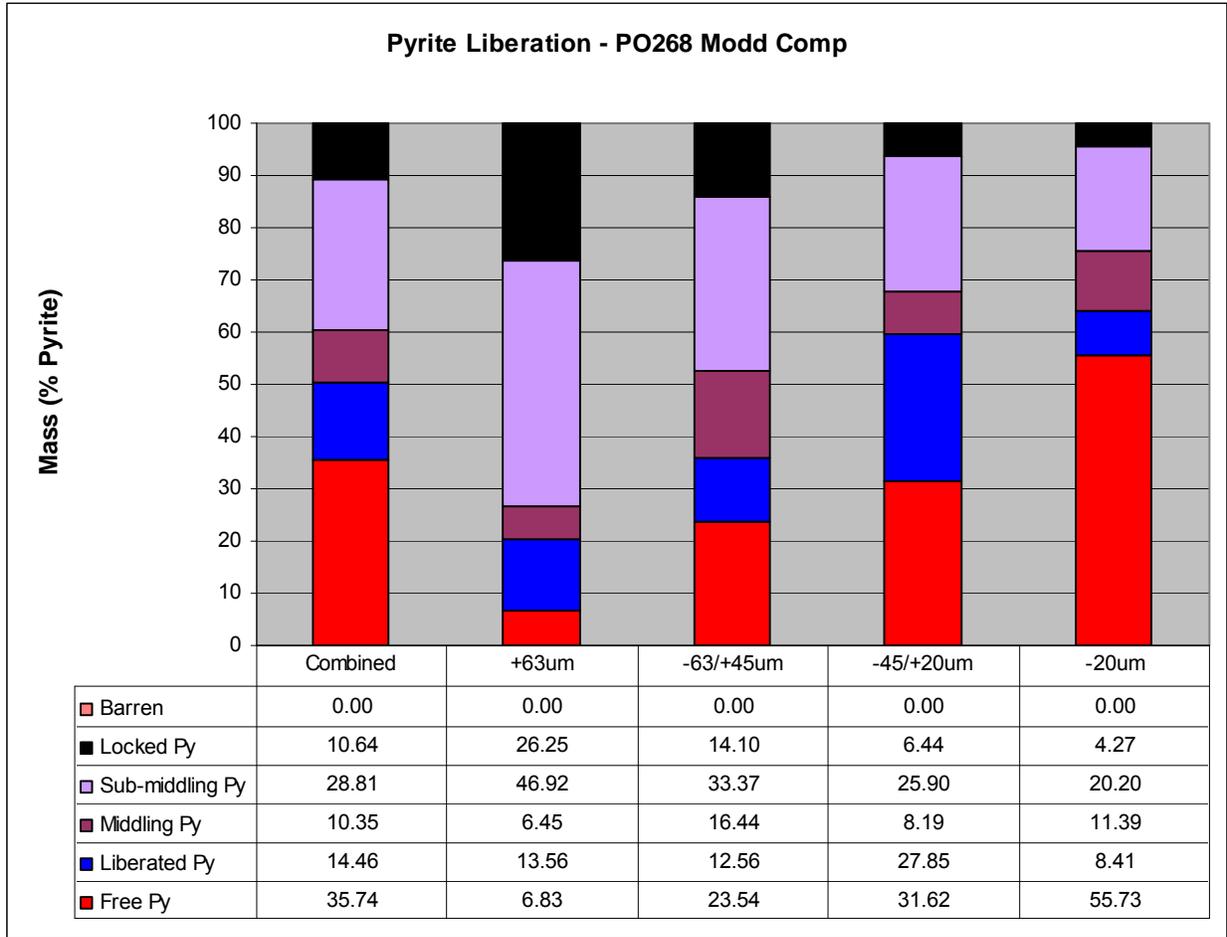


Figure 23: Liberation of Pyrite by Size Fraction for the PO268 Modd Comp.

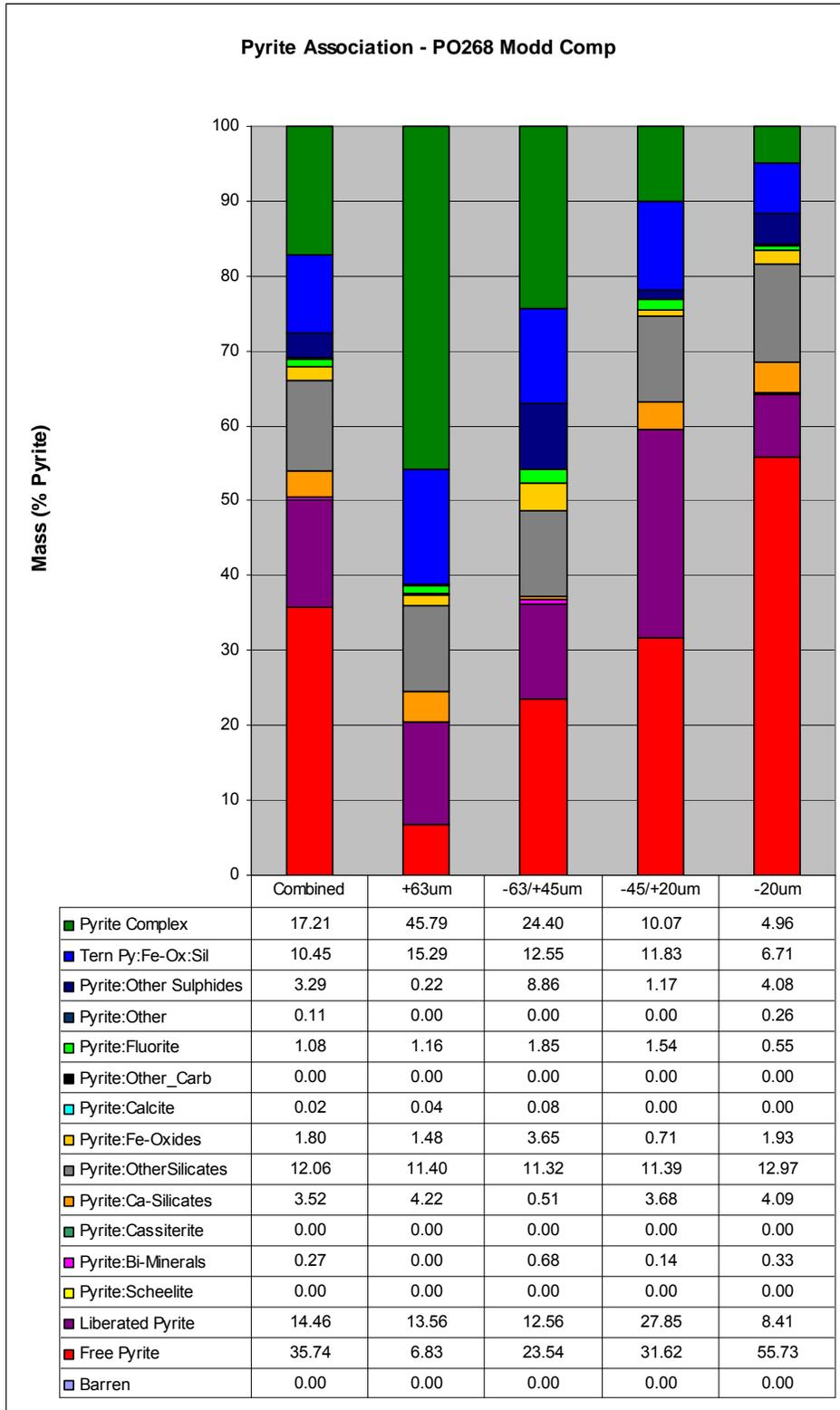


Figure 24: Association of Pyrite by Size Fraction of the PO268 Modd Comp.

4.3.6. Fe-Oxides Liberation and Association

Fe-Oxides liberation and association data are presented in Figure 25 and Figure 26, respectively. Fe-Oxides are moderately liberated at 43%, while “Midds” account for ~8% and “Sub-Midds” for ~42% and “Locked” grains for 7%. Fe-Oxides are commonly present as ternary particles with Fe-Oxides and silicates (~28.5%), binary particles with Ca-Silicates (~16%), complex particles (~8%), and as binary grains with other silicates (6%), and less typically, with fluorite (1.4%).

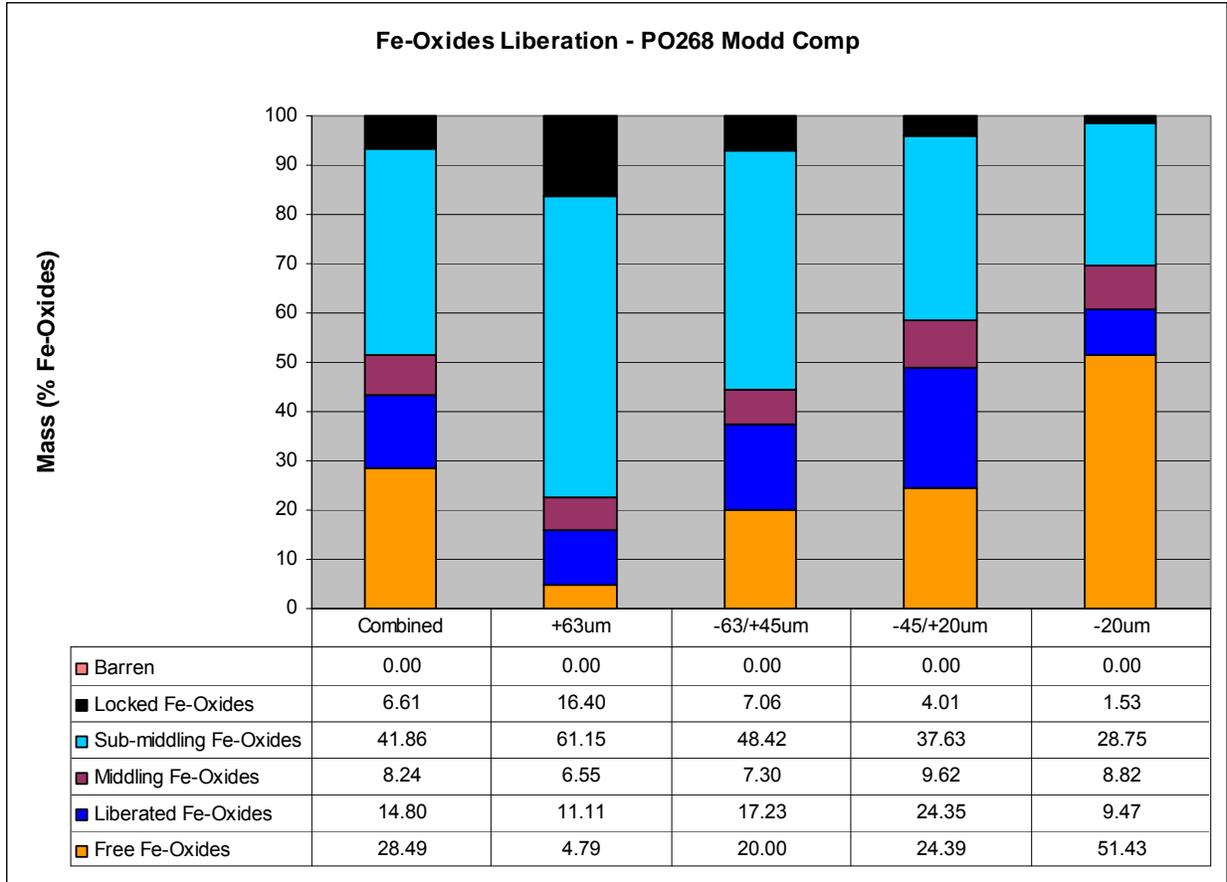


Figure 25: Liberation of Fe-Oxides by Size Fraction for the PO268 Modd Comp.

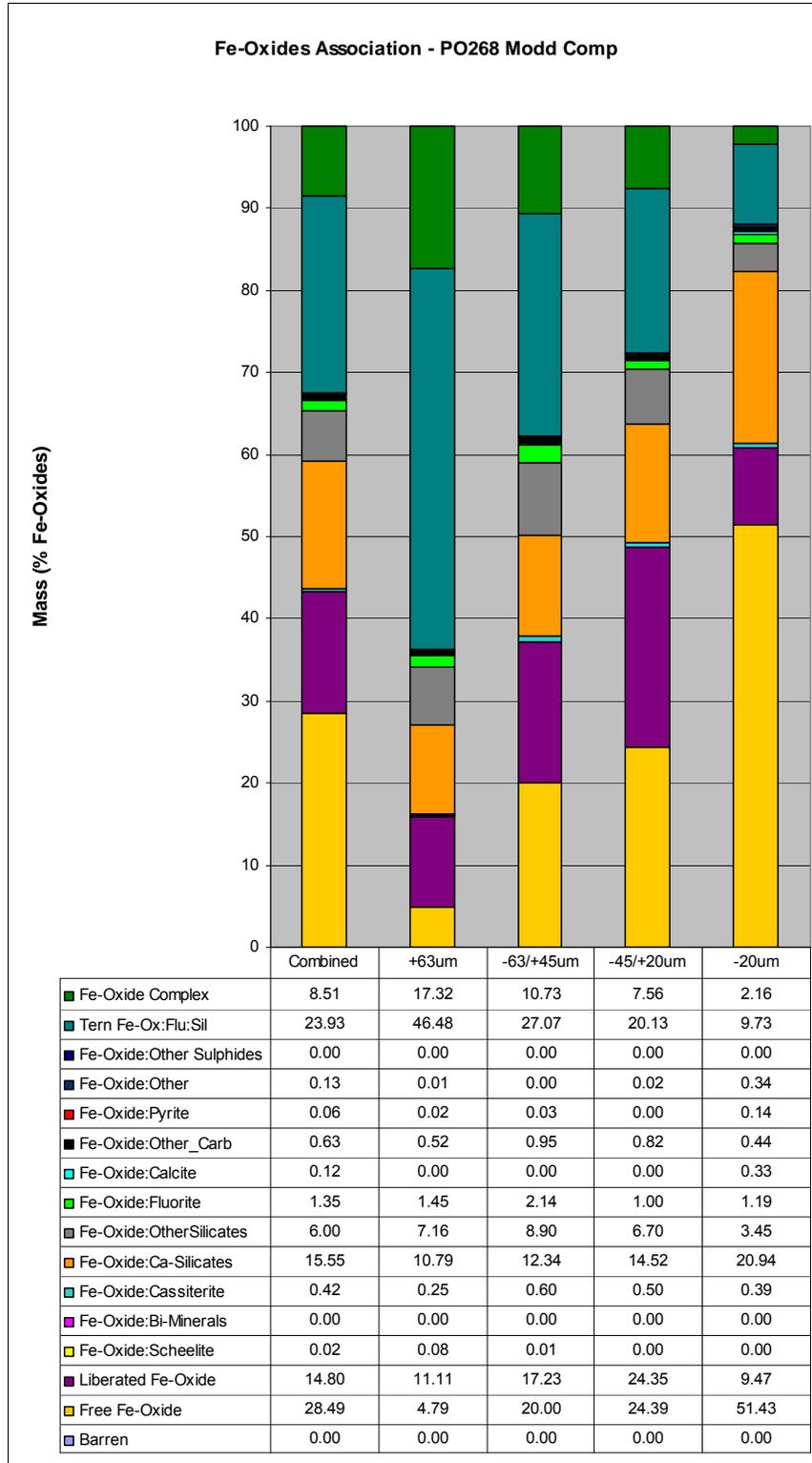


Figure 26: Association of Fe-Oxides by Size Fraction of the PO268 Modd Comp.

4.4. Cumulative Grain Size Distribution

The cumulative grain size distribution for this sample is presented in Figure 27. The graph displays that the cassiterite and the Bi-Minerals are certainly much finer than the other presented minerals. The diameter at ~50% for each is:

- ~7 μm for the cassiterite and Bi-Minerals;
- ~15 μm for fluorite, pyrite, Fe-Oxides and Ca-Silicates; and
- ~25 μm for the average particle size.

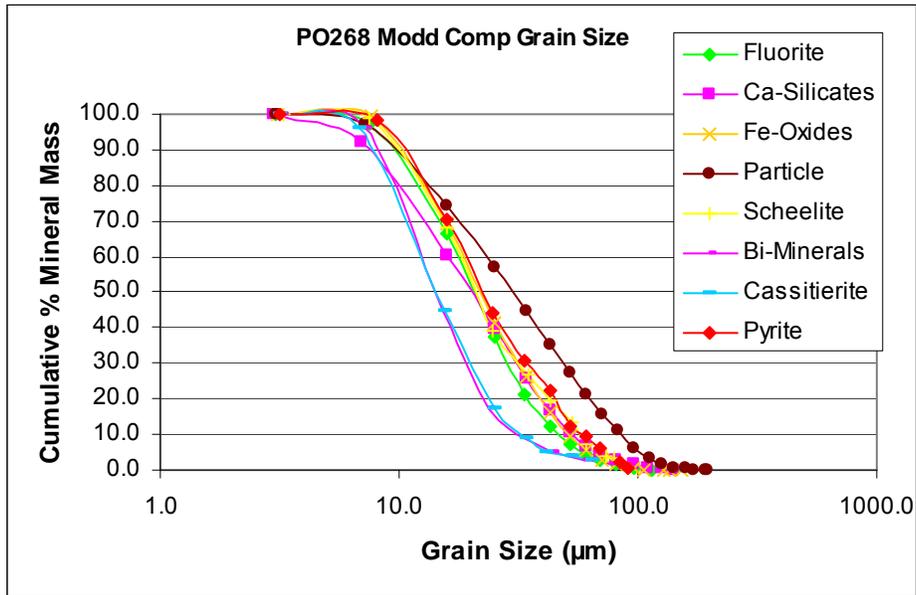


Figure 27: Cumulative Grain Size Distribution for the PO268 Modd Comp

5. Mineral Release

Mineral release curves are presented in Figure 28 and are used to predict the amount of liberated mineral of interest at varying size distributions. This can be an indicator of optimum grind targets for metallurgical processes in order to achieve the most liberation for the least amount of grind energy. The variation between value and gangue mineral release curves may sometimes be used to enhance separation.

Essentially, the graph illustrates that liberation is increasing with decreasing particle size for the desired minerals with a 40% to 50% increase from the coarsest size to the finest particle size for fluorite, pyrite, Fe-Oxides, scheelite and Fe-Oxides. Most notably is the poor liberation of the cassiterite as it increases by 20% from ~60 μm to ~10 μm .

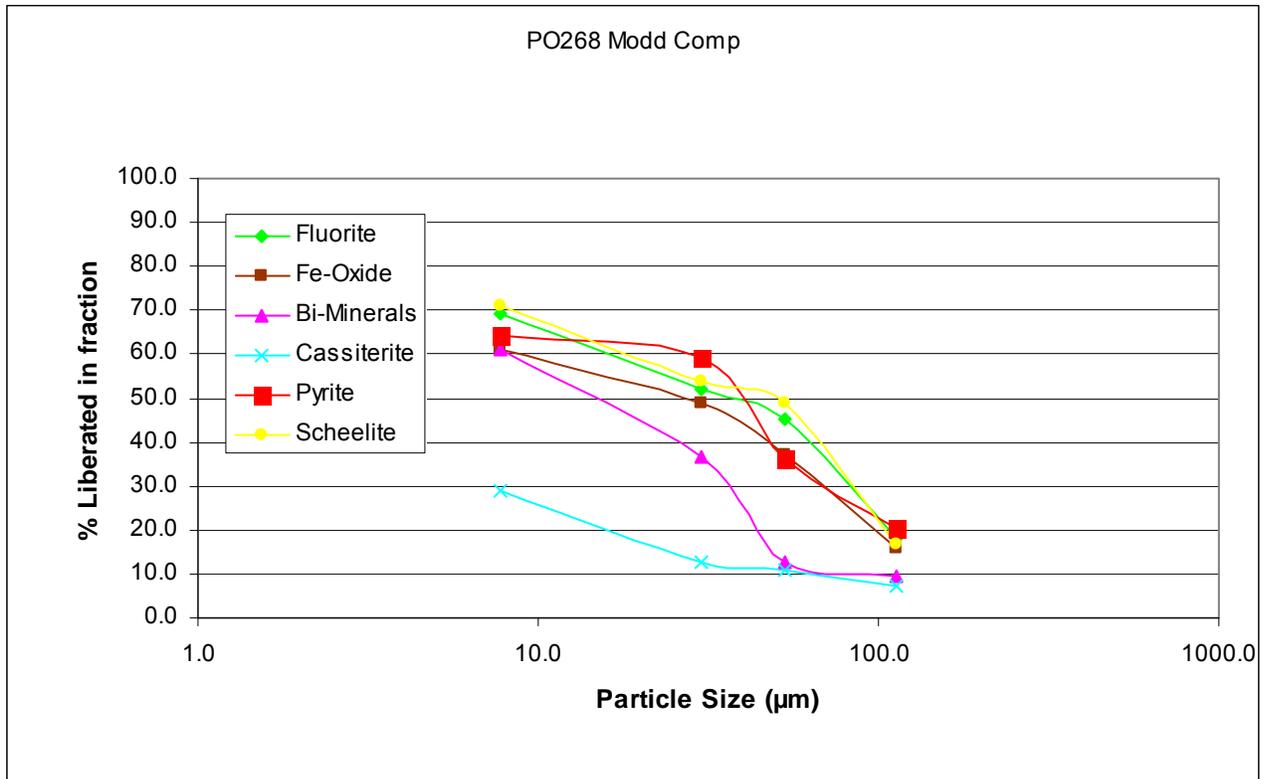


Figure 28: Mineral Release Curves of the PO268 Modd Comp

6. Mineralogically Limiting Grade Recovery Curves

Figure 29 through Figure 32 illustrate the mineralogically limiting grade-recovery curves by size fraction for fluorite, cassiterite, Bi-Minerals and scheelite, respectively. This analysis provides an indication of the maximum achievable grades by recovery based on individual particle liberation and grade. These results, of course, do not reflect gangue activation and entrainment or other factors that could be seen in the actual metallurgical process. The grade and recovery are expected to be higher in the fine than the coarse fraction for each listed mineral. Overall, the maximum achievable grade vs. recovery at this grind target, representing the whole sample, indicates that;

- Fluorite – ~100% CaF_2 grade with ~37% recovery,
- Cassiterite – ~77% Sn grade with ~13% recovery,
- Bi-Mineral – ~81% Bi grade with ~21% recovery,
- Scheelite – ~80% WO_3 grade with ~34% recovery are theoretically achievable.

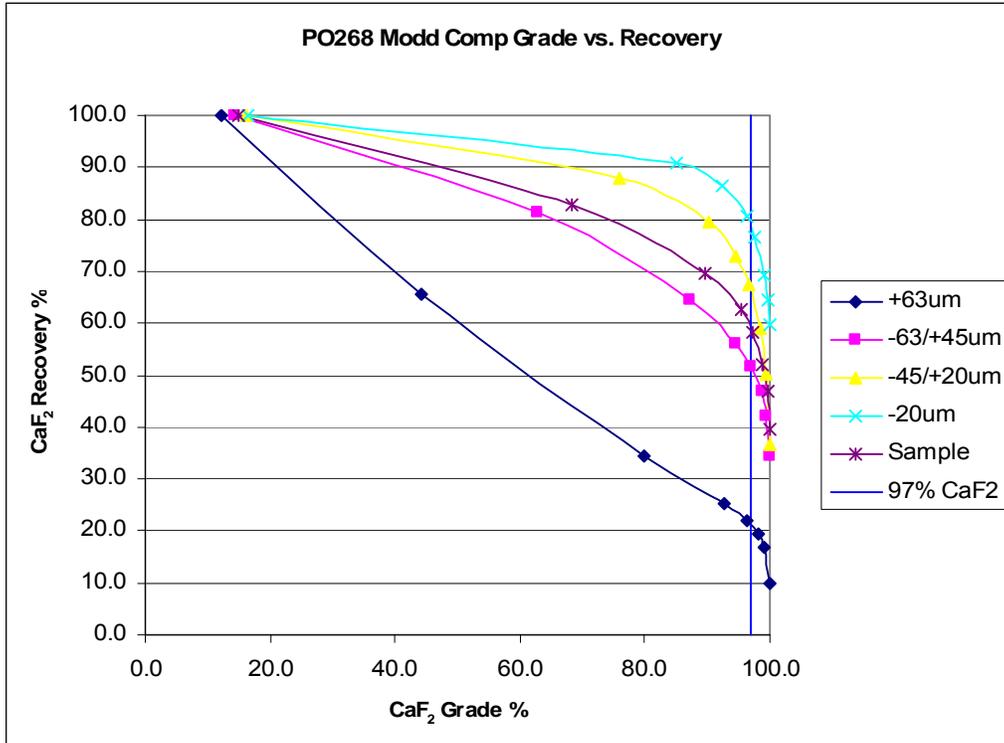


Figure 29: Grade - Recovery of CaF₂ for the PO268 Modd Comp

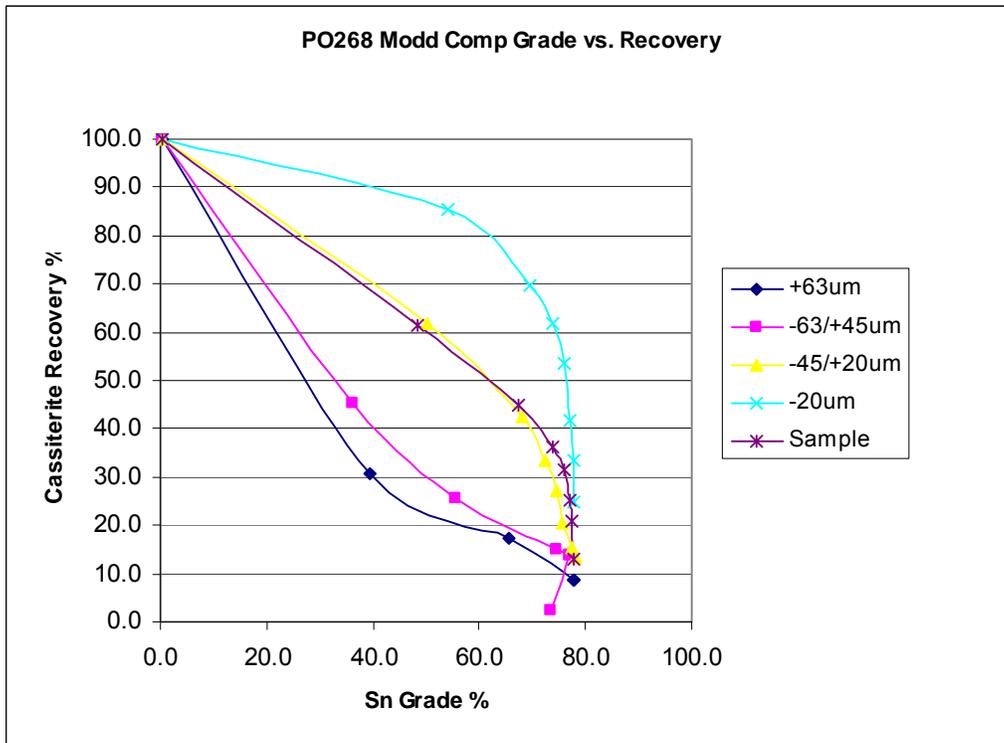


Figure 30: Grade - Recovery of Cassiterite for the PO268 Modd Comp

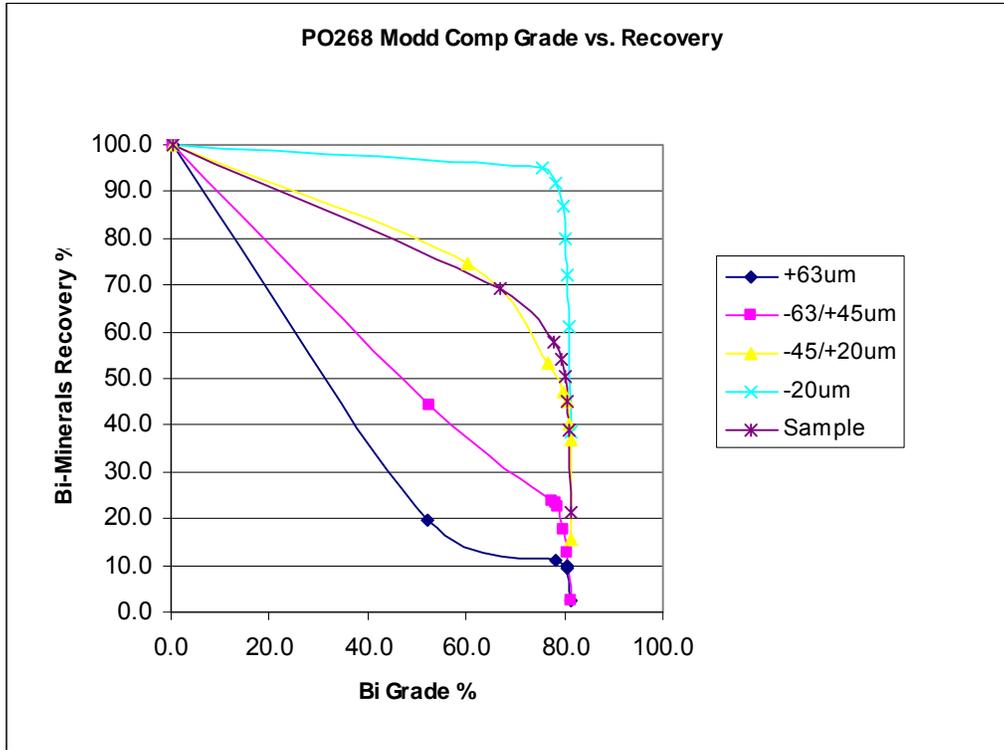


Figure 31: Grade - Recovery of Bi-Minerals for the PO268 Modd Comp

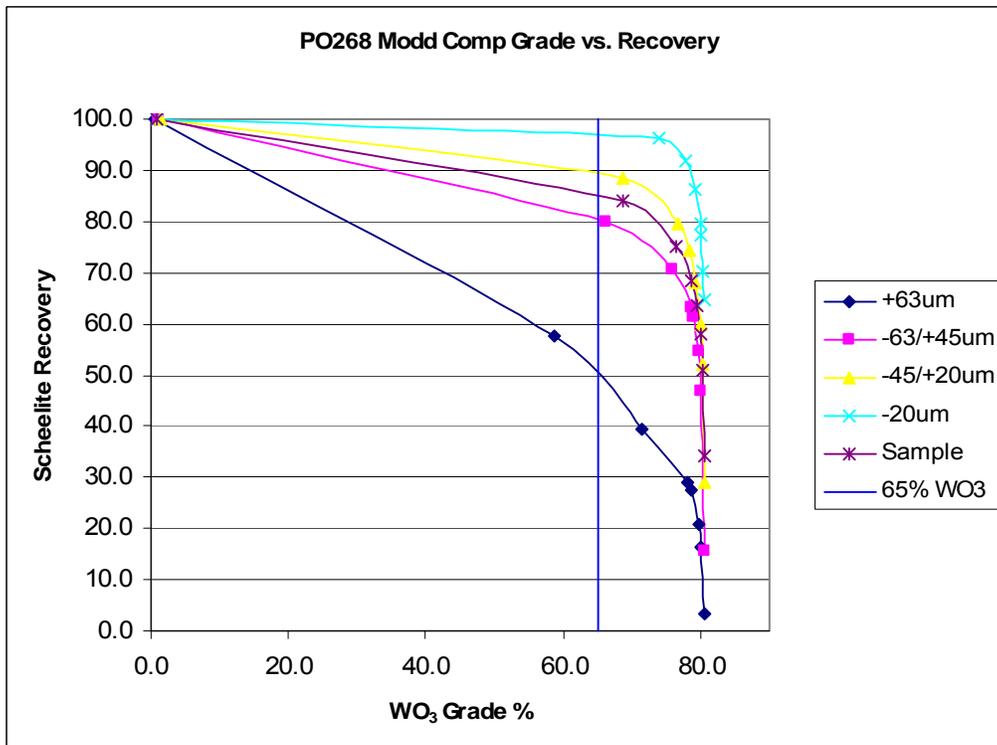


Figure 32: Grade - Recovery of Scheelite for the PO268 Modd Comp

7. Mineralogical Analysis of the -10 Mesh Materials for Coarse Scheelite

The other objective of this program was to determine if coarse scheelite is present within the sample. To complete this, an aliquot of the -10 mesh material was prepared, split and four polished sections were prepared. The SEM was used to scan each polished section for scheelite where roughly 400 scheelite grains were analyzed and measured. Each analysis and the complete results are presented in Appendix E. Overall, the “natural” grain size of scheelite is fine and grains greater than 100 μm in size were not observed. The grain size distributions were categorized in 5 μm intervals and the area of each class was calculated and illustrated in Figure 33. It should be noted, that with this analysis, very fine scheelite <3 μm , but does display that coarse scheelite is not abundant within this composite sample.

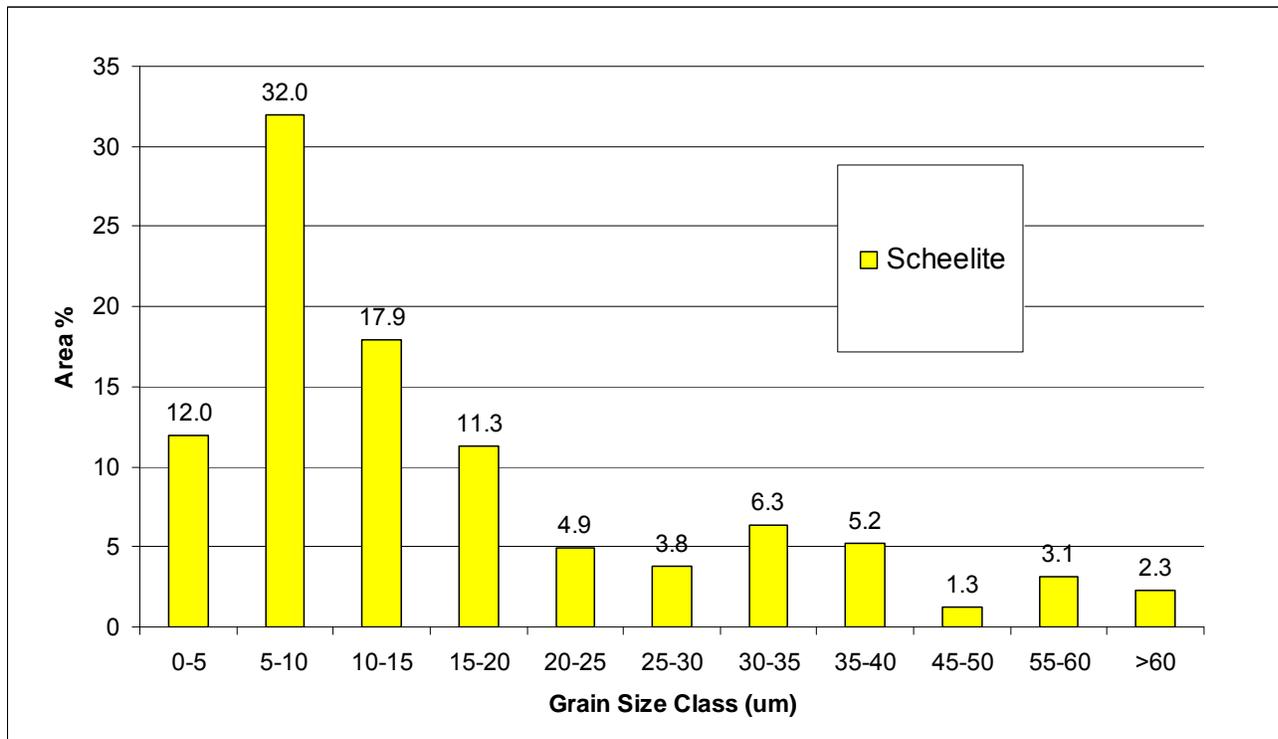


Figure 33: Grade – Grain Size Distribution for Scheelite in the PO268 Modd Comp -10 Mesh Material

Conclusions and Recommendations

The two main objective of this study were to:

1. characterize the sample by size fraction using the QEMSCAN™;
2. analyze coarse material (-10 mesh) and determine the “natural” grain size of scheelite to determine if a gravity concentrate is feasible. This sample was analyzed with the SEM.

For the first objective, the QEMSCAN™ results showed that for:

- **Mineral Abundances**

- The sample consists mainly of various Ca-Silicate minerals such as vesuvianite/epidote (13.8%), garnet (5.6%), actinolite/cummingtonite (5.8%), Fe-Ca-Amphibole (~15%) and diopside (~2%). Moderate levels of Fe-Oxides (~18.5%), fluorite (~14%), biotite (~8%), plagioclase (~8%) and minor levels of calcite (1.5%), chlorite (~1.1%) were also detected. A high F chlorite (~0.6%) was also observed. Pyrite was also detected in trace levels (0.48%), while other sulphides are rare (0.03%).
- The trace phases of particular interest include scheelite (0.21%), Bi-Minerals (0.09%) including Bi-Sulphides and Native bismuth, cassiterite (0.07%) and a Sn-Fe Oxide (0.05%). The highest grade of these minerals is recorded in the -20 µm size fraction.

- **SEM Investigation and Elemental Department**

- An SEM-EDS and QEMSCAN data are in agreement with historical studies and show that F and Sn are present in trace to minor amounts in various calc-silicate phases.
- Approximately ~92% of F is contained by fluorite, while the remaining 8% is carried by the various Ca-silicates and micas. About 35% Sn is accounted by garnet and is considered non-recoverable. Cassiterite and Sn-Fe Oxide (or very fine grained cassiterite in Fe-Oxides) account for 48% and 15% of the Sn, respectively.

- **Liberation/Association and Grain Size of**

- **Fluorite:** Approximately 50% of the fluorite occurs as liberated particles (both the Free and Liberated), and increases from from 19% in the +63 µm to 70% in the -20 µm size fraction. “Midds”, “Sub-Midds” and “Locked” grains represent 5%, 32% and 10%, respectively. The non-liberated fluorite mainly occurs as ternary particles with Fe-Oxides and silicates (~23%), as binary particles with Ca-silicates (~9%), and complex particles (~6%). Fluorite in the “midd”, “sub-midds” and locked classes is generally <30 µm in size.
- **Cassiterite:** It is poorly liberated (~11%) and most commonly occurs as ternary particles with Fe-Oxides and silicates (~27%), complex particles (~27%) and binary particles with Ca-silicates (~15%). Liberation increases moderately with decreasing size from ~nil in the +63 µm to ~30% in the -20 µm size fraction. About 50% of the cassiterite is <10 µm in size.
- **Bi-Minerals:** They are poorly to moderately liberated at ~39%. “Midds” account for ~6%, “Sub-Midds” for 24% and “Locked” grains for 30%. Bi-Minerals are commonly present as ternary particles with Fe-Oxides and silicates (~14%), and complex particles (~30%). Liberation increases moderately with decreasing size from ~10% in the +63 µm to ~60% in the -20 µm size fraction. About 90% of the Bi-Minerals are <12 µm in size.

- **Scheelite:** The scheelite is moderately liberated at 52%, while “Midds” account for ~6% and “Sub-Midds” for ~26%, and “Locked” for ~15%. Scheelite occurs commonly as complex particles (~17%), ternary particles with Fe-Oxides and silicates (~10%), and as binary grains with fluorite. Liberation increases with decreasing size from ~16% in the +63 μm to ~70% in the -20 μm size fraction. Roughly 80% of the scheelite is <30 μm in size.

- **Grade vs. Recovery**

Overall, the maximum achievable grade vs. recovery at this grind target indicates that;

- Fluorite – ~100% CaF_2 grade with ~37% recovery,
- Cassiterite – ~77% Sn grade with ~13% recovery,
- Bi-Mineral – ~81% Bi grade with ~21% recovery,
- Scheelite – ~80% WO_3 grade with ~34% recovery are theoretically achievable.

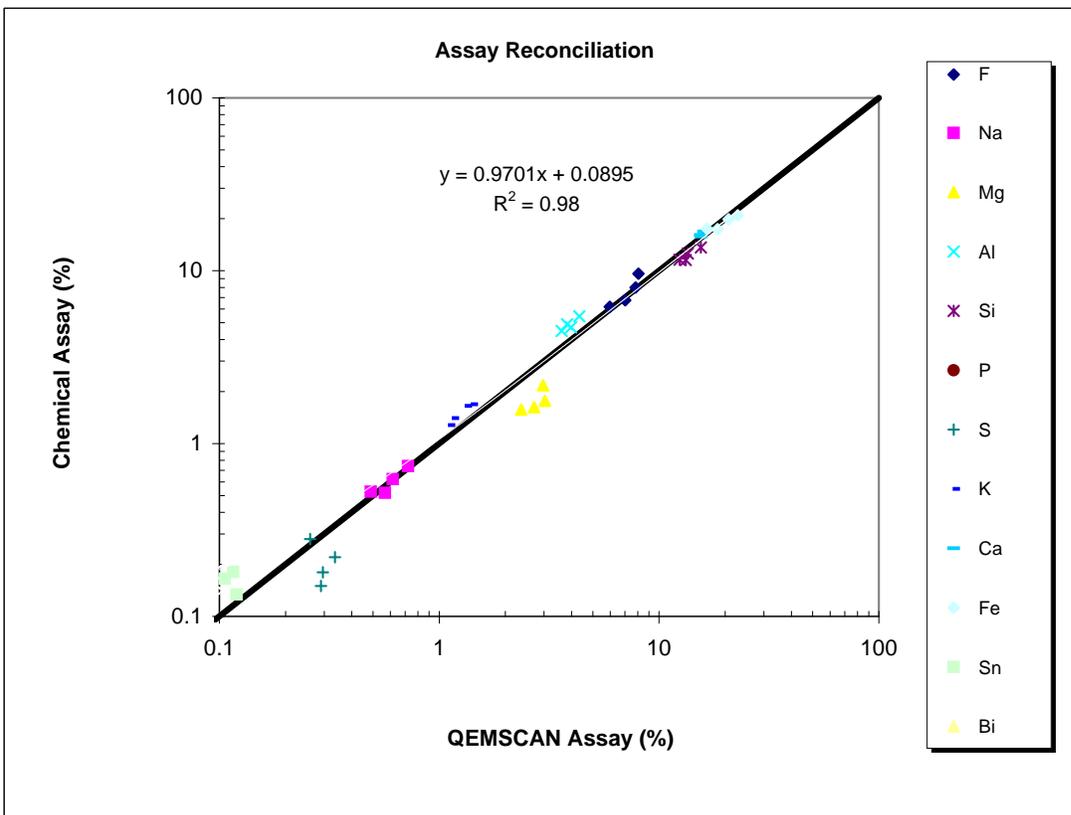
References

Kwak, T.A.P, Askins, P.W. **Geology and Genesis of the F-Sn-W(-Be-Zn) Skarn (Wrigglite) at Moina**, Tasmania. Economic Geology, Vol. 76, 1981, pp 439-467.

Appendix A – QEMSCAN Data

Minemakers
 12547-001
 MI5031-OCT10

Assay Reconciliation



	PO268 Modd Comp				
	Combined	+63um	-63/+45um	-45/+20um	-20um
F (QEMSCAN)	7.26	5.97	7.02	7.82	8.06
F (Chemical)	7.92	6.19	6.74	7.99	9.61
Na (QEMSCAN)	0.59	0.72	0.61	0.57	0.49
Na (Chemical)	0.60	0.74	0.62	0.52	0.53
Mg (QEMSCAN)	2.84	3.03	2.70	2.36	2.97
Mg (Chemical)	1.87	1.77	1.62	1.57	2.18
Al (QEMSCAN)	3.99	4.34	3.82	3.61	3.98
Al (Chemical)	4.91	5.45	4.90	4.48	4.70
Si (QEMSCAN)	13.78	15.50	13.51	12.38	13.22
Si (Chemical)	12.31	13.65	12.57	11.59	11.55
P (QEMSCAN)	0.01	0.01	0.02	0.02	0.01
P (Chemical)	0.03	0.04	0.03	0.01	0.03
S (QEMSCAN)	0.29	0.26	0.34	0.30	0.29
S (Chemical)	0.20	0.28	0.22	0.18	0.15
K (QEMSCAN)	1.29	1.32	1.15	1.11	1.41
K (Chemical)	1.56	1.65	1.40	1.28	1.69
Ca (QEMSCAN)	16.23	15.52	15.40	15.94	17.21
Ca (Chemical)	16.67	15.79	16.08	16.87	17.44
Fe (QEMSCAN)	19.00	16.52	20.72	22.82	18.45
Fe (Chemical)	18.42	17.49	19.86	20.91	17.42
Sn (QEMSCAN)	0.11	0.12	0.11	0.07	0.12
Sn (Chemical)	0.16	0.18	0.17	0.17	0.13
Bi (QEMSCAN)	0.08	0.05	0.06	0.04	0.12
Bi (Chemical)	0.05	0.04	0.04	0.04	0.06

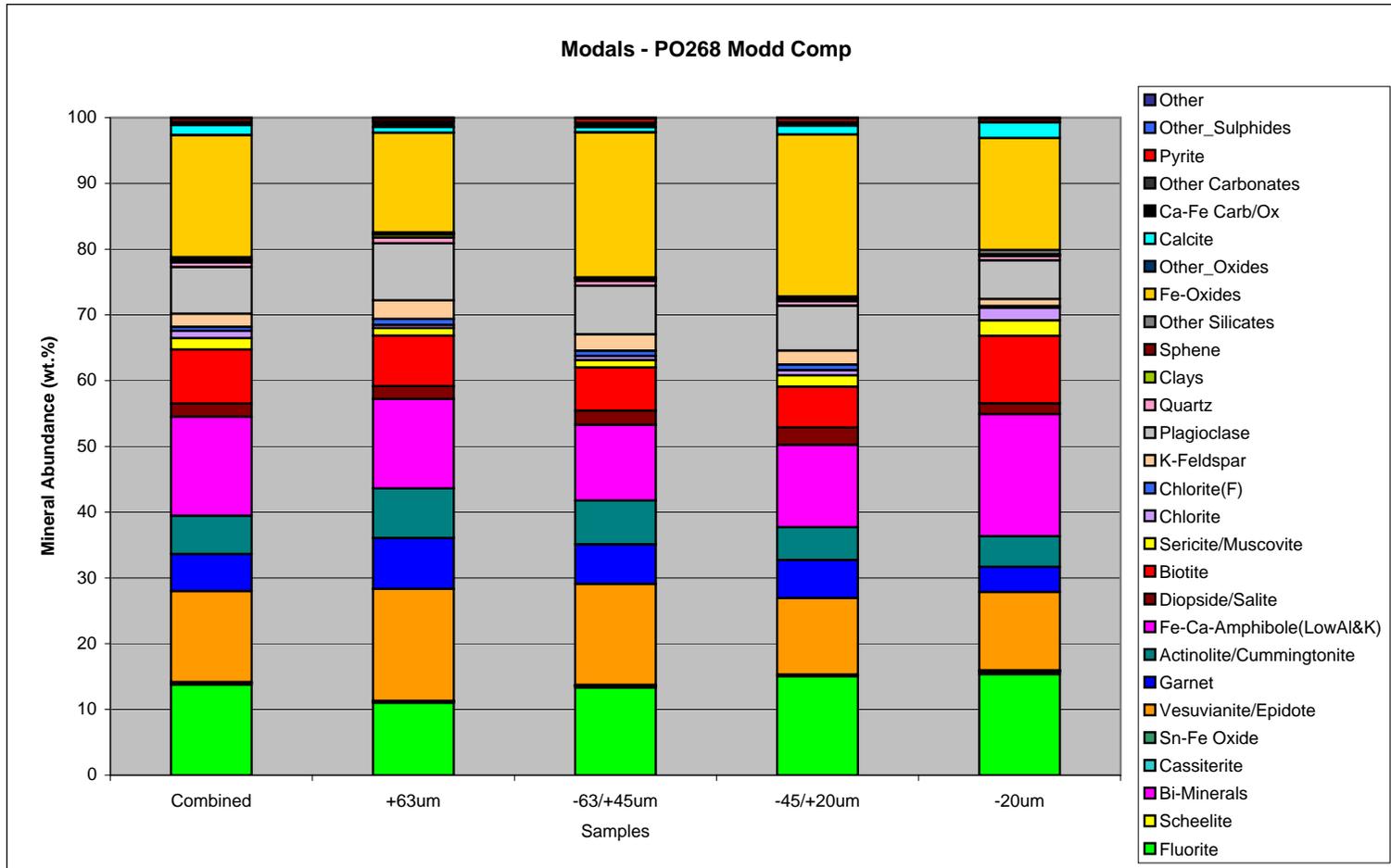
Minemakers
12547-001
MI5031-OCT10

Modals

Survey		Minemakers									
Project		12547-001 / MI5031-OCT10									
Sample		PO268 Modd Comp									
Fraction		Combined	+63um		-63/+45um		-45/+20um		-20um		
Mass Size Distribution (%)			29.8		12.9		19.0		38.4		
Particle Size			56		32		21		8		
Mineral	Mass (%)	Sample	Sample	Fraction	Sample	Fraction	Sample	Fraction	Sample	Fraction	
Fluorite		13.7	3.3	11.0	1.7	13.3	2.9	15.0	5.9	15.4	
Scheelite		0.2	0.0	0.1	0.0	0.2	0.0	0.1	0.1	0.3	
Bi-Minerals		0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	
Cassiterite		0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	
Sn-Fe Oxide		0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	
Vesuvianite/Epidote		13.8	5.1	17.0	2.0	15.4	2.2	11.6	4.6	11.9	
Garnet		5.6	2.3	7.7	0.8	6.0	1.1	5.8	1.5	3.8	
Actinolite/Cummingtonite		5.8	2.2	7.5	0.9	6.7	0.9	5.0	1.8	4.7	
Fe-Ca-Amphibole(LowAl&K)		15.0	4.1	13.6	1.5	11.5	2.4	12.5	7.1	18.6	
Diopside/Salite		2.0	0.6	2.0	0.3	2.2	0.5	2.6	0.6	1.6	
Biotite		8.2	2.3	7.7	0.8	6.5	1.2	6.2	3.9	10.3	
Sericite/Muscovite		1.7	0.3	1.1	0.1	1.1	0.3	1.7	0.9	2.4	
Chlorite		1.1	0.1	0.5	0.1	0.6	0.1	0.8	0.7	1.9	
Chlorite(F)		0.6	0.3	0.9	0.1	0.8	0.2	0.9	0.1	0.3	
K-Feldspar		2.0	0.8	2.8	0.3	2.5	0.4	2.1	0.4	1.1	
Plagioclase		7.1	2.6	8.7	1.0	7.4	1.3	6.8	2.3	5.9	
Quartz		0.7	0.3	0.9	0.1	0.7	0.1	0.7	0.2	0.6	
Clays		0.3	0.1	0.5	0.0	0.3	0.1	0.3	0.1	0.2	
Sphene		0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	
Other Silicates		0.4	0.0	0.2	0.0	0.1	0.0	0.3	0.2	0.6	
Fe-Oxides		18.6	4.5	15.1	2.8	22.1	4.7	24.6	6.5	17.0	
Other_Oxides		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Calcite		1.5	0.3	0.8	0.1	0.8	0.3	1.4	0.9	2.4	
Ca-Fe Carb/Ox		0.5	0.3	0.9	0.1	0.7	0.1	0.5	0.0	0.1	
Other Carbonates		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Pyrite		0.5	0.1	0.4	0.1	0.6	0.1	0.5	0.2	0.5	
Other_Sulphides		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other		0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	
Total		100.0	29.8	100.0	12.9	100.0	19.0	100.0	38.4	100.0	
Mean Grain Size by Frequency (µm)											
Fluorite				20		20		17		8	
Scheelite				18		19		17		7	
Bi-Minerals				9		11		7		6	
Cassiterite				17		11		7		5	
Sn-Fe Oxide				6		6		4		4	
Vesuvianite/Epidote				10		10		6		4	
Garnet				14		13		8		5	
Actinolite/Cummingtonite				8		8		5		4	
Fe-Ca-Amphibole(LowAl&K)				10		9		6		5	
Diopside/Salite				15		15		12		7	
Biotite				16		14		9		6	
Sericite/Muscovite				8		7		5		5	
Chlorite				7		7		5		4	
Chlorite(F)				11		10		7		5	
K-Feldspar				21		17		10		5	
Plagioclase				11		10		7		5	
Quartz				14		14		10		7	
Clays				6		6		3		3	
Sphene				10		10		7		5	
Other Silicates				8		8		5		5	
Fe-Oxides				21		21		17		10	
Other_Oxides				6		6		3		5	
Calcite				16		17		11		7	
Ca-Fe Carb/Ox				8		8		5		6	
Other Carbonates				16		10		7		5	
Pyrite				24		19		15		6	
Other_Sulphides				10		7		5		5	
Other				9		12		9		6	

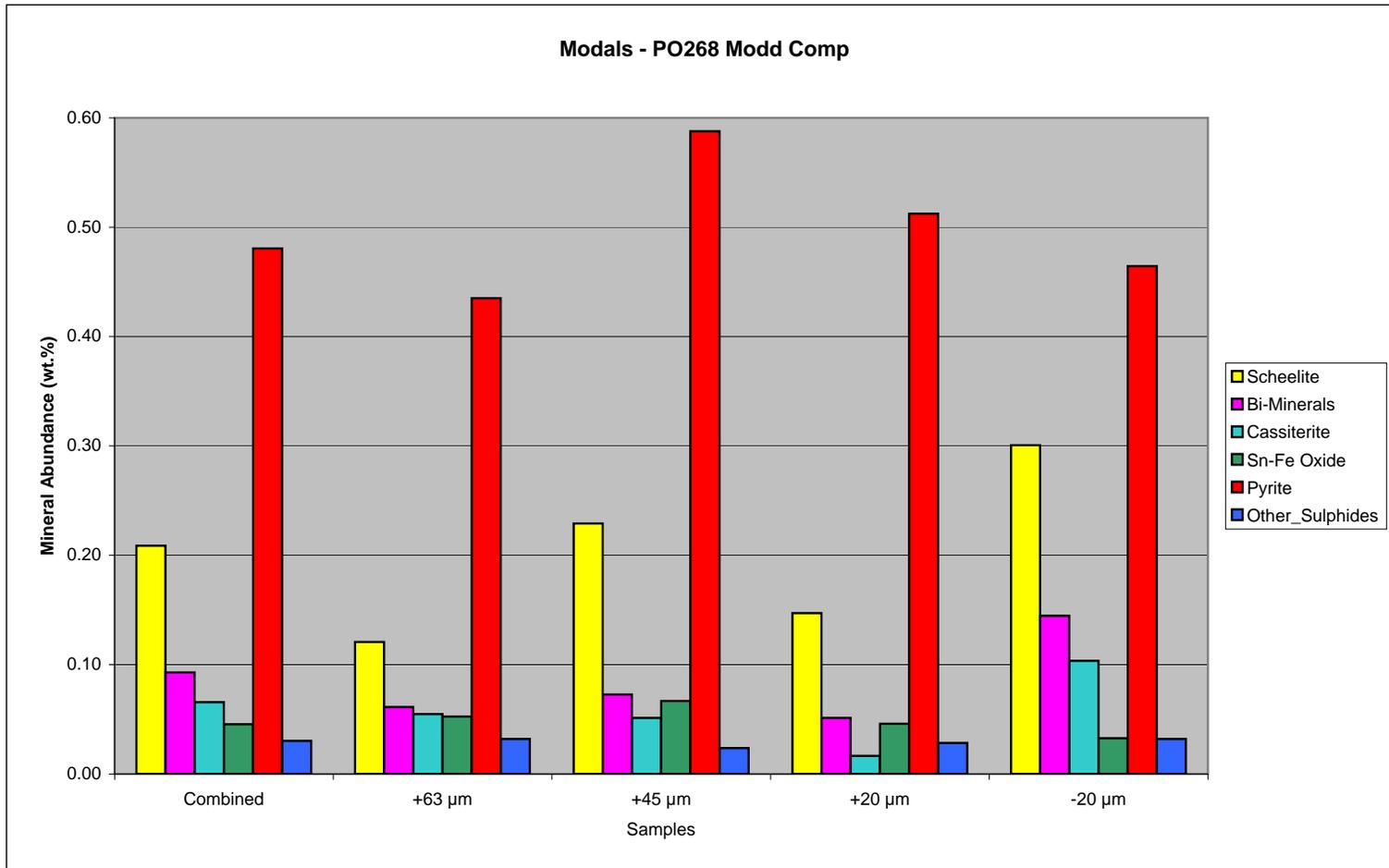
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12547-001
MI5031-OCT10

Modals



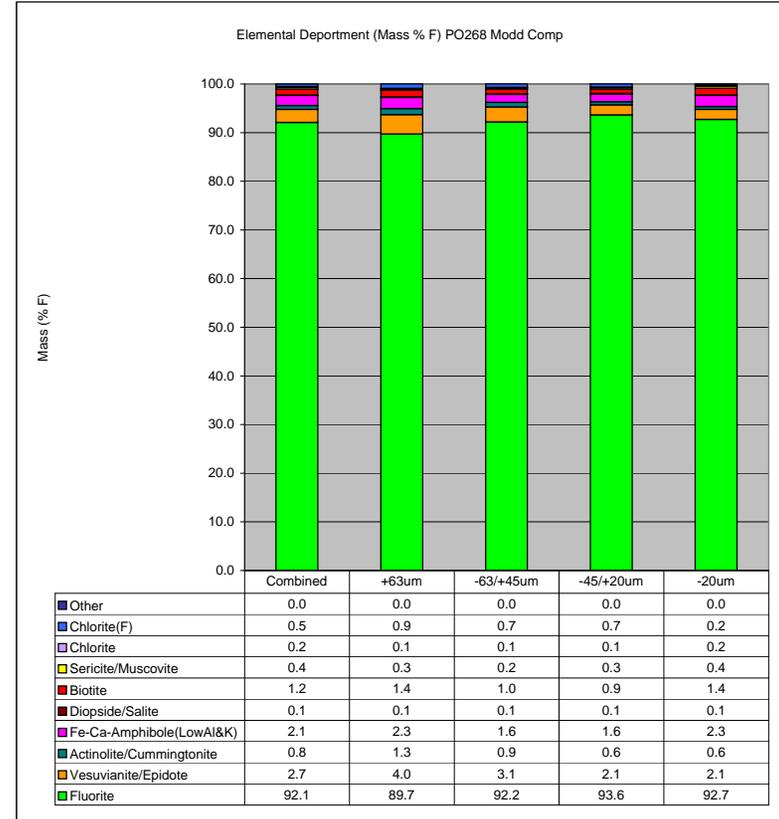
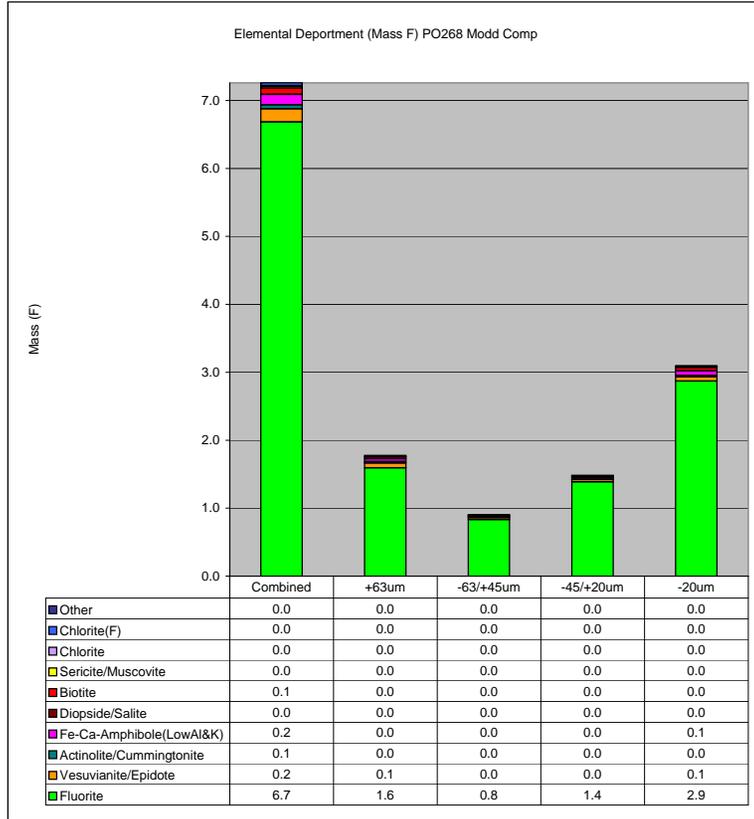
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Modals



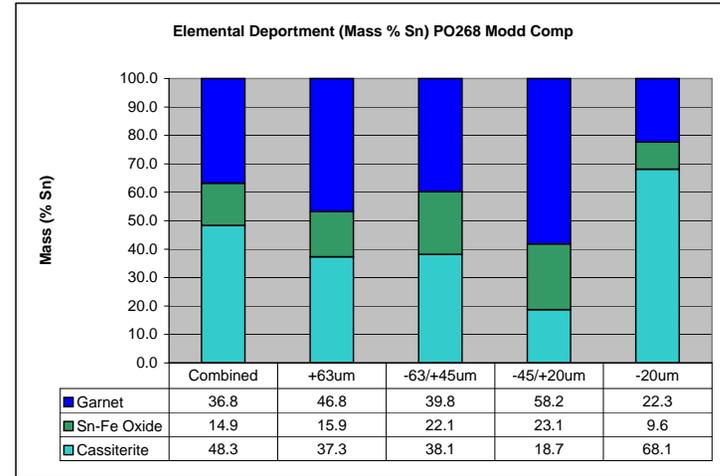
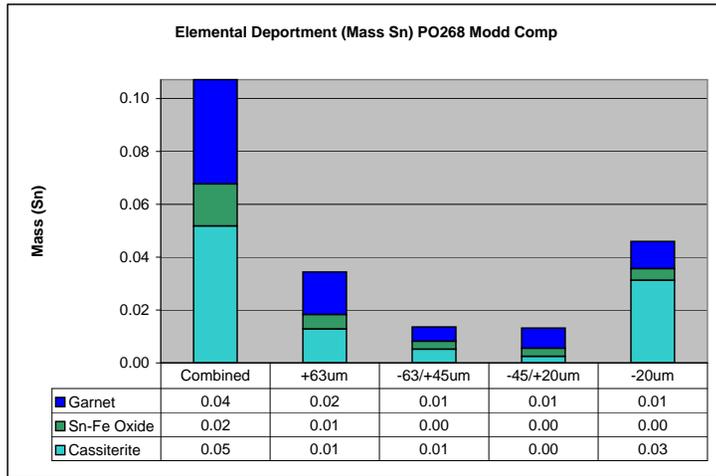
Minemakers
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F Department



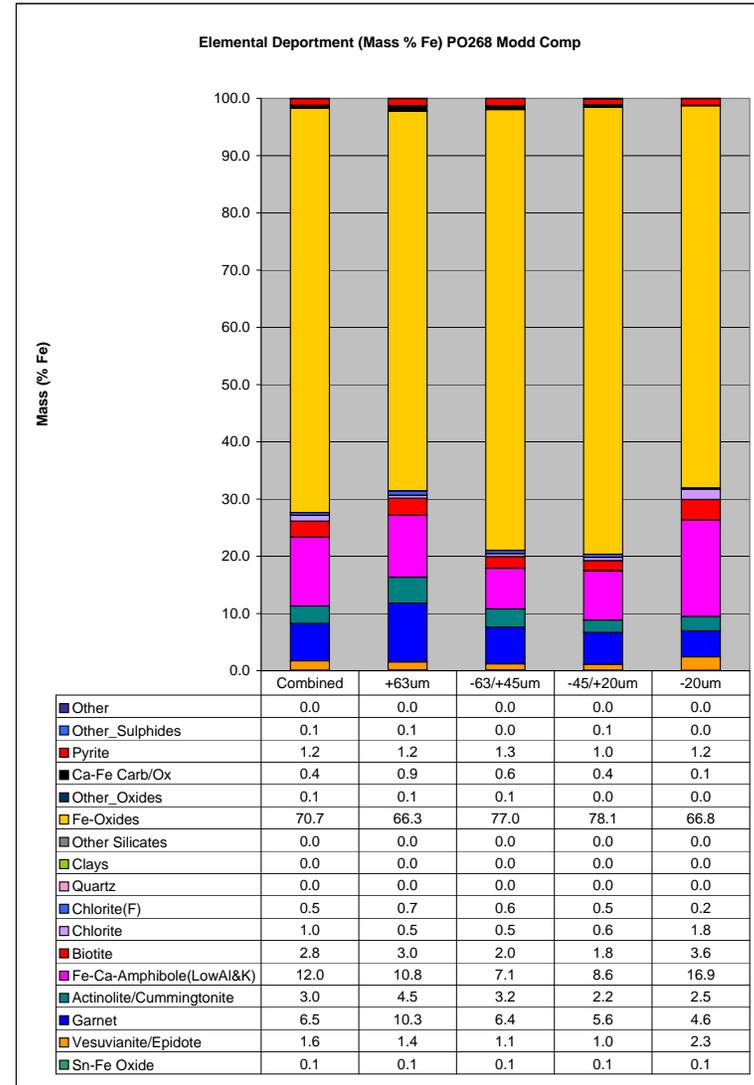
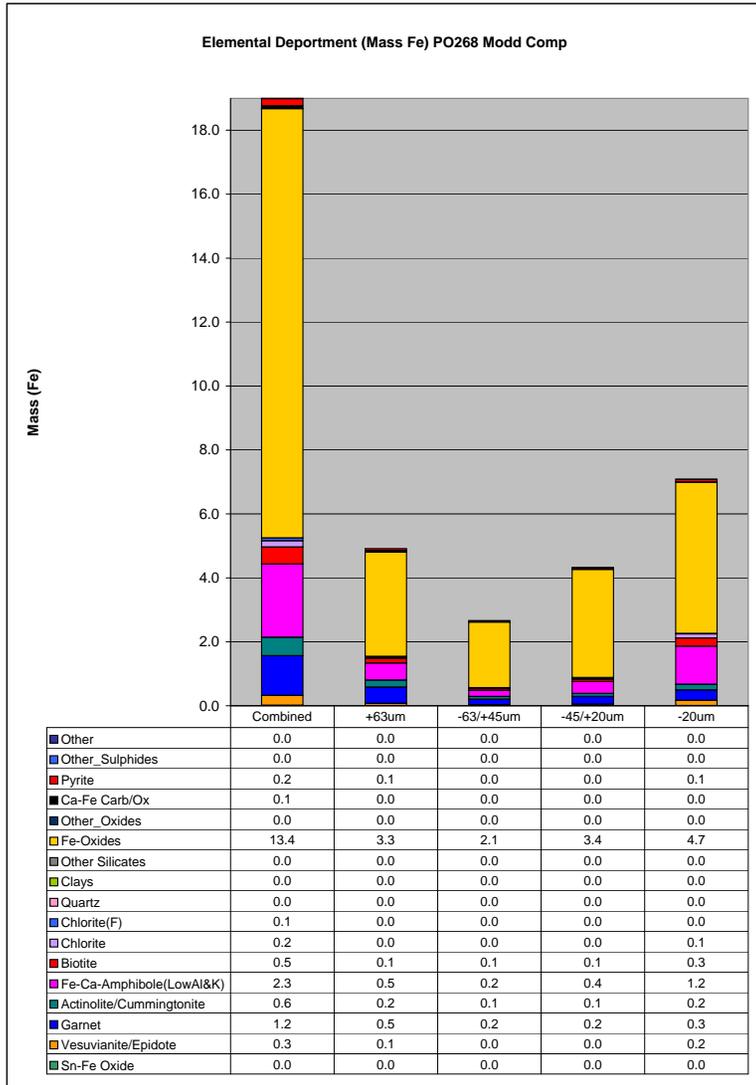
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Sn Department



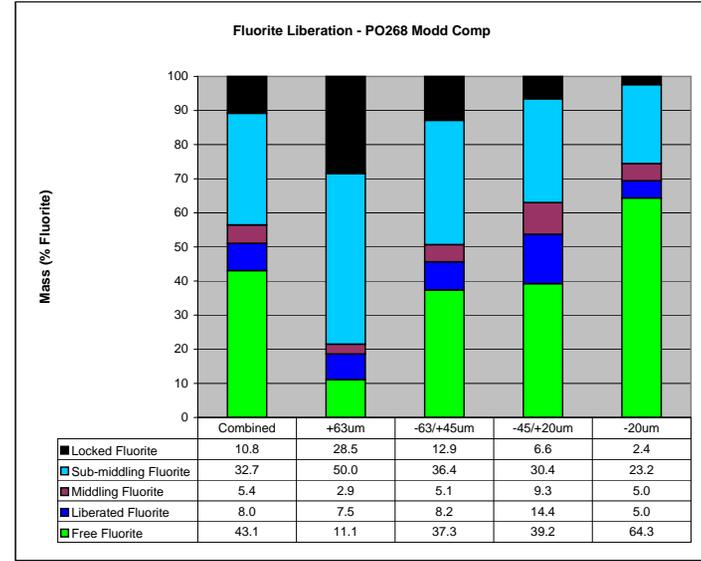
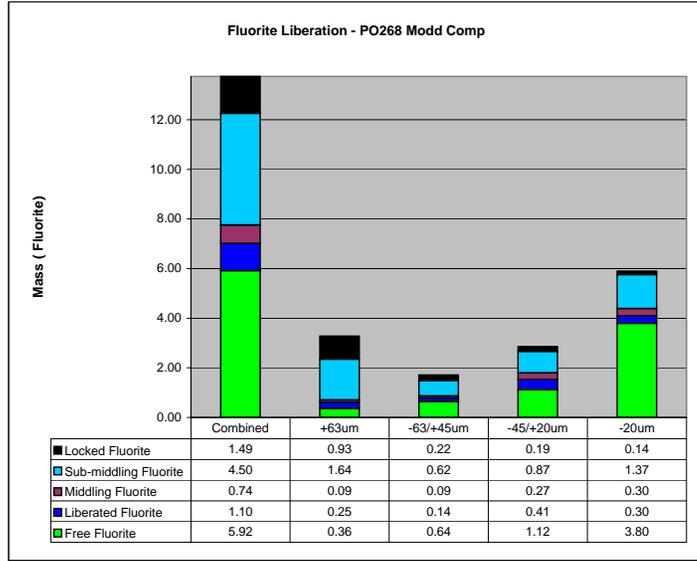
Minemakers
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Fe Department



Minemakers
12547-001
MI5031-OCT10

Fluorite Liberation



Absolute Mass of Fluorite Across Fraction PO268 Modd Comp

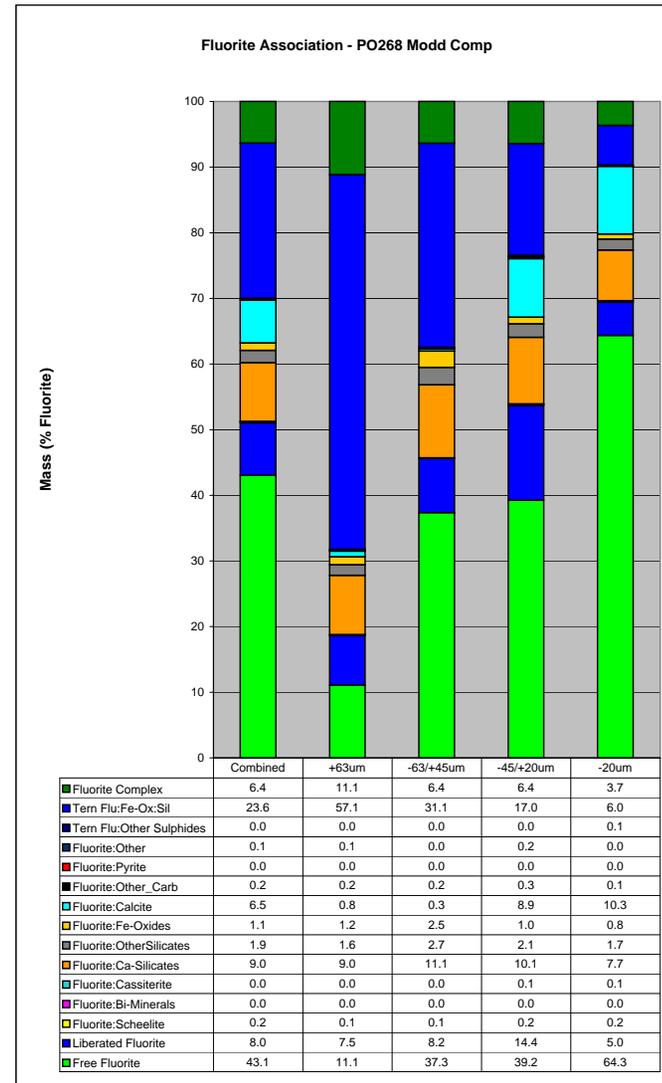
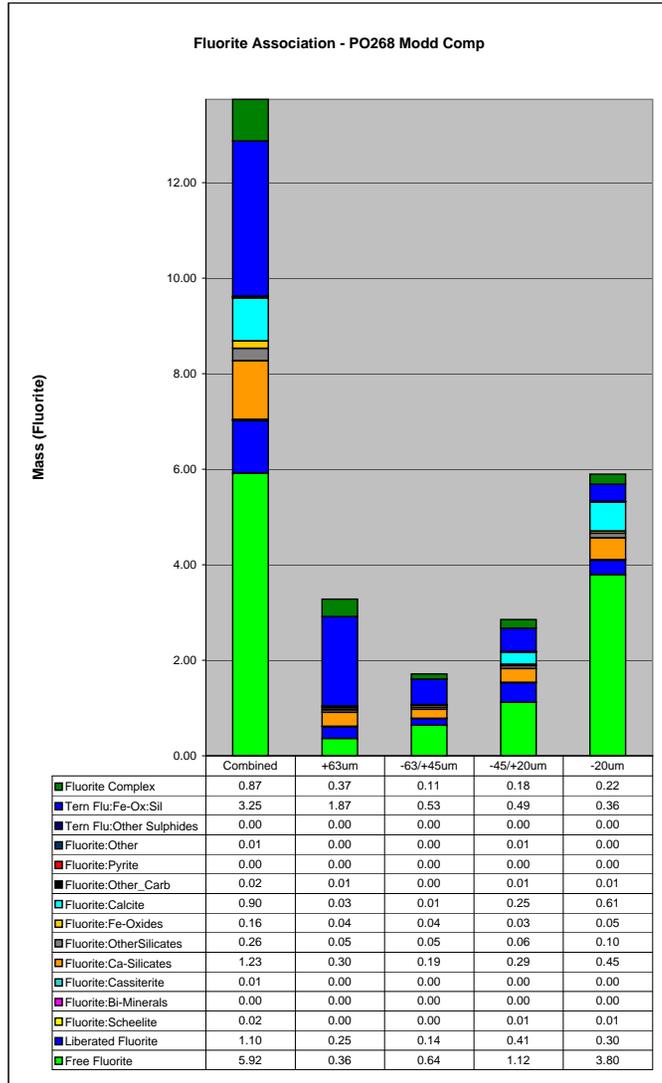
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Fluorite	5.92	0.36	0.64	1.12	3.80
Liberated Fluorite	1.10	0.25	0.14	0.41	0.30
Middling Fluorite	0.74	0.09	0.09	0.27	0.30
Sub-middling Fluorite	4.50	1.64	0.62	0.87	1.37
Locked Fluorite	1.49	0.93	0.22	0.19	0.14
Barren	0.00	0.00	0.00	0.00	0.00
Total	13.74	3.28	1.71	2.85	5.90
Total (% in fraction)	100.0	23.9	12.5	20.8	42.9

Normalized Mass of Fluorite Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Fluorite	43.1	11.1	37.3	39.2	64.3
Liberated Fluorite	8.0	7.5	8.2	14.4	5.0
Middling Fluorite	5.4	2.9	5.1	9.3	5.0
Sub-middling Fluorite	32.7	50.0	36.4	30.4	23.2
Locked Fluorite	10.8	28.5	12.9	6.6	2.4
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

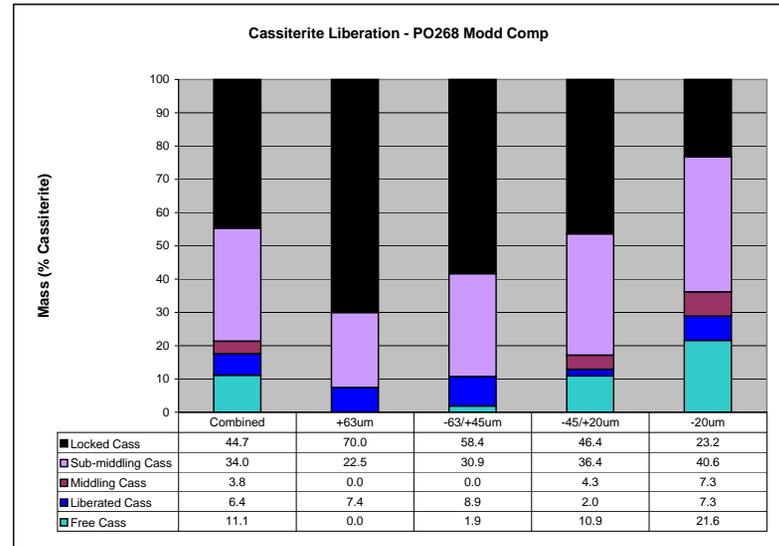
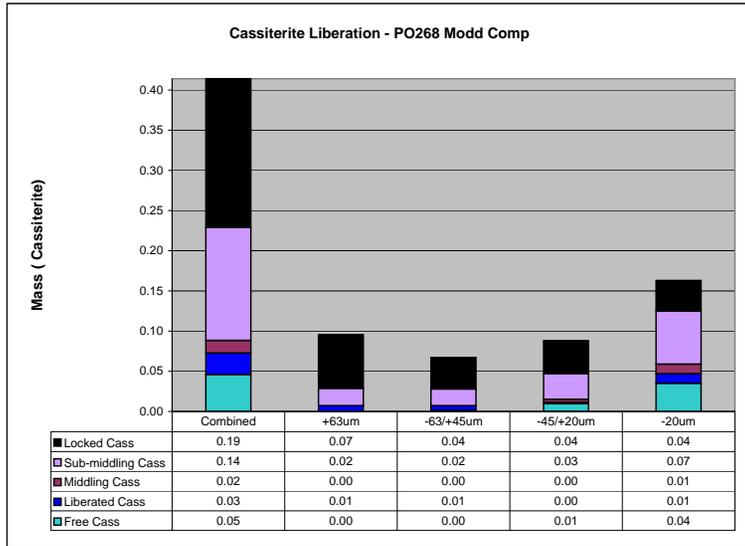
Minemakers
12547-001
MI5031-OCT10

Fluorite Association



Minemakers
12547-001
MI5031-OCT10

Cassiterite Liberation



Absolute Mass of Cassiterite Across Fraction PO268 Modd Comp

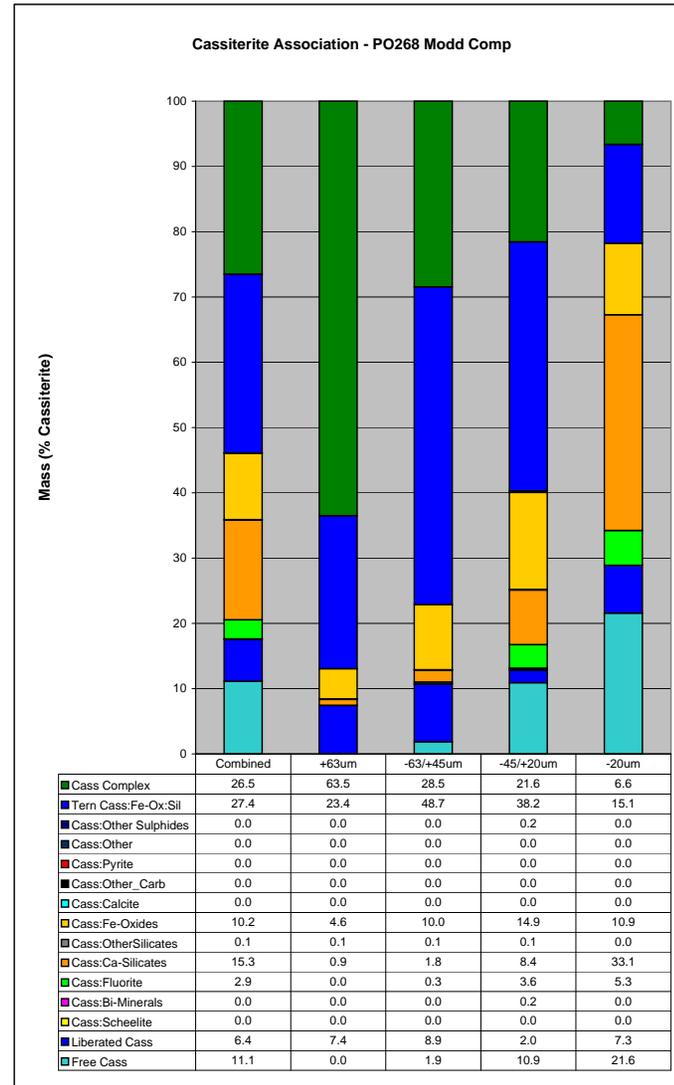
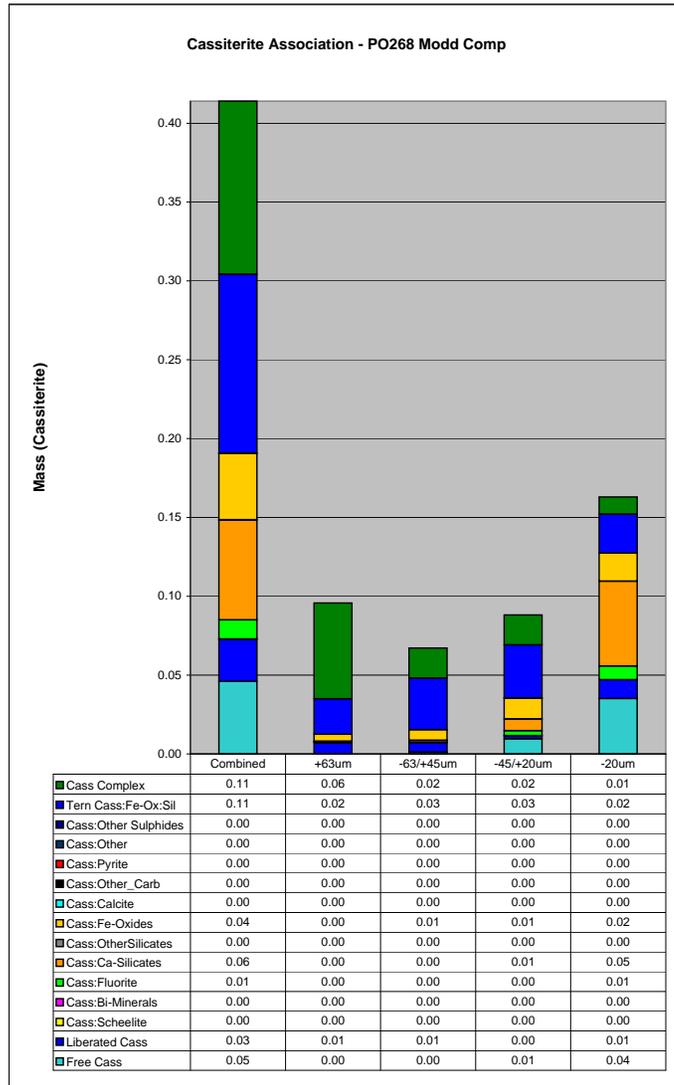
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Cass	0.05	0.00	0.00	0.01	0.04
Liberated Cass	0.03	0.01	0.01	0.00	0.01
Middling Cass	0.02	0.00	0.00	0.00	0.01
Sub-middling Cass	0.14	0.02	0.02	0.03	0.07
Locked Cass	0.19	0.07	0.04	0.04	0.04
Barren	0.00	0.00	0.00	0.00	0.00
Total	0.41	0.10	0.07	0.09	0.16
Total (% in fraction)	100.0	23.1	16.2	21.3	39.4

Normalized Mass of Cassiterite Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Cass	11.1	0.0	1.9	10.9	21.6
Liberated Cass	6.4	7.4	8.9	2.0	7.3
Middling Cass	3.8	0.0	0.0	4.3	7.3
Sub-middling Cass	34.0	22.5	30.9	36.4	40.6
Locked Cass	44.7	70.0	58.4	46.4	23.2
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

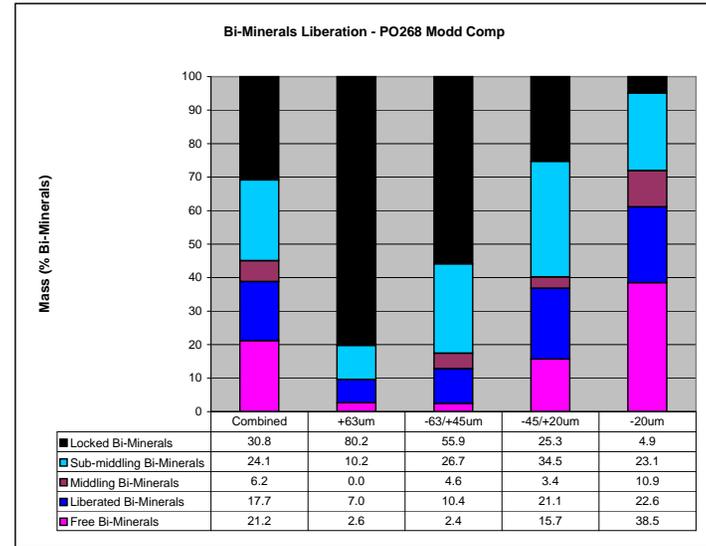
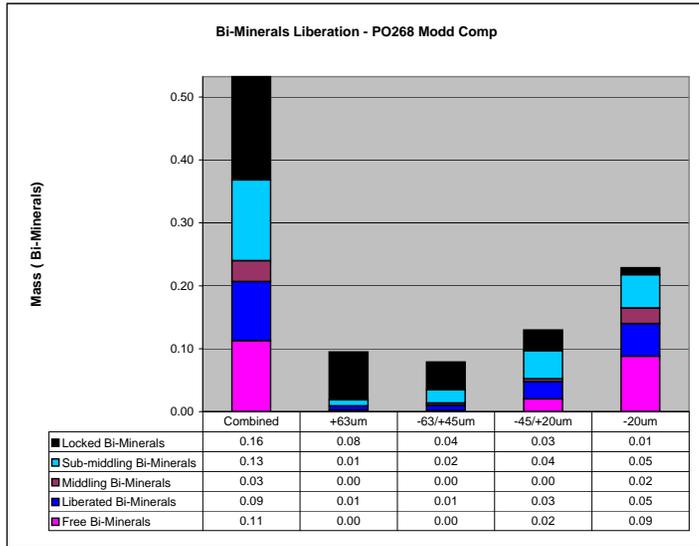
Minemakers
12547-001
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Cassiterite Association



Minemakers
12547-001
MI5031-OCT10

Bi-Minerals Liberation



Absolute Mass of Bi-Minerals Across Fraction PO268 Modd Comp

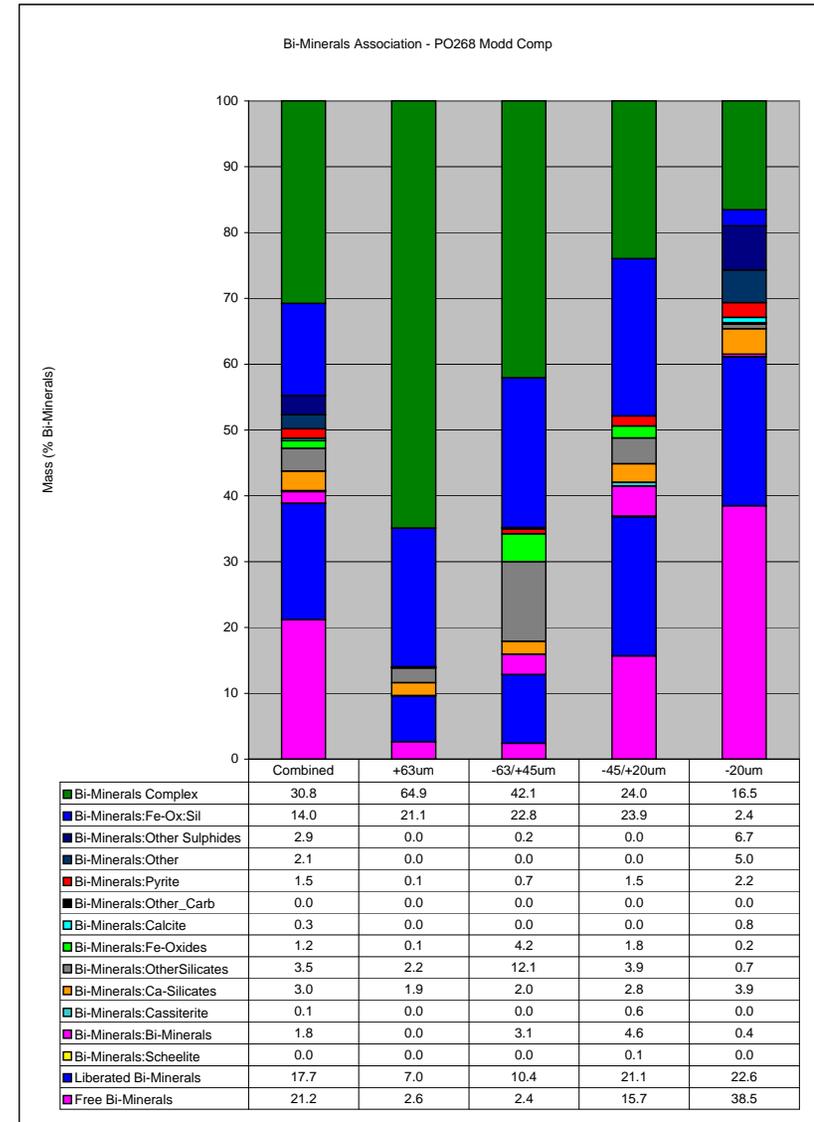
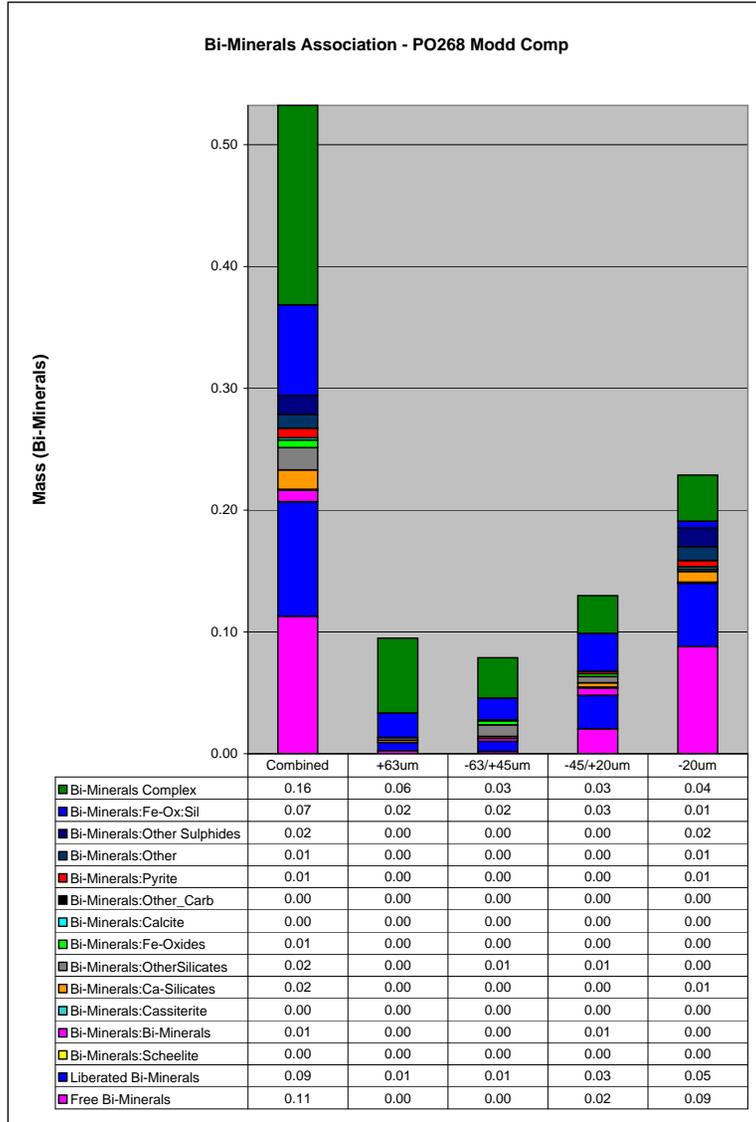
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Bi-Minerals	0.11	0.00	0.00	0.02	0.09
Liberated Bi-Minerals	0.09	0.01	0.01	0.03	0.05
Middling Bi-Minerals	0.03	0.00	0.00	0.00	0.02
Sub-middling Bi-Minerals	0.13	0.01	0.02	0.04	0.05
Locked Bi-Minerals	0.16	0.08	0.04	0.03	0.01
Barren	0.00	0.00	0.00	0.00	0.00
Total	0.53	0.09	0.08	0.13	0.23
Total (% in fraction)	100.0	17.8	14.8	24.4	43.0

Normalized Mass of Bi-Minerals Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Bi-Minerals	21.2	2.6	2.4	15.7	38.5
Liberated Bi-Minerals	17.7	7.0	10.4	21.1	22.6
Middling Bi-Minerals	6.2	0.0	4.6	3.4	10.9
Sub-middling Bi-Minerals	24.1	10.2	26.7	34.5	23.1
Locked Bi-Minerals	30.8	80.2	55.9	25.3	4.9
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

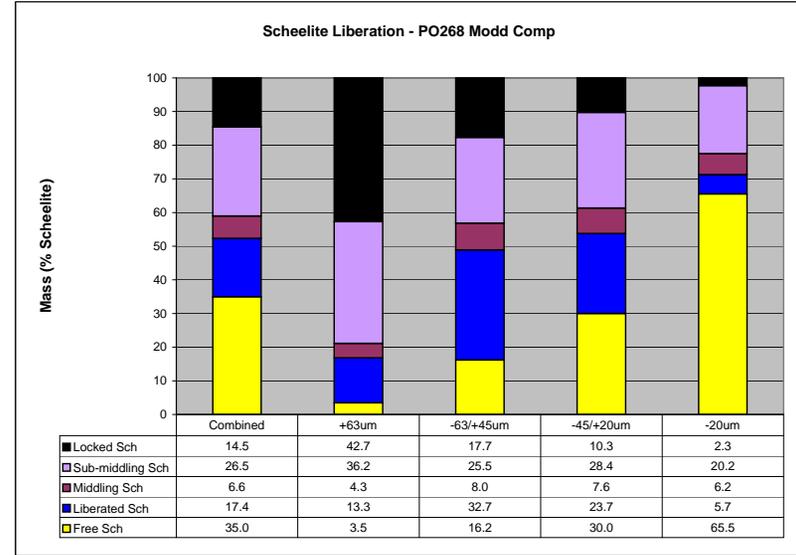
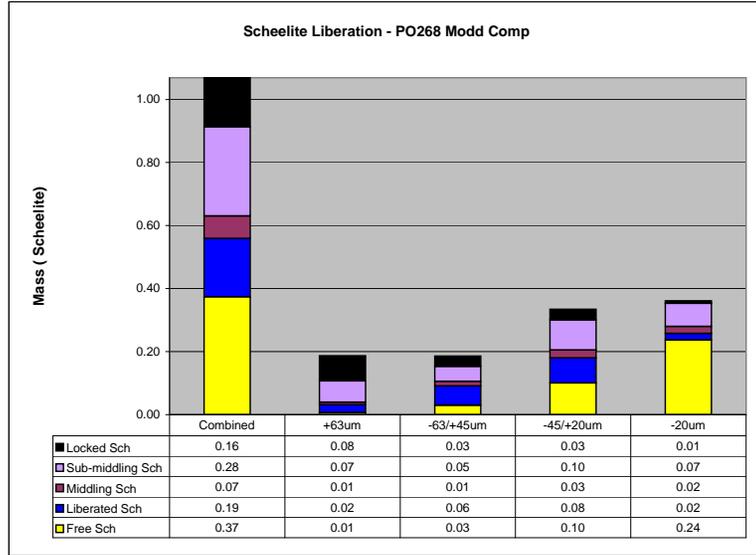
Minemakers
12547-001
MI5031-OCT10

Bi-Minerals Association



Minemakers
12547-001
M15031-OCT10

Scheelite Liberation



Absolute Mass of Scheelite Across Fraction PO268 Modd Comp

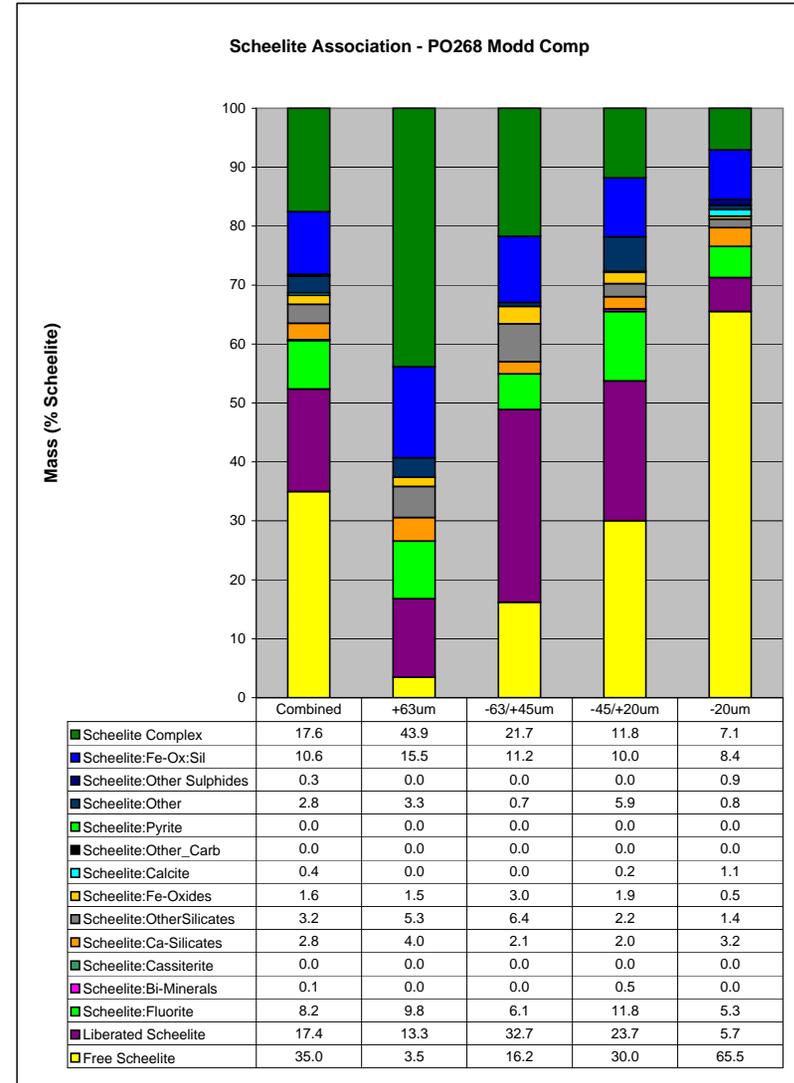
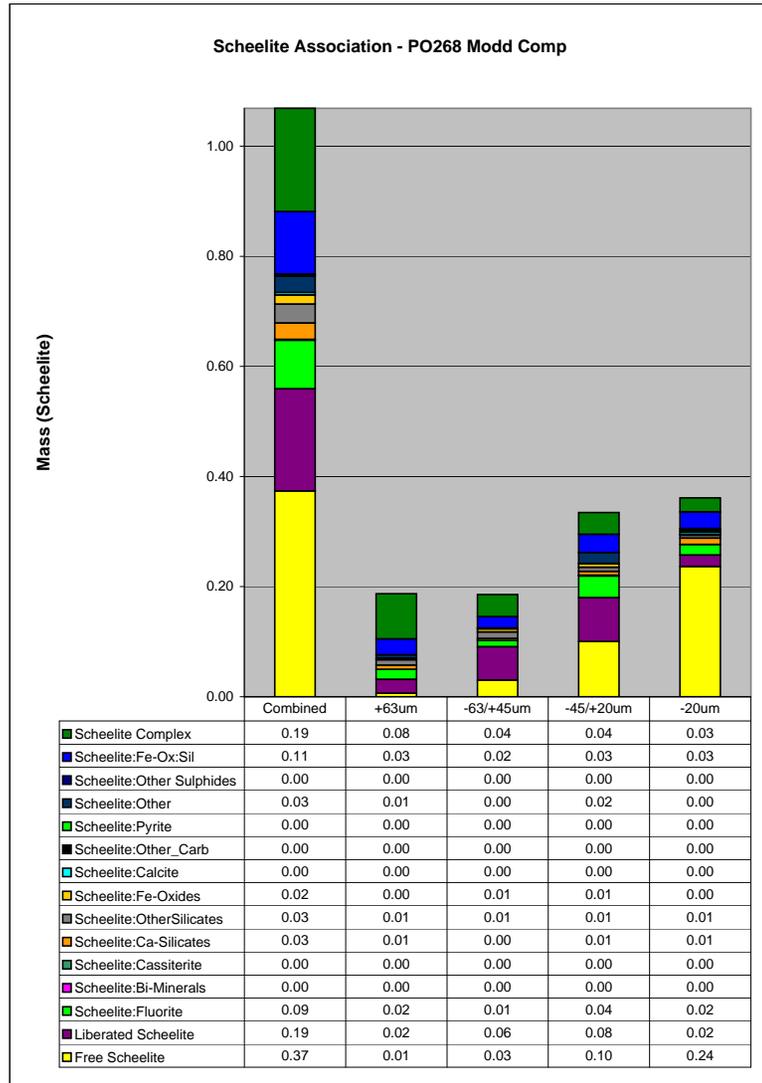
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Sch	0.37	0.01	0.03	0.10	0.24
Liberated Sch	0.19	0.02	0.06	0.08	0.02
Middling Sch	0.07	0.01	0.01	0.03	0.02
Sub-middling Sch	0.28	0.07	0.05	0.10	0.07
Locked Sch	0.16	0.08	0.03	0.03	0.01
Barren	0.00	0.00	0.00	0.00	0.00
Total	1.07	0.19	0.19	0.33	0.36
Total (% in fraction)	100.0	17.5	17.4	31.3	33.8

Normalized Mass of Scheelite Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Sch	35.0	3.5	16.2	30.0	65.5
Liberated Sch	17.4	13.3	32.7	23.7	5.7
Middling Sch	6.6	4.3	8.0	7.6	6.2
Sub-middling Sch	26.5	36.2	25.5	28.4	20.2
Locked Sch	14.5	42.7	17.7	10.3	2.3
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

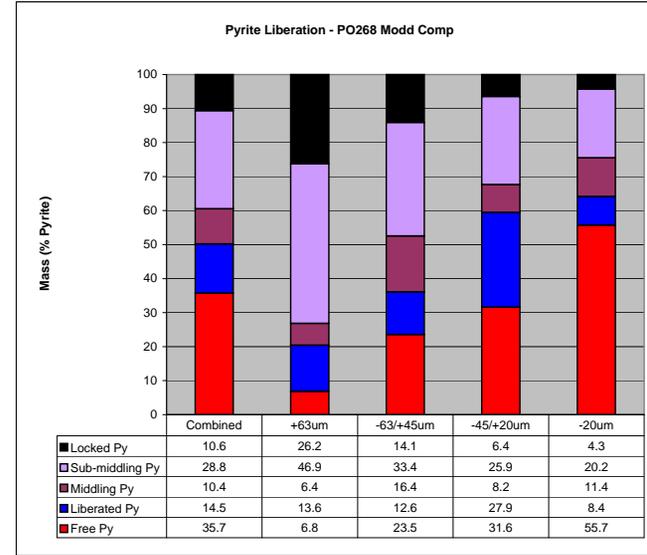
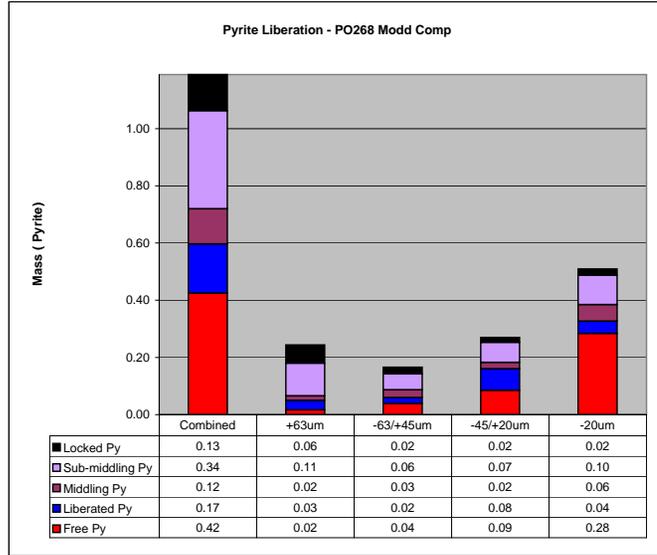
Minemakers
12547-001
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Scheelite Association



Minemakers
12547-001
MI5031-OCT10

Pyrite Liberation



Absolute Mass of Pyrite Across Fraction PO268 Modd Comp

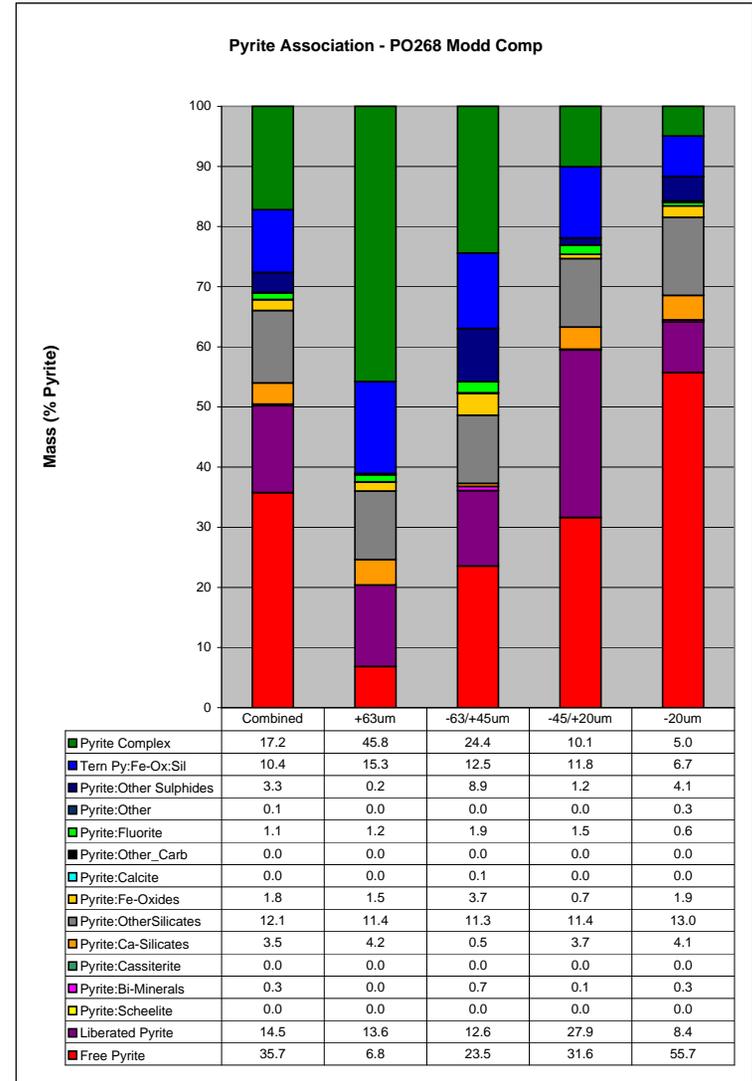
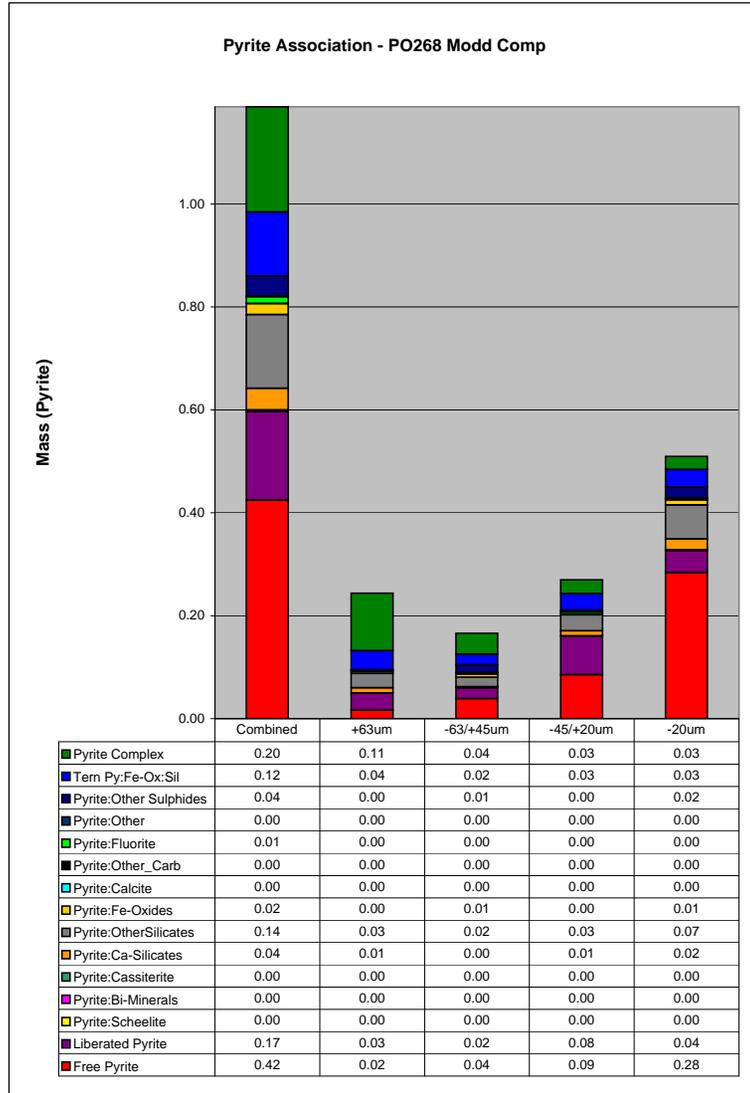
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Py	0.42	0.02	0.04	0.09	0.28
Liberated Py	0.17	0.03	0.02	0.08	0.04
Middling Py	0.12	0.02	0.03	0.02	0.06
Sub-middling Py	0.34	0.11	0.06	0.07	0.10
Locked Py	0.13	0.06	0.02	0.02	0.02
Barren	0.00	0.00	0.00	0.00	0.00
Total	1.19	0.24	0.17	0.27	0.51
Total (% in fraction)	100.0	20.5	13.9	22.7	42.8

Normalized Mass of Pyrite Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Py	35.7	6.8	23.5	31.6	55.7
Liberated Py	14.5	13.6	12.6	27.9	8.4
Middling Py	10.4	6.4	16.4	8.2	11.4
Sub-middling Py	28.8	46.9	33.4	25.9	20.2
Locked Py	10.6	26.2	14.1	6.4	4.3
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

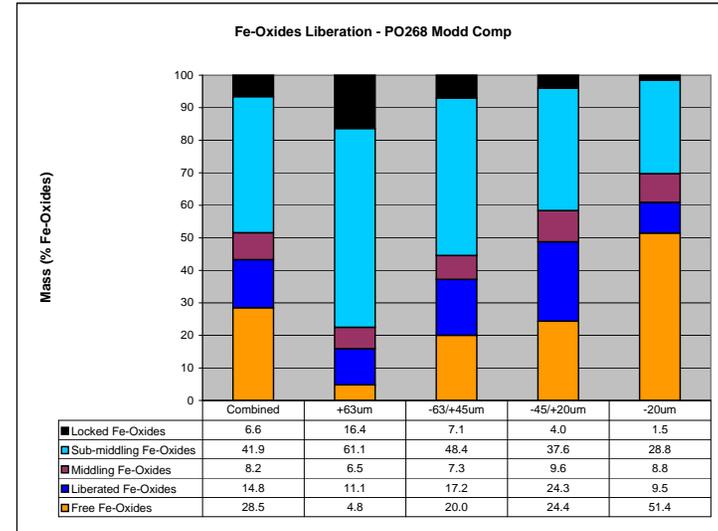
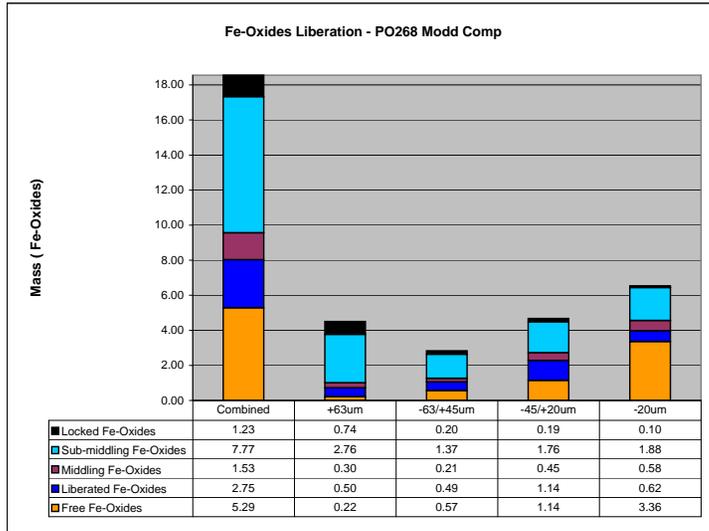
Minemakers
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Pyrite Association



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MI5031-OCT10

Fe-Oxides Liberation



Absolute Mass of Fe-Oxides Across Fraction PO268 Modd Comp

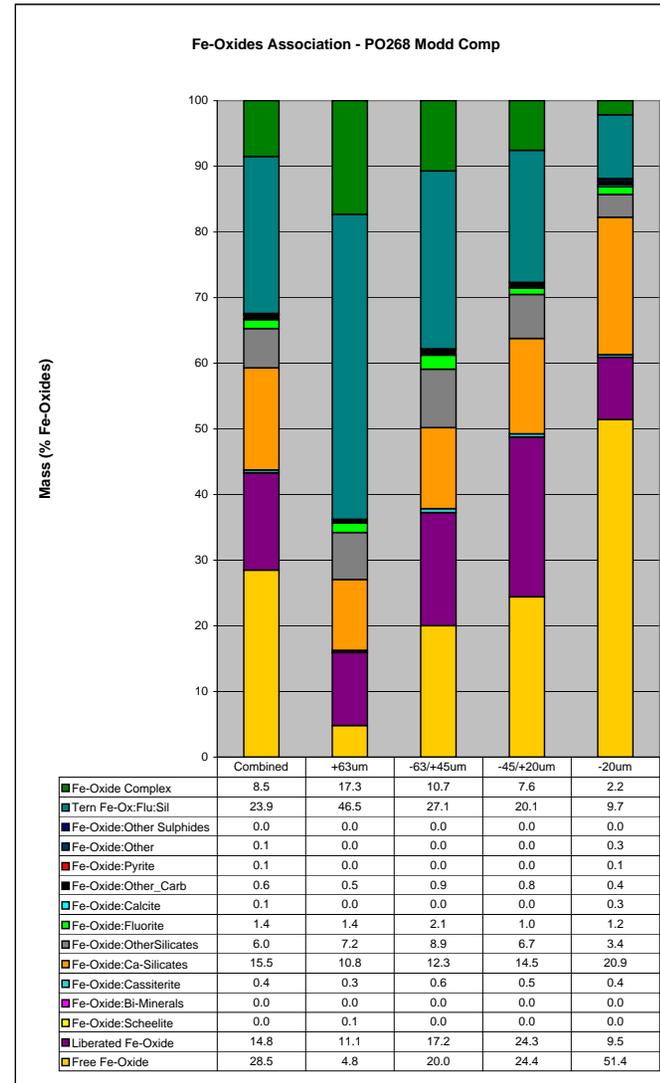
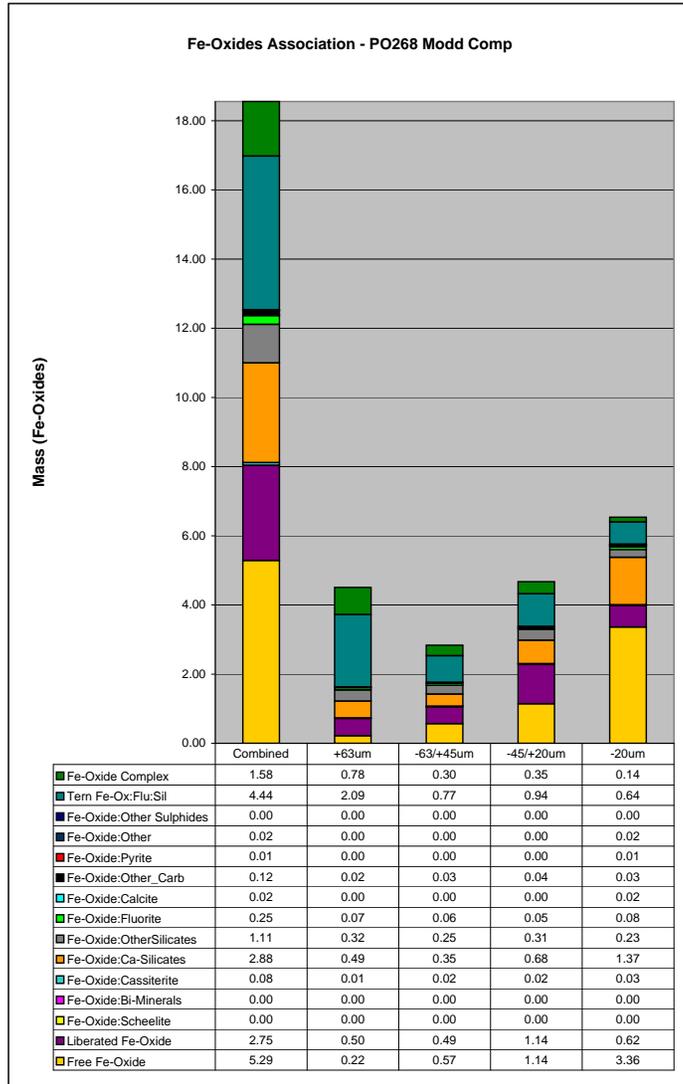
Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Fe-Oxides	5.29	0.22	0.57	1.14	3.36
Liberated Fe-Oxides	2.75	0.50	0.49	1.14	0.62
Middling Fe-Oxides	1.53	0.30	0.21	0.45	0.58
Sub-middling Fe-Oxides	7.77	2.76	1.37	1.76	1.88
Locked Fe-Oxides	1.23	0.74	0.20	0.19	0.10
Barren	0.00	0.00	0.00	0.00	0.00
Total	18.56	4.51	2.84	4.67	6.54
Total (% in fraction)	100.0	24.3	15.3	25.2	35.2

Normalized Mass of Fe-Oxides Across Fraction PO268 Modd Comp

Mineral Name	Combined	+63um	-63/+45um	-45/+20um	-20um
Free Fe-Oxides	28.5	4.8	20.0	24.4	51.4
Liberated Fe-Oxides	14.8	11.1	17.2	24.3	9.5
Middling Fe-Oxides	8.2	6.5	7.3	9.6	8.8
Sub-middling Fe-Oxides	41.9	61.1	48.4	37.6	28.8
Locked Fe-Oxides	6.6	16.4	7.1	4.0	1.5
Barren	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

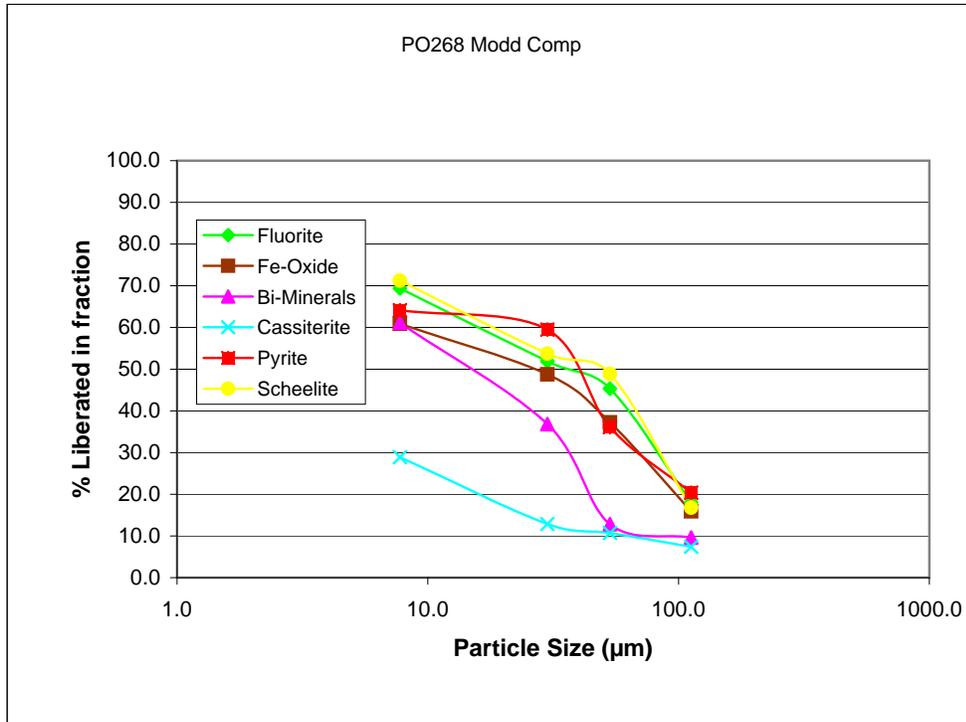
Minemakers
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Fe-Oxides Association



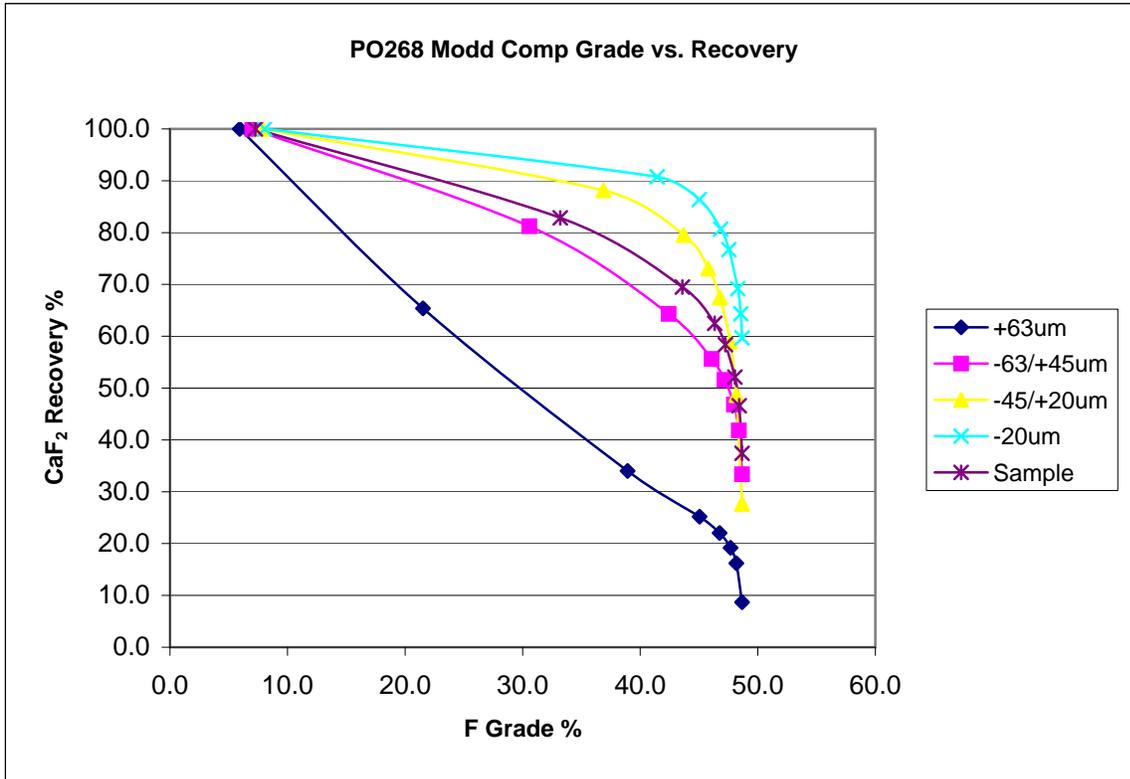
Minemakers
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Mineral Release Curves



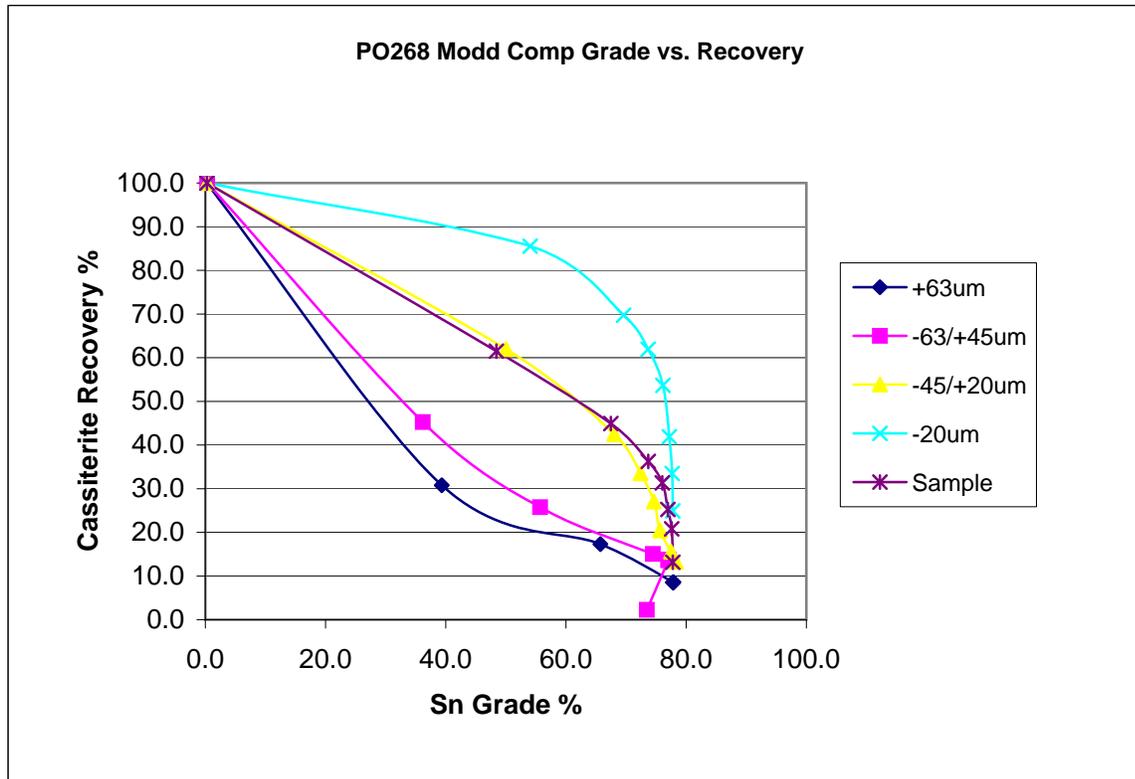
Minemakers
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MI5031-OCT10

F Grade vs. Fluorite Recovery: PO268 Modd Comp



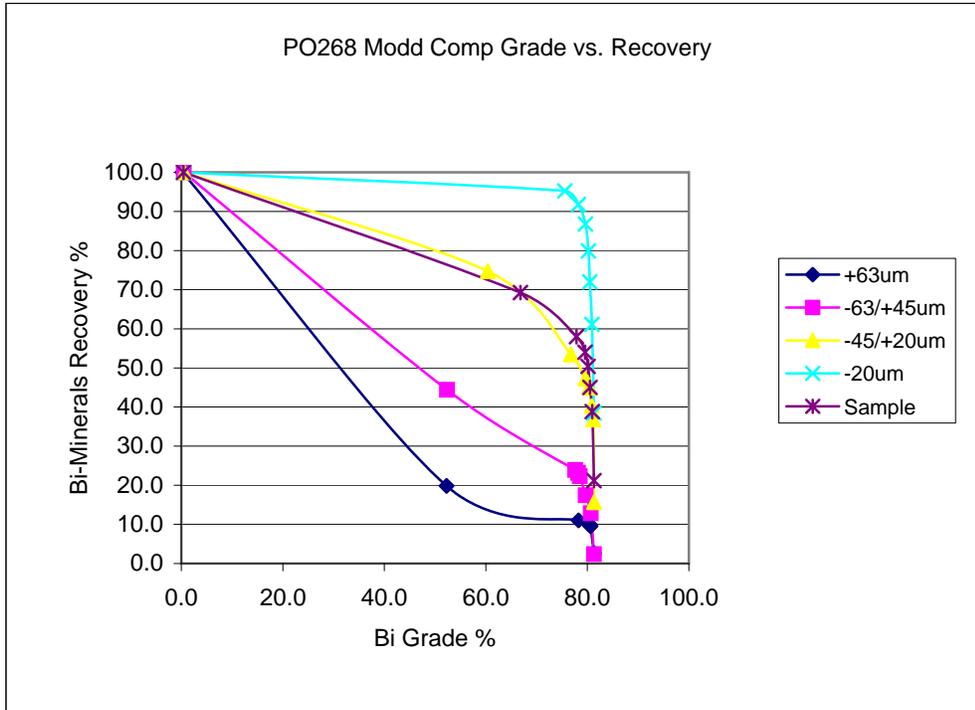
Minemakers
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MI5031-OCT10

Sn Grade vs. Cassiterite Recovery: PO268 Modd Comp



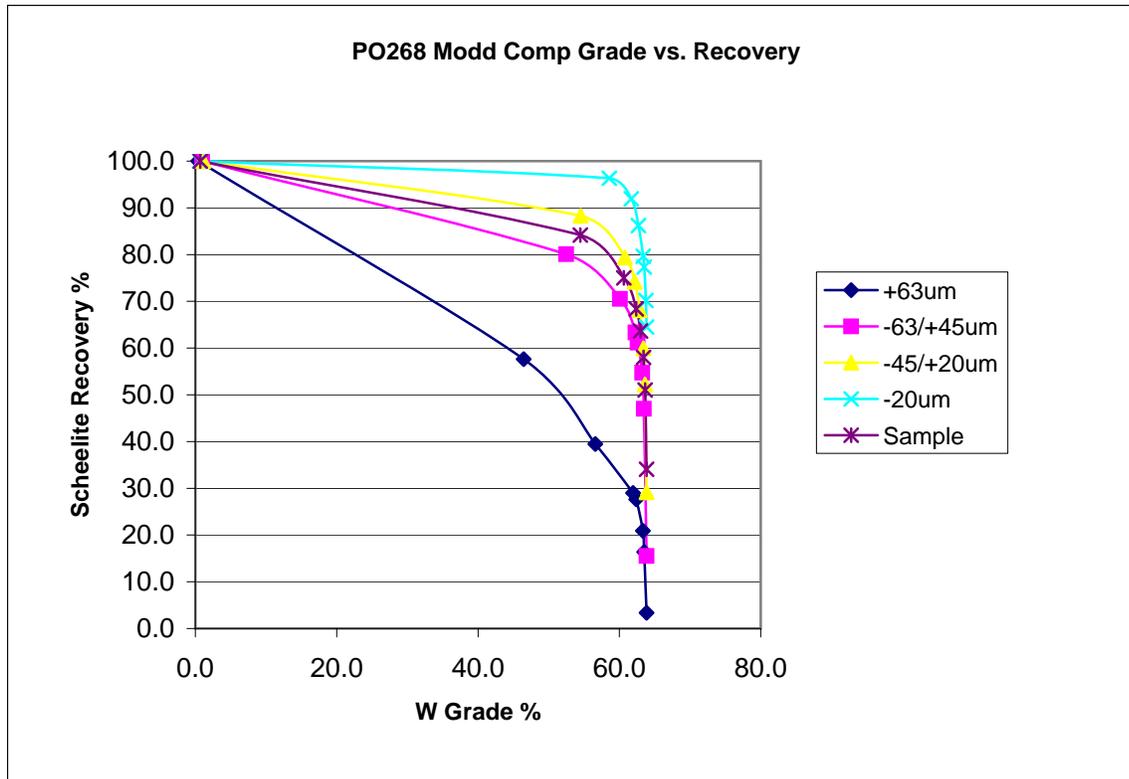
Minemakers
12547-001
MI5031-OCT10

Bi Grade vs. Bi-Mineral Recovery: PO268 Modd Comp

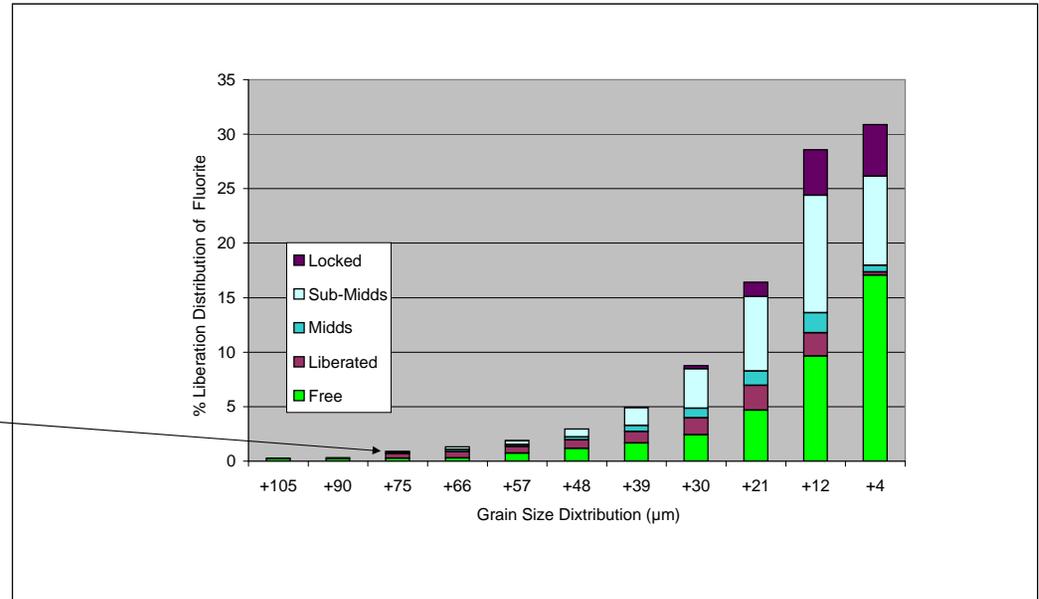
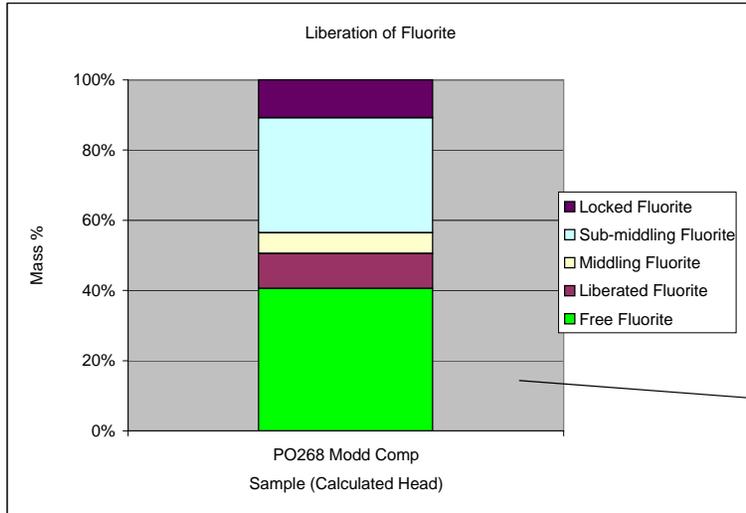


Minemakers
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W Grade vs. Scheelite Recovery: PO268 Modd Comp



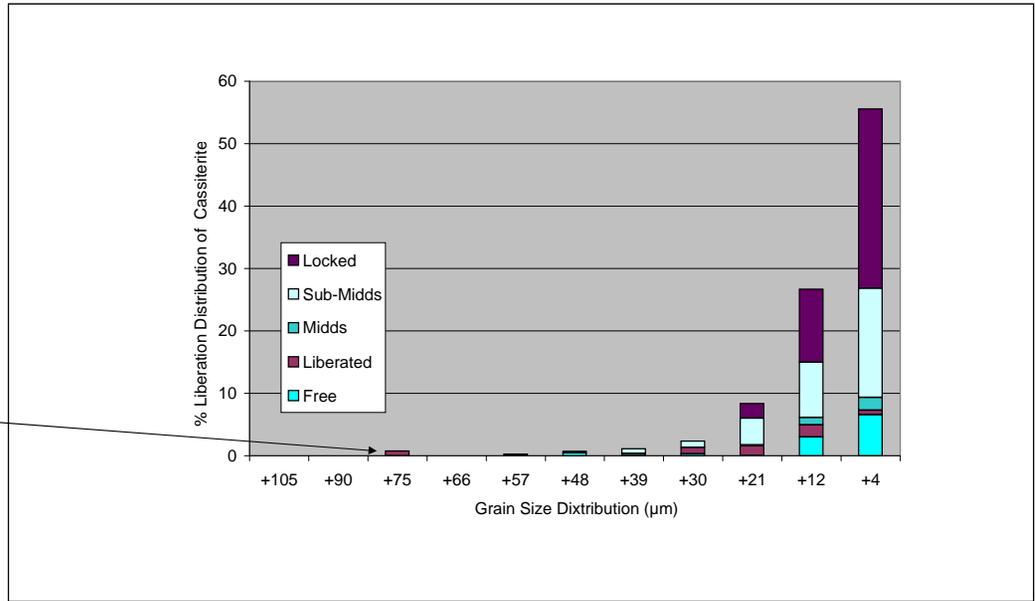
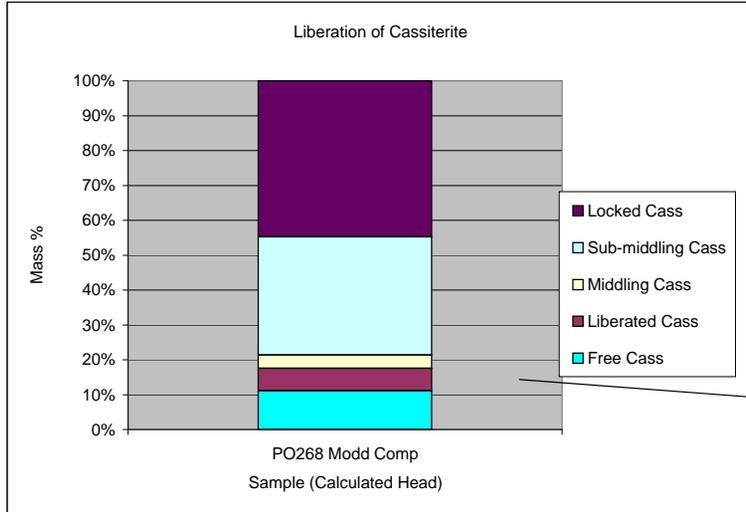
Minemakers
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PO268 Modd Comp
Fluorite Grain Size Distribution of each Liberation Class



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PO268 Modd Comp

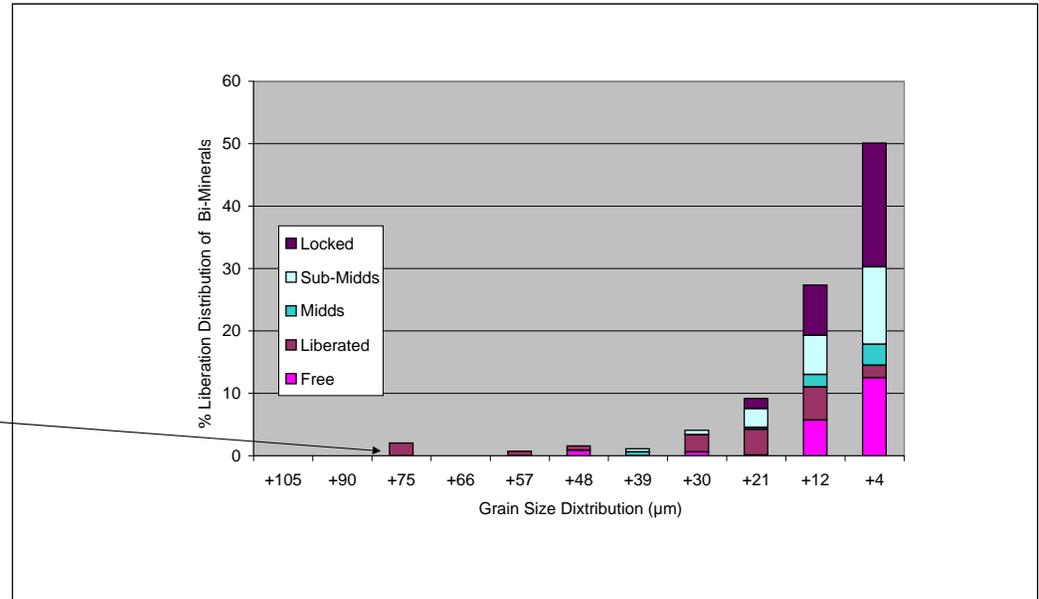
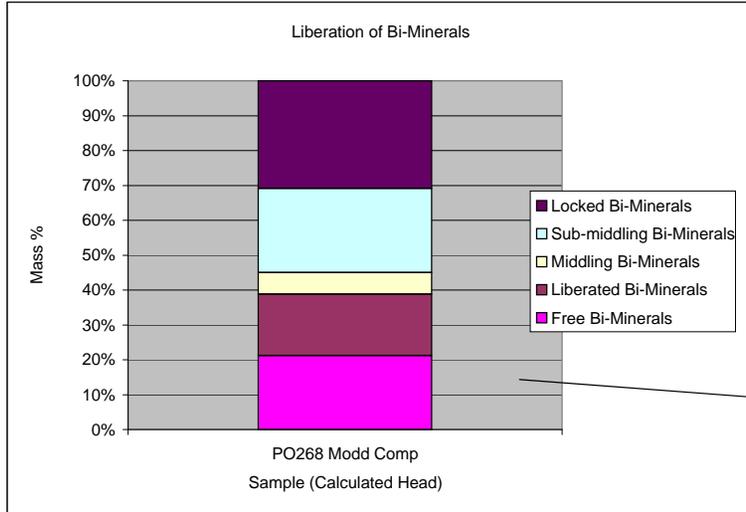
Cassiterite Grain Size Distribution of each Liberation Class



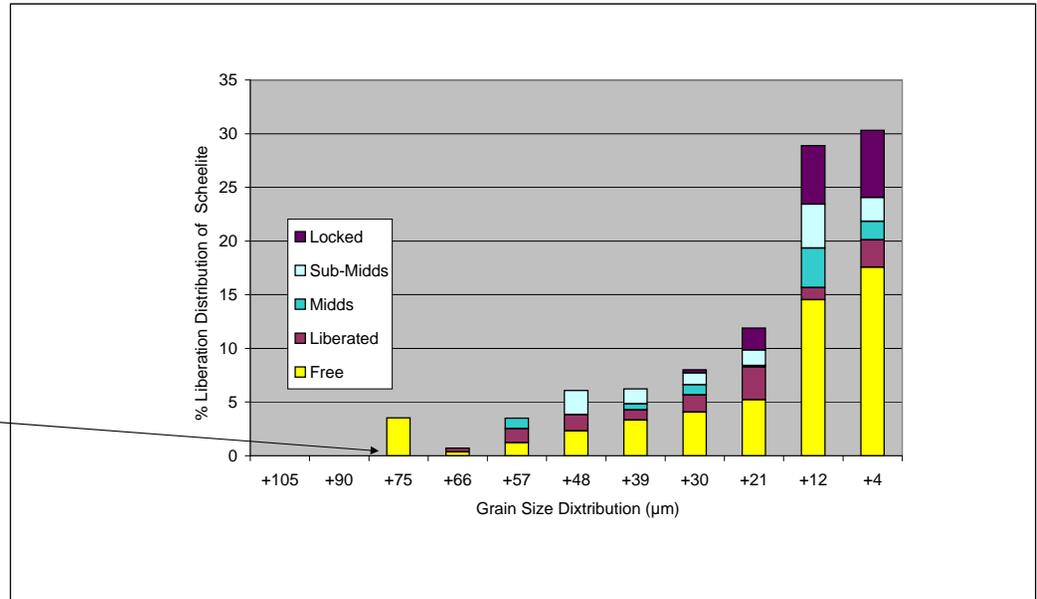
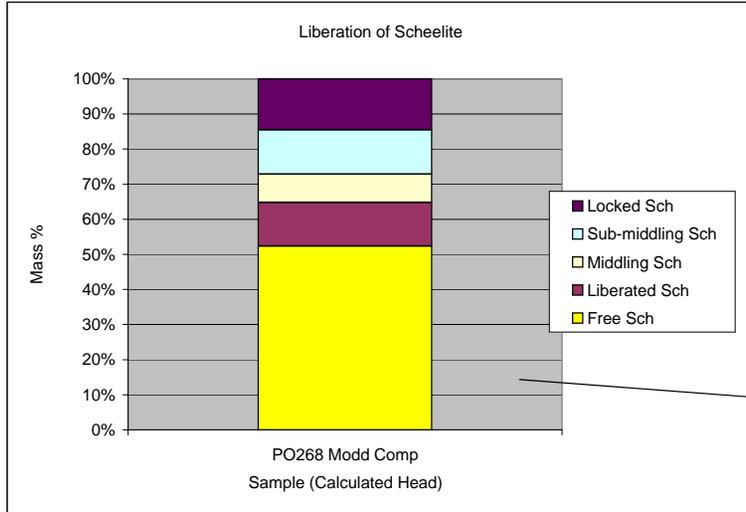
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Bi-Minerals Grain Size Distribution of each Liberation Class



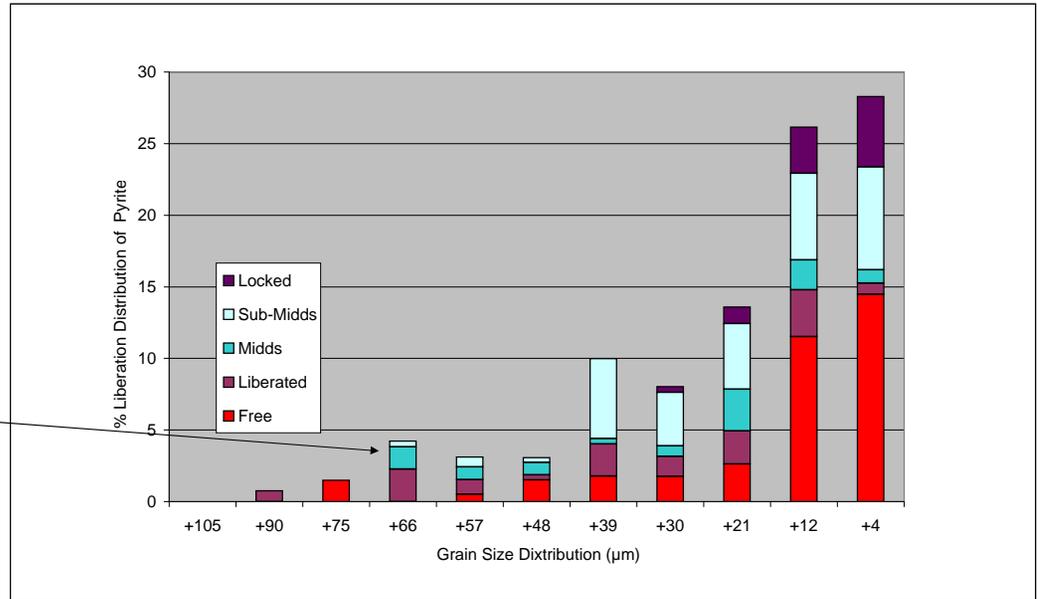
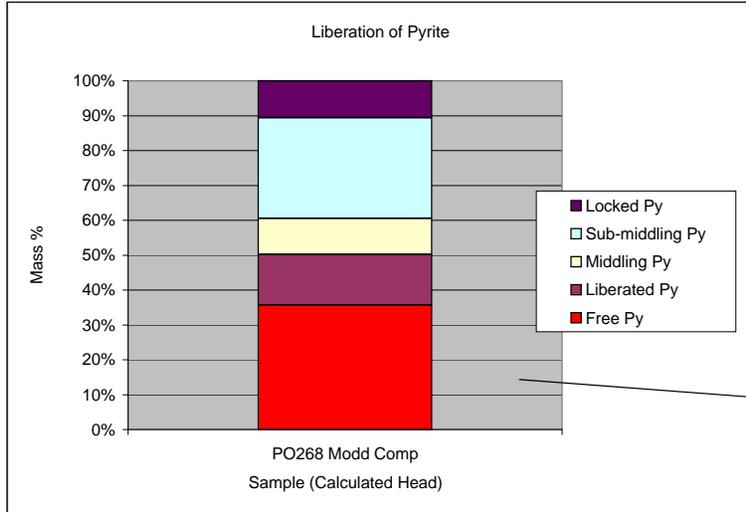
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PO268 Modd Comp
Scheelite Grain Size Distribution of each Liberation Class



Minemakers
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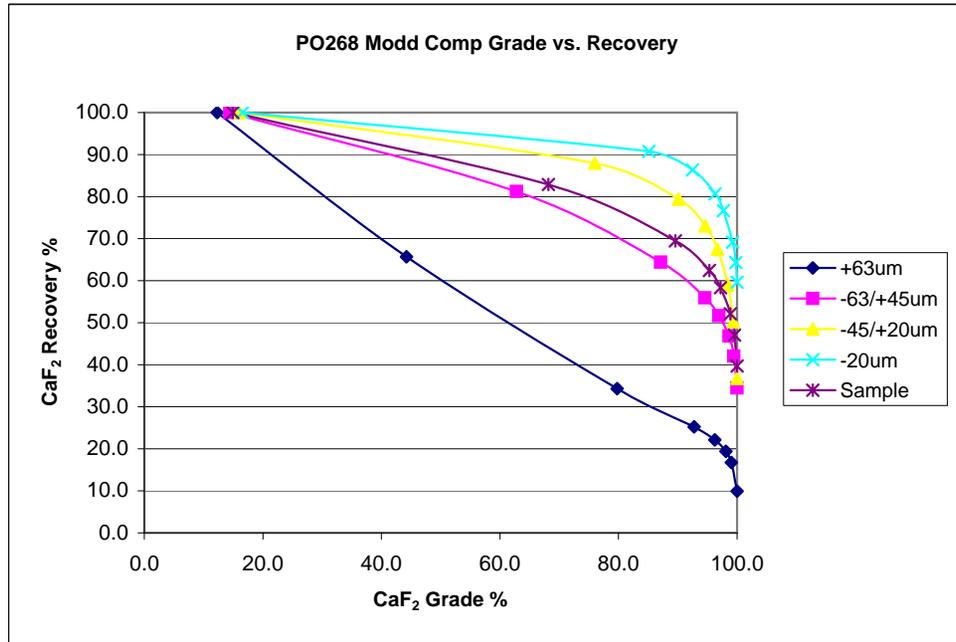
PO268 Modd Comp

Pyrite Grain Size Distribution of each Liberation Class



Minemakers
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CaF₂ Grade vs. Recovery: PO268 Modd Comp



Calculations

A.Grade

A1 Elemental Mass of F by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.18	0.31	0.54	1.85	2.88
>=95	0.12	0.07	0.20	0.14	0.53
>=90	0.05	0.04	0.13	0.15	0.37
>=80	0.05	0.04	0.12	0.23	0.45
>=70	0.06	0.04	0.08	0.12	0.30
>=50	0.16	0.08	0.09	0.18	0.51
>=20	0.56	0.15	0.13	0.14	0.97
>=0	0.61	0.17	0.18	0.29	1.24
0.00	0.00	0.00	0.00	0.00	0.00

B.Recovery

B1 Absolute Elemental Mass of F by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.18	0.31	0.54	1.85	2.88
>=95	0.12	0.07	0.20	0.14	0.53
>=90	0.05	0.04	0.13	0.15	0.37
>=80	0.05	0.04	0.12	0.23	0.45
>=70	0.06	0.04	0.08	0.12	0.30
>=50	0.16	0.08	0.09	0.18	0.51
>=20	0.56	0.15	0.13	0.14	0.97
>=0	0.61	0.17	0.18	0.29	1.24
0.00	0.00	0.00	0.00	0.00	0.00

1.78 0.90 1.48 3.10 7.26

1.78 0.90 1.48 3.10 7.26

A2 Elemental Mass of F, Normalized by Sample (from A1)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	2.43	4.29	7.51	25.44	39.67
>=95	1.66	0.95	2.76	1.99	7.36
>=90	0.65	0.59	1.80	2.07	5.11
>=80	0.67	0.60	1.72	3.21	6.20
>=70	0.76	0.53	1.13	1.69	4.12
>=50	2.22	1.05	1.30	2.43	7.00
>=20	7.67	2.10	1.76	1.87	13.39
>=0	8.41	2.33	2.46	3.95	17.15
0.00	0.00	0.00	0.00	0.00	0.00

B2 Elemental Mass of F, Normalized by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	9.95	34.46	36.75	59.65	39.67
>=95	6.76	7.61	13.52	4.67	7.36
>=90	2.66	4.76	8.79	4.85	5.11
>=80	2.75	4.83	8.42	7.52	6.20
>=70	3.12	4.25	5.55	3.97	4.12
>=50	9.08	8.47	6.34	5.70	7.00
>=20	31.33	16.85	8.61	4.38	13.39
>=0	34.35	18.75	12.03	9.25	17.15
0.00	0.00	0.00	0.00	0.00	0.00

A3 Cumulative by Fraction, Elemental Mass of F Normalized by Sample (from A2)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	2.43	4.29	7.51	25.44	39.67
>=95	4.09	5.23	10.27	27.43	47.03
>=90	4.74	5.83	12.06	29.50	52.13
>=80	5.42	6.43	13.78	32.71	58.34
>=70	6.18	6.96	14.92	34.40	62.46
>=50	8.40	8.01	16.21	36.83	69.46
>=20	16.07	10.11	17.97	38.70	82.85
>=0	24.48	12.44	20.43	42.65	100.00
0.00	24.48	12.44	20.43	42.65	100.00

B3 Cumulative by Fraction, Elemental Mass of F Normalized by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	9.95	34.46	36.75	59.65	39.67
>=95	16.71	42.07	50.26	64.32	47.03
>=90	19.37	46.83	59.05	69.18	52.13
>=80	22.12	51.67	67.47	76.69	58.34
>=70	25.24	55.92	73.02	80.67	62.46
>=50	34.32	64.40	79.36	86.37	69.46
>=20	65.65	81.25	87.97	90.75	82.85
>=0	100.00	100.00	100.00	100.00	100.00
0.00	100.00	100.00	100.00	100.00	100.00

A4 F Grade by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	100.00	100.00	100.00	100.00	0.00
>=95	97.70	97.10	97.64	96.90	0.00
>=90	92.77	91.95	93.49	92.64	0.00
>=80	84.65	83.10	85.73	85.31	0.00
>=70	73.89	72.73	75.32	75.42	0.00
>=50	57.36	57.38	58.34	59.56	0.00
>=20	29.72	30.41	31.06	33.10	0.00
>=0	5.15	3.32	2.37	1.86	0.00
0.00	0.00	0.00	0.00	0.00	0.00

A5 F Dist in Sample / Category Grade (A2/A4)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.02	0.04	0.08	0.25	0.40
>=95	0.02	0.01	0.03	0.02	0.08
>=90	0.01	0.01	0.02	0.02	0.06
>=80	0.01	0.01	0.02	0.04	0.07
>=70	0.01	0.01	0.02	0.02	0.06
>=50	0.04	0.02	0.02	0.04	0.12
>=20	0.26	0.07	0.06	0.06	0.44
>=0	1.63	0.70	1.04	2.12	5.49
0.00	0.00	0.00	0.00	0.00	0.00

A6 A5 Cumulative by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.02	0.04	0.08	0.25	0.40
>=95	0.04	0.05	0.10	0.27	0.47
>=90	0.05	0.06	0.12	0.30	0.53
>=80	0.06	0.07	0.14	0.33	0.60
>=70	0.07	0.07	0.16	0.36	0.66
>=50	0.11	0.09	0.18	0.40	0.78
>=20	0.36	0.16	0.24	0.45	1.22
>=0	2.00	0.86	1.27	2.57	6.70
0.00	2.00	0.86	1.27	2.57	6.70

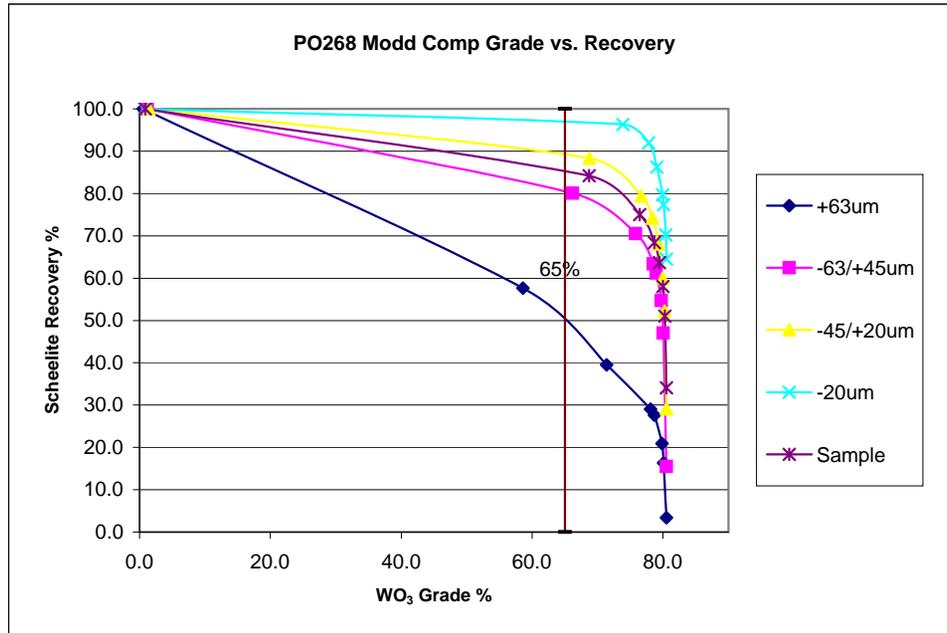
A7 F Grade

	+63um	-63/+45um	-45/+20um	-20um	Sample
>=100	100.00	100.00	100.00	100.00	100.00
>=95	99.06	99.47	99.36	99.77	99.58
>=90	98.14	98.65	98.44	99.23	98.88
>=80	96.24	96.95	96.65	97.67	97.21
>=70	92.77	94.55	94.61	96.27	95.32
>=50	79.75	87.13	90.13	92.51	89.59
>=20	44.22	62.82	75.99	85.13	68.17

≥ 0	12.27	14.42	16.07	16.56	14.92
0.00	12.27	14.42	16.07	16.56	14.92

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W Grade vs. Recovery: PO268 Modd Comp



0
65

**Calculations
 A. Grade**

A1 Elemental Mass of W by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.00	0.02	0.06	0.15	0.24
>=95	0.02	0.04	0.05	0.01	0.12
>=90	0.01	0.01	0.02	0.02	0.05
>=80	0.01	0.01	0.02	0.01	0.04
>=70	0.00	0.00	0.01	0.02	0.03
>=50	0.01	0.01	0.01	0.01	0.05
>=20	0.02	0.01	0.02	0.01	0.06
>=0	0.05	0.02	0.03	0.01	0.11
0.00	0.00	0.00	0.00	0.00	0.00

B. Recovery

B1 Absolute Elemental Mass of W by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.00	0.02	0.06	0.15	0.24
>=95	0.02	0.04	0.05	0.01	0.12
>=90	0.01	0.01	0.02	0.02	0.05
>=80	0.01	0.01	0.02	0.01	0.04
>=70	0.00	0.00	0.01	0.02	0.03
>=50	0.01	0.01	0.01	0.01	0.05
>=20	0.02	0.01	0.02	0.01	0.06
>=0	0.05	0.02	0.03	0.01	0.11
0.00	0.00	0.00	0.00	0.00	0.00

0.12 0.12 0.22 0.23 0.70

0.12 0.12 0.22 0.23 0.70

A2 Elemental Mass of W , Normalized by Sample (from A1)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.59	2.74	9.15	21.57	34.05
>=95	2.28	5.55	7.25	1.90	16.97
>=90	0.80	1.36	2.42	2.39	6.97
>=80	1.18	1.13	2.56	0.78	5.66
>=70	0.24	0.39	1.91	2.20	4.73
>=50	1.83	1.26	1.63	1.91	6.64
>=20	3.18	1.68	2.80	1.47	9.14
>=0	7.42	3.51	3.67	1.23	15.84
0.00	0.00	0.00	0.00	0.00	0.00

B2 Elemental Mass of W , Normalized by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	3.36	15.54	29.14	64.50	34.05
>=95	13.00	31.48	23.08	5.67	16.97
>=90	4.55	7.72	7.72	7.14	6.97
>=80	6.74	6.43	8.16	2.34	5.66
>=70	1.35	2.19	6.07	6.57	4.73
>=50	10.47	7.17	5.21	5.71	6.64
>=20	18.15	9.55	8.92	4.40	9.14
>=0	42.37	19.92	11.70	3.67	15.84
0.00	0.00	0.00	0.00	0.00	0.00

A3 Cumulative by Fraction, Elemental Mass of W Normalized by Sample (from A2)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.59	2.74	9.15	21.57	34.05
>=95	2.87	8.29	16.40	23.47	51.03
>=90	3.66	9.65	18.83	25.86	58.00
>=80	4.84	10.78	21.39	26.64	63.66
>=70	5.08	11.17	23.30	28.84	68.38
>=50	6.91	12.44	24.93	30.75	75.03
>=20	10.09	14.12	27.73	32.22	84.16
>=0	17.51	17.63	31.41	33.45	100.00
0.00	17.51	17.63	31.41	33.45	100.00

B3 Cumulative by Fraction, Elemental Mass of W Normalized by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	3.36	15.54	29.14	64.50	34.05
>=95	16.36	47.02	52.22	70.18	51.03
>=90	20.91	54.73	59.94	77.32	58.00
>=80	27.65	61.16	68.10	79.66	63.66
>=70	29.01	63.35	74.17	86.22	68.38
>=50	39.48	70.52	79.38	91.93	75.03
>=20	57.63	80.08	88.30	96.33	84.16
>=0	100.00	100.00	100.00	100.00	100.00
0.00	100.00	100.00	100.00	100.00	100.00

A4 W Grade by Category

	+63um	-63/+45um	-45/+20um	-20um	
>=100	80.52	80.52	80.52	80.52	0.00
>=95	79.99	79.78	79.85	79.23	0.00
>=90	79.01	78.09	78.17	77.11	0.00
>=80	75.20	72.68	74.83	74.48	0.00
>=70	68.04	68.97	69.39	70.07	0.00
>=50	57.59	57.79	58.31	62.61	0.00
>=20	42.14	34.19	35.89	35.95	0.00
>=0	0.22	0.24	0.17	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.00

A5 W Dist in Sample / Category Grade (A2/A4)

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.01	0.03	0.11	0.27	0.42
>=95	0.03	0.07	0.09	0.02	0.21
>=90	0.01	0.02	0.03	0.03	0.09
>=80	0.02	0.02	0.03	0.01	0.08
>=70	0.00	0.01	0.03	0.03	0.07
>=50	0.03	0.02	0.03	0.03	0.11
>=20	0.08	0.05	0.08	0.04	0.24
>=0	33.51	14.35	21.07	43.04	111.97
0.00	0.00	0.00	0.00	0.00	0.00

A6 A5 Cumulative by Fraction

	+63um	-63/+45um	-45/+20um	-20um	
>=100	0.01	0.03	0.11	0.27	0.42
>=95	0.04	0.10	0.20	0.29	0.64
>=90	0.05	0.12	0.24	0.32	0.73
>=80	0.06	0.14	0.27	0.33	0.80
>=70	0.07	0.14	0.30	0.36	0.87
>=50	0.10	0.16	0.33	0.40	0.98
>=20	0.17	0.21	0.40	0.44	1.23
>=0	33.69	14.56	21.47	43.47	113.19
0.00	33.69	14.56	21.47	43.47	113.19

A7 W Grade

	+63um	-63/+45um	-45/+20um	-20um	Sample
>=100	80.52	80.52	80.52	80.52	80.52
>=95	80.10	80.02	80.22	80.42	80.27
>=90	79.86	79.75	79.95	80.10	79.98
>=80	78.67	78.94	79.30	79.92	79.45
>=70	78.10	78.55	78.38	79.07	78.68
>=50	71.36	75.78	76.65	77.80	76.45
>=20	58.57	66.18	68.76	73.87	68.70
>=0	0.52	1.21	1.46	0.77	0.88
0.00	0.52	1.21	1.46	0.77	0.88

100

65

Appendix B – Certificate of Analysis

SGS Canada Inc.
 P.O. Box 4300 - 185 Concession St.
 Lakefield - Ontario - KOL 2HO
 Phone: 705-652-2000 FAX: 705-652-6365

LR Internal Dept 14
 Attn : Chris Gunning

January 26, 2011

---, ---
 ---, ---
 Phone: ---, Fax:---

Date Rec. : 28 October 2010
LR Report : CA03327-OCT10
Project : CALR-12547-001
Client Ref : MI5031-OCT20

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	SiO2 %	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %
1: PO268 Modd Comp +63µm	29.2	10.3	25.0	2.93	22.1	1.00	1.99	0.18	0.09	0.71	0.02
2: PO268 Modd Comp -63/+45µm	26.9	9.26	28.4	2.69	22.5	0.84	1.69	0.16	0.07	0.67	< 0.01
3: PO268 Modd Comp -45/+20µm	24.8	8.47	29.9	2.61	23.6	0.70	1.54	0.15	0.03	0.65	0.03
4: PO268 Modd Comp -20µm	24.7	8.89	24.9	3.61	24.4	0.71	2.03	0.16	0.06	0.62	0.09

Sample ID	V2O5 %	LOI %	Sum %	F %	Bi %	Mo %	Zn %	SnO2 %	W %	S %	CO3 %
1: PO268 Modd Comp +63µm	< 0.01	3.14	96.7	6.19	0.037	0.004	0.020	0.23	0.05	0.28	0.18
2: PO268 Modd Comp -63/+45µm	< 0.01	3.89	97.0	6.74	0.035	0.003	0.021	0.21	0.07	0.22	0.26
3: PO268 Modd Comp -45/+20µm	0.01	3.26	95.8	7.99	0.038	0.004	0.012	0.22	0.08	0.18	0.29
4: PO268 Modd Comp -20µm	0.01	3.82	93.9	9.61	0.061	0.009	0.016	0.17	0.08	0.15	0.34



Tom Watt
 Project Coordinator

Appendix C – X-Ray Diffraction Analysis



Qualitative X-Ray Diffraction

Report Prepared for: Minemakers Australia Pty Ltd

Project Number/ LIMS No. 12547-001/MI5031-OCT10

Reporting Date: December 21, 2010

Instrument: BRUKER AXS D8 Advance Diffractometer

Test Conditions: Co radiation, 40 kV, 35 mA
Regular Scanning: Step: 0.02°, Step time: 0.2s, 2θ range: 3-70°

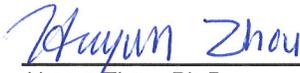
Interpretations : PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva software.

Detection Limit: 0.5-2%. Strongly dependent on crystallinity.

Contents:

- 1) Method Summary
- 2) Summary of Mineral Assemblages
- 3) XRD Pattern(s)


 Anita Coppaway
 Mineralogical Technologist


 Huyun Zhou, Ph.D.
 Senior Mineralogist



Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involve matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds. Mineral proportions are based on relative peak heights and may be strongly influenced by crystallinity, structural group or preferred orientations. Interpretations and relative proportions should be accompanied by supporting petrographic and geochemical data (Whole Rock Analysis, Inductively Coupled Plasma - Optical Emission Spectroscopy, etc.).

Summary of Qualitative X-ray Diffraction Results

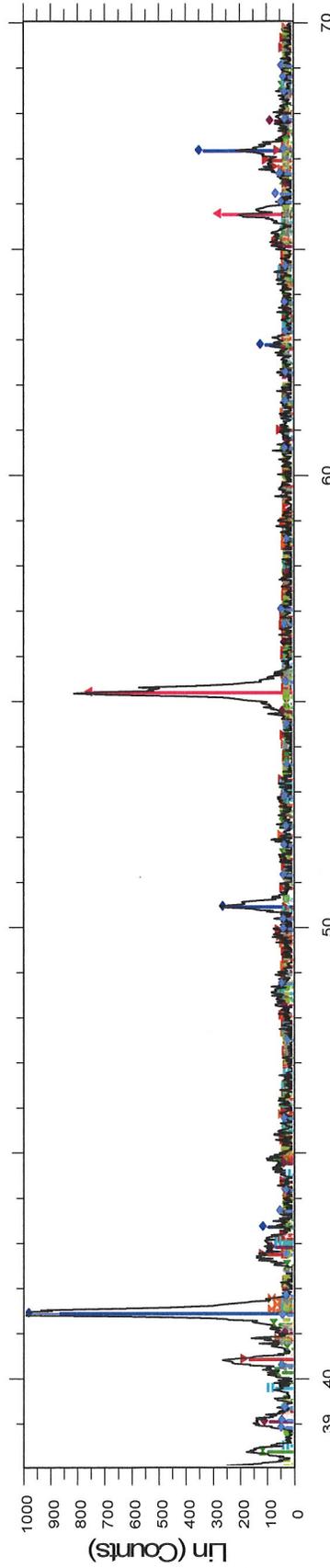
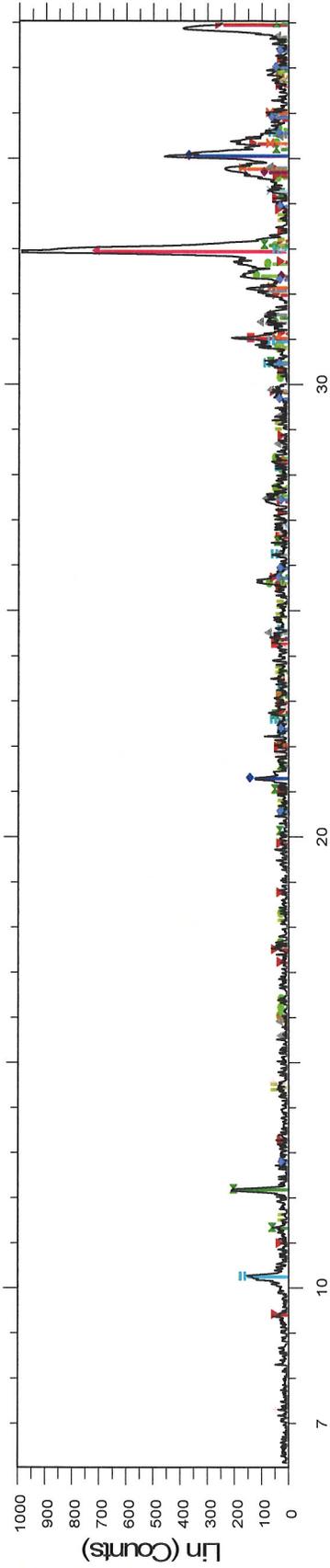
Crystalline Mineral Assemblage (relative proportions based on peak height)

Sample	Major	Moderate	Minor	Trace
(1) PO268 Modd Comp +63 µm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, potassium feldspar, mica, garnet, quartz	*chlorite, *kaolinite, *epidote, *calcite
(2) PO268 Modd Comp - 63/+45 µm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, garnet, quartz	*chlorite, *epidote, *potassium feldspar, *calcite
(3) PO268 Modd Comp - 45/20 µm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, garnet, quartz	*chlorite, *epidote, *calcite
(4) PO268 Modd Comp - 20 µm	-	magnetite, fluorite	vesuvianite, pyroxene, plagioclase, amphibole, mica, quartz	*chlorite, *kaolinite, *epidote, *calcite, *garnet

*tentative identification due to low concentrations, diffraction line overlap or poor crystallinity

Mineral	Composition
Amphibole	(Na,K)Ca ₂ (Fe,Mg) ₅ (Al,Si) ₈ O ₂₂ (OH) ₂
Calcite	CaCO ₃
Chlorite	(Fe,(Mg,Mn) ₅ ,Al)(Si ₃ Al)O ₁₀ (OH) ₈
Epidote	Ca ₂ (Al,Fe)Al ₂ O(SiO ₄)(Si ₂ O ₇)(OH)
Fluorite	CaF ₂
Garnet	(Ca,Mg,Mn) ₃ (V,Al,Fe ₃) ₂ (SiO ₄) ₃
Kaolinite	Al ₂ Si ₂ O ₅ (OH) ₄
Magnetite	Fe ₃ O ₄
Mica	K(Mg,Fe)Al ₂ Si ₃ AlO ₁₀ (OH) ₂
Plagioclase	(NaSi,CaAl)AlSi ₂ O ₈
Potassium Feldspar	KAlSi ₃ O ₈
Pyroxene	(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al) ₂ O ₆
Quartz	SiO ₂
Vesuvianite	Ca ₁₀ Mg ₂ Al ₄ (Si ₂ O ₇) ₂ (SiO ₄) ₅ (OH) ₄

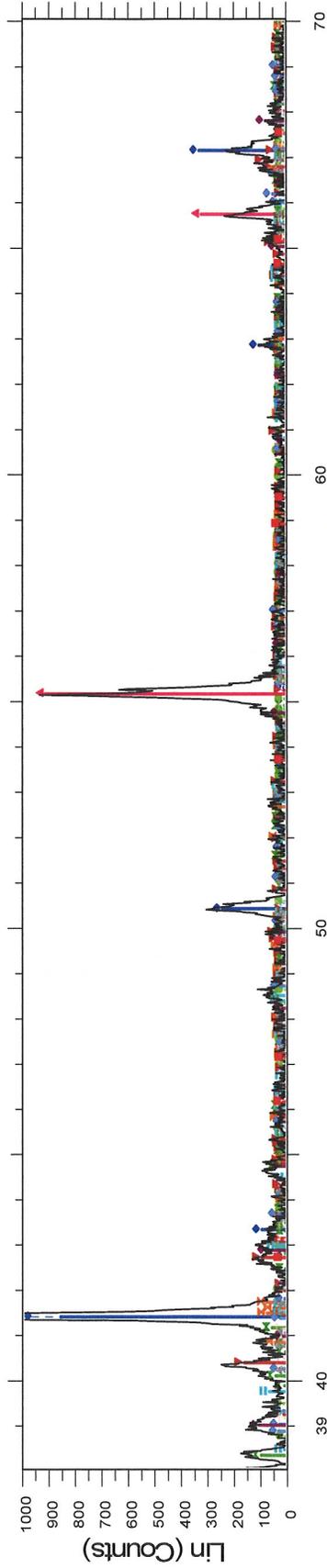
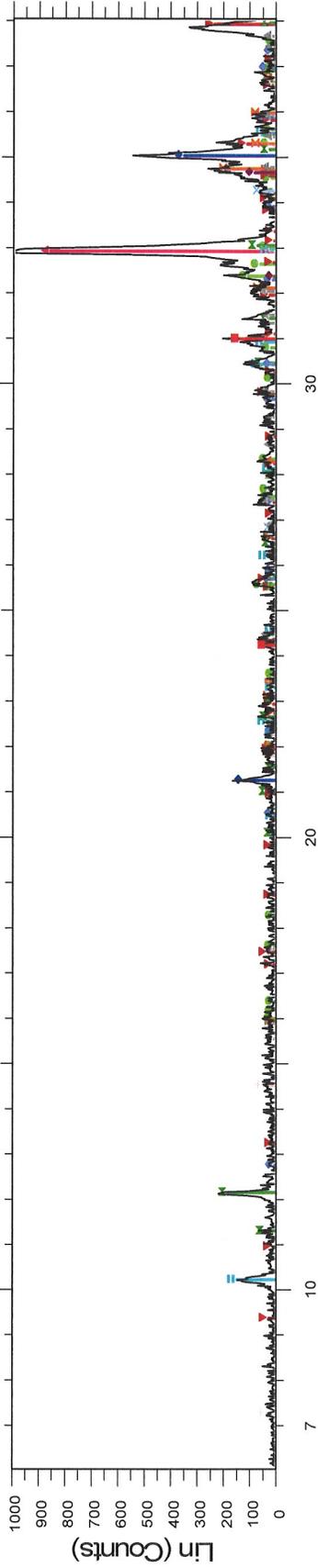
PO268 Modd Comp +63µm



2-Theta - Scale

- | | | | |
|--|--|--|---|
| | PO268 Modd Comp +63µm - File: Oct5031-1.raw | | 01-080-1109 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2 |
| | 01-079-1910 (C) - Quartz - SiO2 | | 01-075-1593 (C) - Kaolinite - Al2Si2O5(OH)4 |
| | 01-087-2334 (C) - Magnetite - synthetic - Fe3O4 | | 01-086-2334 (C) - Calcite - Ca(CO3) |
| | 01-085-1415 (C) - Anorthite (Na-exchanged) - (Na.45Ca.55)(Al1.55Si2.45O8) | | 01-079-1270 (C) - Clinocllore - (Mg2.96Fe1.55Fe.136Al1.275)(Si2.622Al1.376O |
| | 00-004-0864 (D) - Fluorite, syn - CaF2 | | 00-045-1446 (I) - Epidote - Ca2(Al,Fe)3(Si2O7)(SiO4)(OH)2 |
| | 01-074-2028 (C) - Vesuvianite - Ca19MgFe2Al10Si18O70(OH)8 | | 01-071-1540 (C) - Orthoclase - KSi3AlO8 |
| | 01-073-2339 (C) - Actinolite - Na.08Ca1.76Mn.16Mg1.88Fe2.72Fe.32Al.32Si7.6 | | 01-084-1936 (C) - Andradite - Ca3Fe2(SiO4)3 |
| | 01-075-1092 (C) - Diopside - CaMgSi2O6 | | |

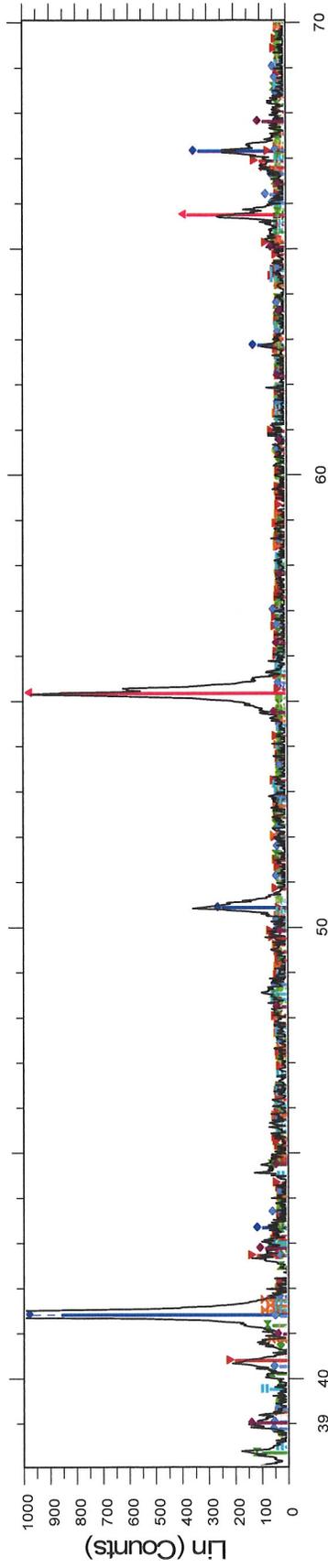
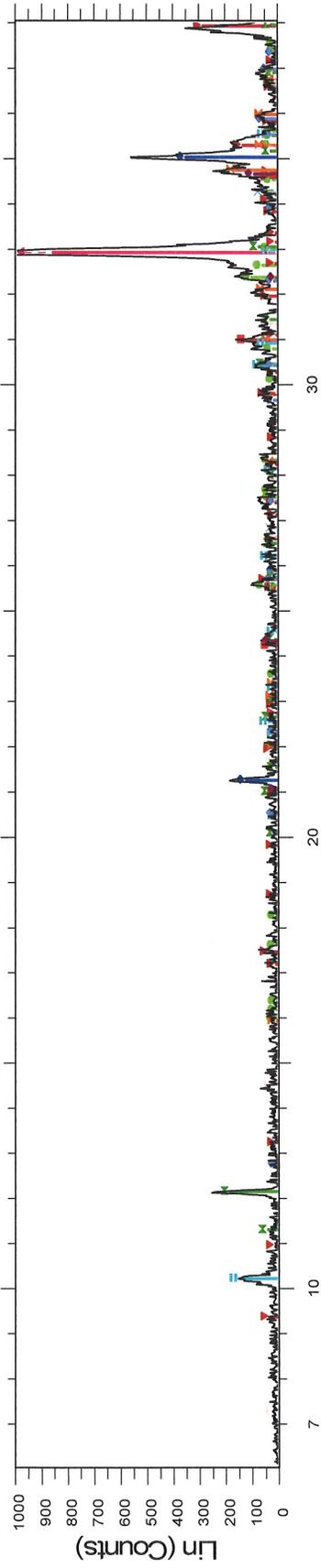
PO268 Modd Comp -63/+45µm



2-Theta - Scale

- | | | | |
|--|--|--|--|
| | PO268 Modd Comp -63/+45µm - File: Oct5031-6.raw | | 01-080-1109 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2 |
| | 01-079-1910 (C) - Quartz - SiO2 | | 01-086-2334 (C) - Calcite - Ca(CO3) |
| | 01-087-2334 (C) - Magnetite - synthetic - Fe3O4 | | 01-079-1270 (C) - Clinocllore - (Mg2.96Fe1.55Fe.136Al1.275)(Si2.622Al1.376O10) |
| | 01-085-1415 (C) - Anorthite (Na-exchanged) - (Na.45Ca.55)(Al1.55Si2.45O8) | | 00-045-1446 (I) - Epidote - Ca2(Al,Fe)3(Si2O7)(SiO4)(OH)2 |
| | 00-004-0864 (D) - Fluorite, syn - CaF2 | | 01-071-1540 (C) - Orthoclase - KSi3AlO8 |
| | 01-074-2028 (C) - Vesuvianite - Ca19MgFe2Al10Si118O70(OH)8 | | 01-084-1936 (C) - Andradite - Ca3Fe2(SiO4)3 |
| | 01-073-2339 (C) - Actinolite - Na.08Ca1.76Mn.16Mg1.88Fe2.72Fe.32Al.32Si7.68O | | |
| | 01-075-1092 (C) - Diopside - CaMgSi2O6 | | |

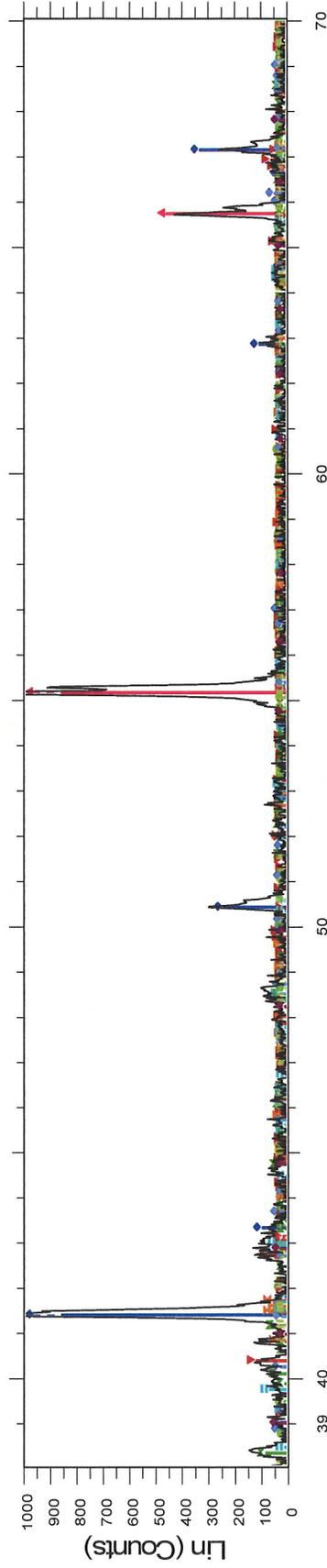
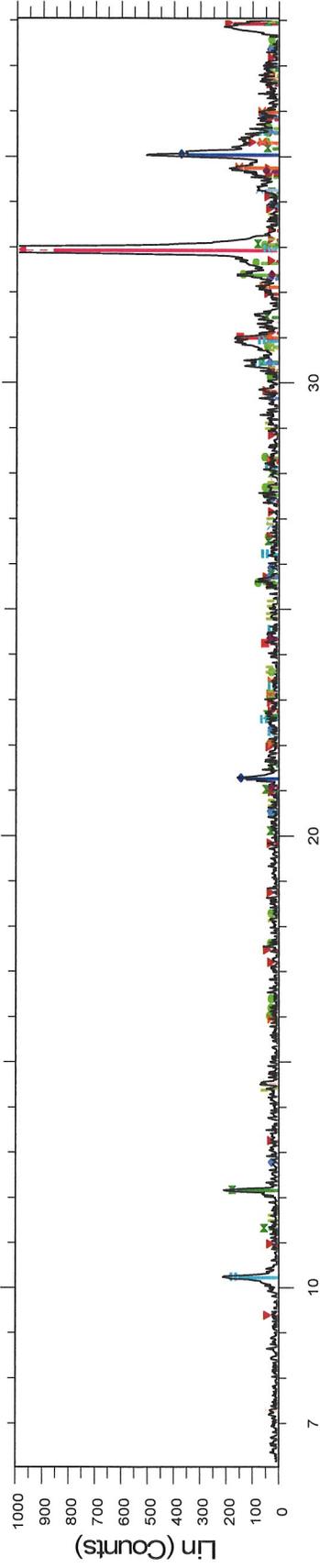
PO268 Modd Comp -45/+20µm



2-Theta - Scale

- PO268 Modd Comp -45/+20µm - File: Oct5031-10.raw
- 01-079-1910 (C) - Quartz - SiO2
- 01-087-2334 (C) - Magnetite - synthetic - Fe3O4
- 01-085-1415 (C) - Anorthite (Na-exchanged) - (Na.45Ca.55)(Al1.55Si2.45O8)
- 00-004-0864 (D) - Fluorite, syn - CaF2
- 01-074-2028 (C) - Vesuvianite - Ca19MgFe2Al10Si18O70(OH)8
- 01-073-2339 (C) - Actinolite - Na.08Ca1.76Mn.16Mg1.88Fe2.72Fe.32Al.32Si7.68O
- 01-075-1092 (C) - Diopside - CaMgSi2O6
- 01-080-1109 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2
- 01-086-2334 (C) - Calcite - Ca(CO3)
- 01-079-1270 (C) - Clinoclhire - (Mg2.96Fe1.55Fe.136Al1.275)(Si2.622Al1.376O10)
- 00-045-1446 (I) - Epidote - Ca2(Al,Fe)3(Si2O7)(SiO4)(OH)2
- 01-084-1936 (C) - Andradite - Ca3Fe2(SiO4)3

PO268 Modd Comp -20µm



2-Theta - Scale

- | | | | |
|--|--|--|--|
| | PO268 Modd Comp -20µm - File: Oct5031-13.raw | | 01-080-1109 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2 |
| | 01-079-1910 (C) - Quartz - SiO2 | | 01-075-1593 (C) - Kaolinite - Al2Si2O5(OH)4 |
| | 01-087-2334 (C) - Magnetite - synthetic - Fe3O4 | | 01-086-2334 (C) - Calcite - Ca(CO3) |
| | 01-085-1415 (C) - Anorthite (Na-exchanged) - (Na.45Ca.55)(Al1.55Si2.45O8) | | 01-079-1270 (C) - Clinocllore - (Mg2.96Fe1.55Fe.136Al1.275)(Si2.622Al1.376O10) |
| | 00-004-0864 (D) - Fluorite, syn - CaF2 | | 00-045-1446 (I) - Epidote - Ca2(Al,Fe)3(Si2O7)(SiO4)(OH)2 |
| | 01-074-2028 (C) - Vesuvianite - Ca19MgFe2Al10Si18O70(OH)8 | | 01-084-1936 (C) - Andradite - Ca3Fe2(SiO4)3 |
| | 01-073-2339 (C) - Actinolite - Na.08Ca1.76Mn.16Mg1.88Fe2.72Fe.32Al.32Si7.68O | | |
| | 01-075-1092 (C) - Diopside - CaMgSi2O6 | | |

***Appendix D – Scanning Electron Microscope – Energy Dispersive
Detector Analysis (SEM-EDS)***

Project: 12547-001 MI5031-OCT10 MineMakers

Ca-Al Silicate Low Fe & Mg

Spectrum	O	F	Al	Si	Ca	Fe	Mg	Cl	Mn	Ti
1	43.5	4.1	6.9	17.0	22.4	3.5	1.9	0.0	0.7	0.0
2	43.2	4.4	7.8	16.7	22.4	3.1	1.5	0.5	0.0	0.4
3	42.7	3.5	7.1	17.1	22.6	3.7	2.4	0.0	0.9	0.0
4	46.3	0.0	7.8	16.6	22.7	4.3	1.3	0.0	0.7	0.5
5	42.7	4.2	8.4	16.7	22.7	3.0	1.1	0.4	0.8	0.0
6	41.7	4.2	7.8	16.8	22.7	4.6	1.3	0.4	0.6	0.0
7	46.0	0.0	5.7	17.2	22.7	6.0	1.8	0.0	0.6	0.0
8	46.1	0.0	7.4	16.9	22.7	3.9	1.9	0.0	0.7	0.4
9	45.2	0.0	8.0	17.1	22.8	4.6	1.3	0.4	0.6	0.0
10	43.7	2.9	7.0	17.0	22.8	4.0	2.2	0.6	0.0	0.0
11	46.3	0.0	5.8	16.7	22.9	6.3	1.7	0.4	0.0	0.0
12	45.8	0.0	7.1	17.0	22.9	5.7	0.9	0.0	0.6	0.0
13	43.8	3.6	7.4	17.3	23.0	2.8	2.1	0.0	0.0	0.0
14	43.1	3.3	8.3	16.7	23.0	3.1	1.8	0.0	0.7	0.0
15	45.4	0.0	5.6	16.6	23.0	7.3	1.9	0.4	0.0	0.0
16	46.0	0.0	7.3	17.4	23.0	4.3	2.1	0.0	0.0	0.0
17	45.6	0.0	7.4	17.4	23.1	3.7	2.1	0.0	0.8	0.0
18	45.7	0.0	7.5	16.8	23.1	4.4	1.7	0.0	0.9	0.0
19	44.1	3.6	7.7	16.8	23.1	2.8	1.9	0.0	0.0	0.0
20	45.8	0.0	7.6	17.5	23.1	4.6	1.4	0.0	0.0	0.0
21	44.9	0.0	7.1	17.6	23.2	4.5	1.9	0.0	0.8	0.0
22	46.2	0.0	7.0	17.0	23.2	3.4	2.6	0.0	0.7	0.0
23	45.4	0.0	6.6	17.0	23.3	5.2	1.9	0.0	0.6	0.0
24	46.1	0.0	7.6	16.6	23.3	3.6	1.5	0.0	0.7	0.6
25	44.5	0.0	7.1	17.6	23.6	4.7	1.6	0.0	0.9	0.0
26	45.7	0.0	7.3	17.1	23.6	3.3	1.8	0.0	0.7	0.5
27	45.6	0.0	8.8	16.6	23.7	2.8	1.4	0.5	0.7	0.0
28	46.6	0.0	8.9	16.9	23.7	3.1	0.9	0.0	0.0	0.0
29	45.3	0.0	7.6	18.3	23.9	3.3	1.6	0.0	0.0	0.0
Average	44.9	1.2	7.4	17.0	23.0	4.1	1.7	0.1	0.5	0.1
Stdev	1.3	1.8	0.8	0.4	0.4	1.1	0.4	0.2	0.4	0.2
Min	41.7	0.0	5.6	16.6	22.4	2.8	0.9	0.0	0.0	0.0
Max	46.6	4.4	8.9	18.3	23.9	7.3	2.6	0.6	0.9	0.6

*SEM Semi-Quantitative Data Normalized (wt%)

Project: 12547-001 MI5031-OCT10 MineMakers

Vesuvianite

Spectrum	O	F	Al	Si	Ca	Fe	Mg	K	Mn	Sn	S
1	42.5	4.8	7.9	16.7	22.3	3.4	1.5	0.0	0.9	0.0	0.0
2	43.2	3.1	8.6	17.1	22.0	4.1	1.2	0.0	0.9	0.0	0.0
3	41.7	4.8	7.6	17.0	21.5	4.6	1.5	0.0	1.5	0.0	0.0
4	42.1	5.0	7.6	16.4	22.0	5.1	1.0	0.0	0.8	0.0	0.0
5	42.2	4.8	7.8	16.8	21.5	5.2	0.7	0.0	1.0	0.0	0.0
6	45.2	0.0	7.7	17.4	22.2	5.2	1.2	0.0	1.0	0.0	0.0
7	42.5	3.8	7.4	16.7	22.1	5.3	1.4	0.0	0.9	0.0	0.0
8	44.2	0.0	9.3	17.5	19.8	6.1	0.0	0.0	3.1	0.0	0.0
9	41.9	0.0	6.2	18.5	19.8	10.7	0.9	0.4	1.7	0.0	0.0
10	43.9	0.0	5.2	17.3	21.6	11.1	0.0	0.0	0.9	0.0	0.0
11	42.8	0.0	4.3	17.6	22.2	11.4	0.0	0.0	1.6	0.0	0.0
12	42.8	0.0	4.3	17.4	21.7	12.5	0.0	0.0	1.3	0.0	0.0
13	42.5	0.0	2.8	16.4	20.6	13.4	0.4	0.0	1.4	2.6	0.0
14	42.6	0.0	2.6	16.6	21.4	14.8	0.0	0.0	0.7	1.4	0.0
15	42.6	0.0	2.3	16.8	21.2	14.9	0.0	0.0	0.6	1.6	0.0
16	38.7	0.0	5.7	14.2	19.5	14.9	0.5	0.0	0.0	0.0	6.5
17	42.7	0.0	2.4	16.9	22.4	15.1	0.0	0.0	0.6	0.0	0.0
18	42.0	0.0	1.0	15.9	21.4	16.9	0.0	0.0	1.2	1.7	0.0
19	41.7	0.0	1.6	16.7	21.5	17.3	0.0	0.0	1.3	0.0	0.0
Average	42.5	1.4	5.4	16.8	21.4	10.1	0.5	0.0	1.1	0.4	0.3
Stdev	1.3	2.1	2.6	0.9	0.9	4.9	0.6	0.1	0.6	0.8	1.5
Min	38.7	0.0	1.0	14.2	19.5	3.4	0.0	0.0	0.0	0.0	0.0
Max	45.2	5.0	9.3	18.5	22.4	17.3	1.5	0.4	3.1	2.6	6.5

*SEM Semi-Quantitative Data Normalized (wt%)

Project: 12547-001 MI5031-OCT10 MineMakers

Sn Oxides (w Fe)

Spectrum	O	F	Na	Al	Si	Ca	Fe	Mg	Mn	Ti	Sn	Zn	P
1	39.2	0.0	0.0	0.0	0.0	2.6	46.2	0.0	0.0	0.0	11.9	0.0	0.0
2	40.9	0.0	0.0	0.0	0.0	0.0	43.6	0.0	0.0	0.0	15.6	0.0	0.0
3	41.2	0.0	0.0	2.9	0.0	0.0	32.6	0.0	1.5	1.0	18.3	2.6	0.0
4	38.7	0.0	0.0	4.6	0.0	0.0	30.0	0.0	0.7	0.0	20.7	5.4	0.0
5	41.2	0.0	0.0	7.7	0.0	0.0	17.0	0.0	1.6	1.4	24.2	7.0	0.0
6	47.3	0.0	0.0	3.5	10.0	0.0	0.6	0.0	0.0	0.0	38.6	0.0	0.0
7	30.0	17.9	0.7	1.7	3.2	6.2	1.7	0.0	0.0	0.0	38.6	0.0	0.0
8	42.4	0.0	0.0	1.8	4.8	2.0	4.1	1.1	0.0	0.0	44.0	0.0	0.0
9	33.1	0.0	0.0	0.8	0.5	0.0	2.4	0.0	0.0	0.0	62.4	0.0	0.8
10	34.1	0.0	0.0	0.0	0.7	0.0	1.6	0.0	0.0	0.0	65.6	0.0	0.0
11	33.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.0	0.0	0.0
12	32.5	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	67.7	0.0	0.0
13	33.5	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	70.2	0.0	0.0
Average	37.5	1.4	0.1	1.8	1.5	0.8	14.0	0.1	0.3	0.2	41.8	1.2	0.1
Stdev	5.1	5.0	0.2	2.4	3.0	1.8	17.7	0.3	0.6	0.5	22.3	2.4	0.2
Min	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.9	0.0	0.0
Max	47.3	17.9	0.7	7.7	10.0	6.2	46.2	1.1	1.6	1.4	70.2	7.0	0.8

*SEM Semi-Quantitative Data Normalized (wt%)

Appendix E – SEM-EDS Investigation for -10 Mesh Material for Coarse Scheelite

Paticle #	Area (sq. μm)	Calcutated ECD		Paticle #	Area (sq. μm)	Calcutated ECD
1	6	3		52	13	4
2	6	3		53	13	4
3	6	3		54	13	4
4	6	3		55	13	4
5	6	3		56	13	4
6	6	3		57	13	4
7	6	3		58	13	4
8	6	3		59	13	4
9	6	3		60	13	4
10	6	3		61	13	4
11	6	3		62	13	4
12	6	3		63	13	4
13	6	3		64	13	4
14	6	3		65	13	4
15	6	3		66	13	4
16	6	3		67	13	4
17	6	3		68	13	4
18	6	3		69	13	4
19	6	3		70	13	4
20	6	3		71	13	4
21	6	3		72	13	4
22	6	3		73	13	4
23	6	3		74	13	4
24	6	3		75	13	4
25	6	3		76	13	4
26	6	3		77	13	4
27	6	3		78	13	4
28	6	3		79	13	4
29	6	3		80	13	4
30	6	3		81	13	4
31	6	3		82	13	4
32	6	3		83	13	4
33	6	3		84	13	4
34	6	3		85	13	4
35	6	3		86	13	4
36	6	3		87	13	4
37	6	3		88	13	4
38	6	3		89	13	4
39	6	3		90	13	4
40	6	3		91	13	4
41	6	3		92	13	4
42	6	3		93	13	4
43	6	3		94	13	4
44	6	3		95	13	4
45	13	4		96	13	4
46	13	4		97	13	4
47	13	4		98	13	4
48	13	4		99	19	4
49	13	4		100	19	4
50	13	4		101	19	4
51	13	4		102	19	4

Paticle #	Area (sq. μm)	Calcutated ECD		Paticle #	Area (sq. μm)	Calcutated ECD
103	19	4		156	25	5
104	19	4		157	25	5
105	19	4		158	25	5
106	19	4		159	25	5
107	19	4		160	25	5
108	19	4		161	25	5
109	19	4		162	25	5
110	19	4		163	32	6
111	19	4		164	32	6
112	19	4		165	32	6
113	19	4		166	32	6
114	19	4		167	32	6
115	19	4		168	32	6
116	19	4		169	32	6
117	19	4		170	32	6
118	19	4		171	32	6
119	19	4		172	32	6
120	19	4		173	32	6
121	19	4		174	32	6
122	19	4		175	32	6
123	19	4		176	32	6
124	19	4		177	32	6
125	19	4		178	32	6
126	19	4		179	32	6
127	19	4		180	32	6
128	19	4		181	32	6
129	25	5		182	32	6
130	25	5		183	32	6
131	25	5		184	32	6
132	25	5		185	32	6
133	25	5		186	32	6
134	25	5		187	32	6
135	25	5		188	32	6
136	25	5		189	38	6
137	25	5		190	38	6
138	25	5		191	38	6
139	25	5		192	38	6
140	25	5		193	38	6
141	25	5		194	38	6
142	25	5		195	38	6
143	25	5		196	38	6
144	25	5		197	38	6
145	25	5		198	38	6
146	25	5		199	38	6
147	25	5		200	38	6
148	25	5		201	38	6
149	25	5		202	38	6
150	25	5		203	44	7
151	25	5		204	44	7
152	25	5		205	44	7
153	25	5		206	44	7
154	25	5		207	44	7
155	25	5				

Paticle #	Area (sq. μm)	Calcutated ECD		Paticle #	Area (sq. μm)	Calcutated ECD
208	44	7		264	76	9
209	44	7		265	76	9
210	44	7		266	76	9
211	44	7		267	76	9
212	44	7		268	76	9
213	44	7		269	76	9
214	44	7		270	76	9
215	44	7		271	76	9
216	51	7		272	76	9
217	51	7		273	76	9
218	51	7		274	76	9
219	51	7		275	76	9
220	51	7		276	81	9
221	51	7		277	82	9
222	51	7		278	82	9
223	51	7		279	82	9
224	51	7		280	82	9
225	51	7		281	82	9
226	51	7		282	88	9
227	51	7		283	88	9
228	51	7		284	88	9
229	57	8		285	95	10
230	57	8		286	95	10
231	57	8		287	95	10
232	57	8		288	95	10
233	57	8		289	95	10
234	57	8		290	95	10
235	57	8		291	95	10
236	57	8		292	95	10
237	57	8		293	95	10
238	57	8		294	95	10
239	57	8		295	95	10
240	63	8		296	101	10
241	63	8		297	101	10
242	63	8		298	101	10
243	63	8		299	101	10
244	63	8		300	101	10
245	63	8		301	107	10
246	63	8		302	107	10
247	63	8		303	107	10
248	63	8		304	107	10
249	63	8		305	107	10
250	63	8		306	107	10
251	63	8		307	114	11
252	70	8		308	114	11
253	70	8		309	114	11
254	70	8		310	114	11
255	70	8		311	120	11
256	70	8		312	120	11
257	70	8		313	120	11
258	70	8		314	120	11
259	70	8		315	120	11
260	70	8		316	126	11
261	76	9		317	133	12
262	76	9		318	133	12
263	76	9		319	133	12

Paticle #	Area (sq. μm)	Calcutated ECD		Paticle #	Area (sq. μm)	Calcutated ECD
320	139	12		373	411	20
321	145	12		374	436	21
322	145	12		375	461	21
323	145	12		376	468	22
324	152	12		377	468	22
325	158	13		378	468	22
326	164	13		379	556	24
327	171	13		380	556	24
328	171	13		381	562	24
329	177	13		382	645	25
330	177	13		383	689	26
331	177	13		384	746	27
332	177	13		385	765	28
333	177	13		386	859	29
334	183	14		387	904	30
335	190	14		388	935	31
336	196	14		389	935	31
337	196	14		390	954	31
338	196	14		391	967	31
339	196	14		392	1017	32
340	202	14		393	1068	33
341	202	14		394	1125	34
342	209	14		395	1175	34
343	209	14		396	1188	34
344	209	14		397	1239	35
345	209	14		398	1289	36
346	215	15		399	1390	37
347	215	15		400	1523	39
348	221	15		401	1592	40
349	234	15		402	2047	45
350	240	15		403	2945	54
351	246	16		404	3299	57
352	246	16		405	6787	82
353	253	16				
354	253	16				
355	253	16				
356	259	16				
357	259	16				
358	272	16				
359	278	17				
360	284	17				
361	284	17				
362	284	17				
363	297	17				
364	303	17				
365	316	18				
366	316	18				
367	316	18				
368	322	18				
369	329	18				
370	329	18				
371	373	19				
372	379	19				

Appendix F – Terminology of Liberation and Association

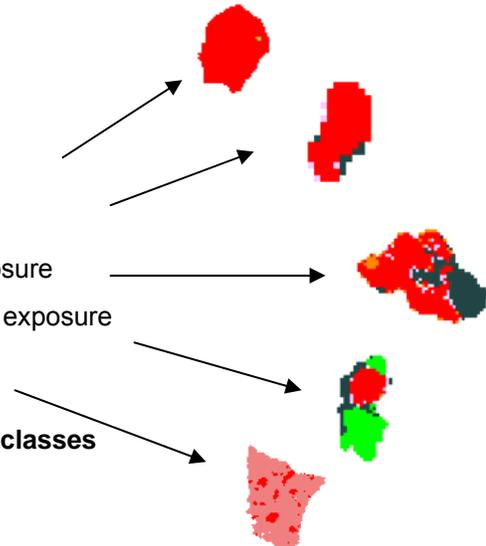
Terminology – Liberation and Association

Terminology developed for liberation and association are presented below.

Liberation classes were defined as the following;

- **Free:** A mineral with 100% surface exposure
- **Liberated:** A mineral with $\geq 95\%$ surface exposure
- **Midds:** A mineral with $\geq 90\%$ but $< 95\%$ surface exposure
- **Sub-Midds:** A mineral with $\geq 20\%$ but $< 95\%$ surface exposure
- **Locked:** A mineral with $< 20\%$ surface exposure

Legend for liberation classes



Association classes were defined as the following;

- **Barren** - A particle that has 0% of **Fluorite**
- **Free Fluorite** - A particle that has $\geq 95\%$ of **Fluorite**
- **Binary Fluorite: Scheelite** - A particle that has ≥ 95 area% of **Fluorite + Scheelite**
- **Binary Fluorite: Bi-Minerals** - A particle that has ≥ 95 area% of **Fluorite + Bi-Minerals**
- **Binary Fluorite: Cassiterite** - A particle that has ≥ 95 area% of **Fluorite + Cassiterite**
- **Binary Fluorite: Ca-Silicates** - A particle that has ≥ 95 area% of **Fluorite + Ca-Silicates**
- **Binary Fluorite: Other Silicates** - A particle that has ≥ 95 area% of **Fluorite + Other Silicates**
- **Binary Fluorite: Fe-Oxides** - A particle that has ≥ 95 area% of **Fluorite + Fe-Oxides**
- **Binary Fluorite: Calcite** - A particle that has ≥ 95 area% of **Fluorite + Calcite**
- **Binary Fluorite: Other Carbonates** - A particle that has ≥ 95 area% of **Fluorite + Other Carbonates**
- **Binary Fluorite: Pyrite** - A particle that has ≥ 95 area% of **Fluorite + Pyrite**
- **Binary Fluorite: Other** - A particle that has ≥ 95 area% of **Fluorite + Other Binary**
- **Fluorite: Other Sulphides** - A particle that has ≥ 95 area% of **Fluorite + Other Sulphides**
- **Ternary Fluorite:Fe-Oxides:Silicates** - A particle that has ≥ 95 area% of **Fluorite + Fe-Oxides , Ca-Silicates + Other Silicates**
- **Complex:** Any combination of the above definitions has been defined as a complex particle

Association categories for Cassiterite, Bi-Minerals, Scheelite, Pyrite, Fe-oxides are based on the same principal.

Appendix G – QEMSCAN™ Modes of Operation

QEMSCAN™ Operational Modes

QEMSCAN is an acronym for Quantitative Evaluation of Materials by Scanning Electron Microscopy, a system which differs from image analysis systems in that it is configured to measure mineralogical variability based on chemistry at the micrometer-scale. QEMSCAN utilizes both the back-scattered electron (BSE) signal intensity as well as an Energy Dispersive X-ray Signal (EDS) at each measurement point. It thus makes no simplifications or assumptions of homogeneity based on the BSE intensity, as many mineral phases show BSE overlap. EDS signals are used to assign mineral identities to each measurement point by comparing the EDS spectrum against a mineral species identification program (SIP) or database.

There are three general types of measurement: those using the linear intercept and those based on particle mapping. Bulk mineral analysis (BMA) is performed using the linear intercept method, and is used to provide statistically abundant data for speciation and mineral distribution. Particle mapping modes, including Particle Mineral Analysis (PMA), Specific Mineral Search (SMS) analysis and Trace Mineral Search (TMS) analysis provide information on spatial relationships of minerals, including liberation and association data and provide a visual representation of mineral textures. The particle mapping modes of measurement also allow for advanced analysis of the minerals of interest, including grade vs. recovery relationships and mineral release curves. Specific details of the measurement modes are presented below, while visual examples of these two measurement classes are presented in Figures 1 and 2. The Field Stitch (FS) mode of measurement maps a core sample that has been mounted in the polished section. It collects a chemical spectrum at a set interval within the field of view. Each field of view is then processed offline and a pseudo image of the core sample is produced.

Bulk Mineral Analysis, or BMA, is performed by the linear intercept method, in which the electron beam is rastered at a pre-defined point spacing (nominally 3 micrometers, but variable with particle size) along several lines per field, and covering the entire polished section at any given magnification. An example of a BMA measurement image is shown in Figure 1. This measurement provides a robust data set for determination of the bulk mineralogy, with mineral identities and proportions, along with grain size measurements.

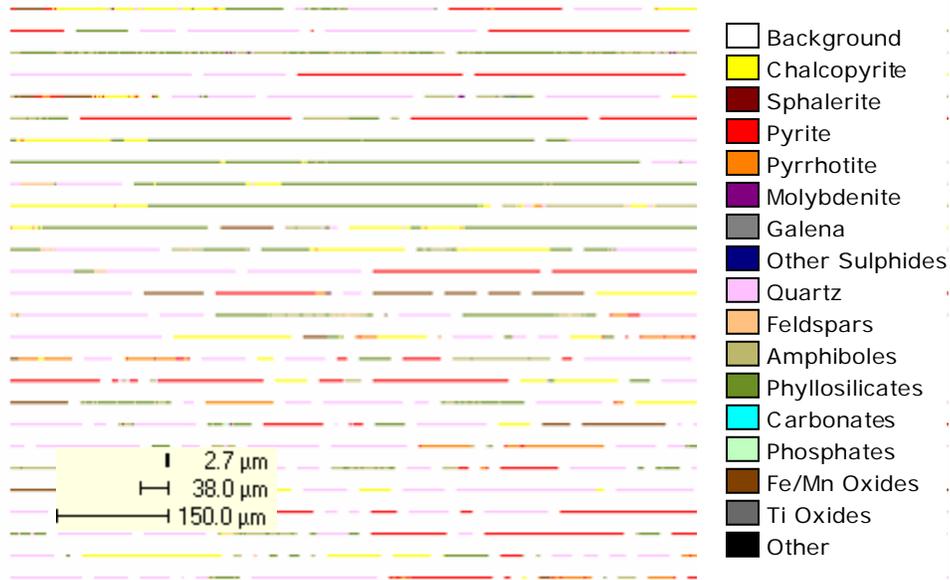


Figure 1. BMA Measurement Mode

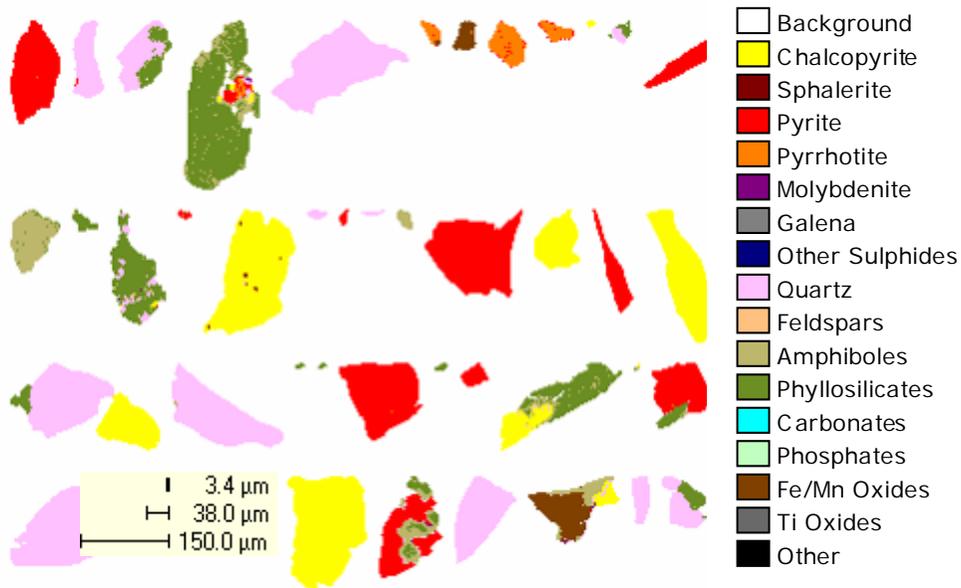


Figure 2. Particle Mapping (PMA, SMS or TMS) Measurement Mode

Particle Mineral Analysis (PMA) is a two-dimensional mapping analysis aimed at resolving liberation and locking characteristics of a generic set of particles. A pre-defined number of particles are mapped at a point spacing selected in order to spatially resolve and describe mineral textures and associations. This mode is often selected to characterize concentrate products, as both gangue and value minerals report in statistically abundant quantities to be resolved.

Specific Mineral Search, or SMS, is a modified Particle Mineral Analysis (PMA) routine. However, in an SMS routine, a phase reports as a low-grade constituent and can be located by thresholding of the back-scattered electron intensity. Any accompanying phases of similar and higher brightness are also mapped. For example, this mode of measurement would be selected in ores of low sulphide grade, searching specifically for particles containing sulphide minerals.

Trace Mineral Search (TMS) is an additional mapping routine, where a phase reports as a trace constituent and can be located by thresholding of the back-scattered electron intensity. The objective of this routine is to reject barren fields and increase analysis efficiency. The outputs are otherwise identical to the SMS routine. This mode of measurement is often used for advanced studies of PGE ore types, or trace minerals of interest such as molybdenite.

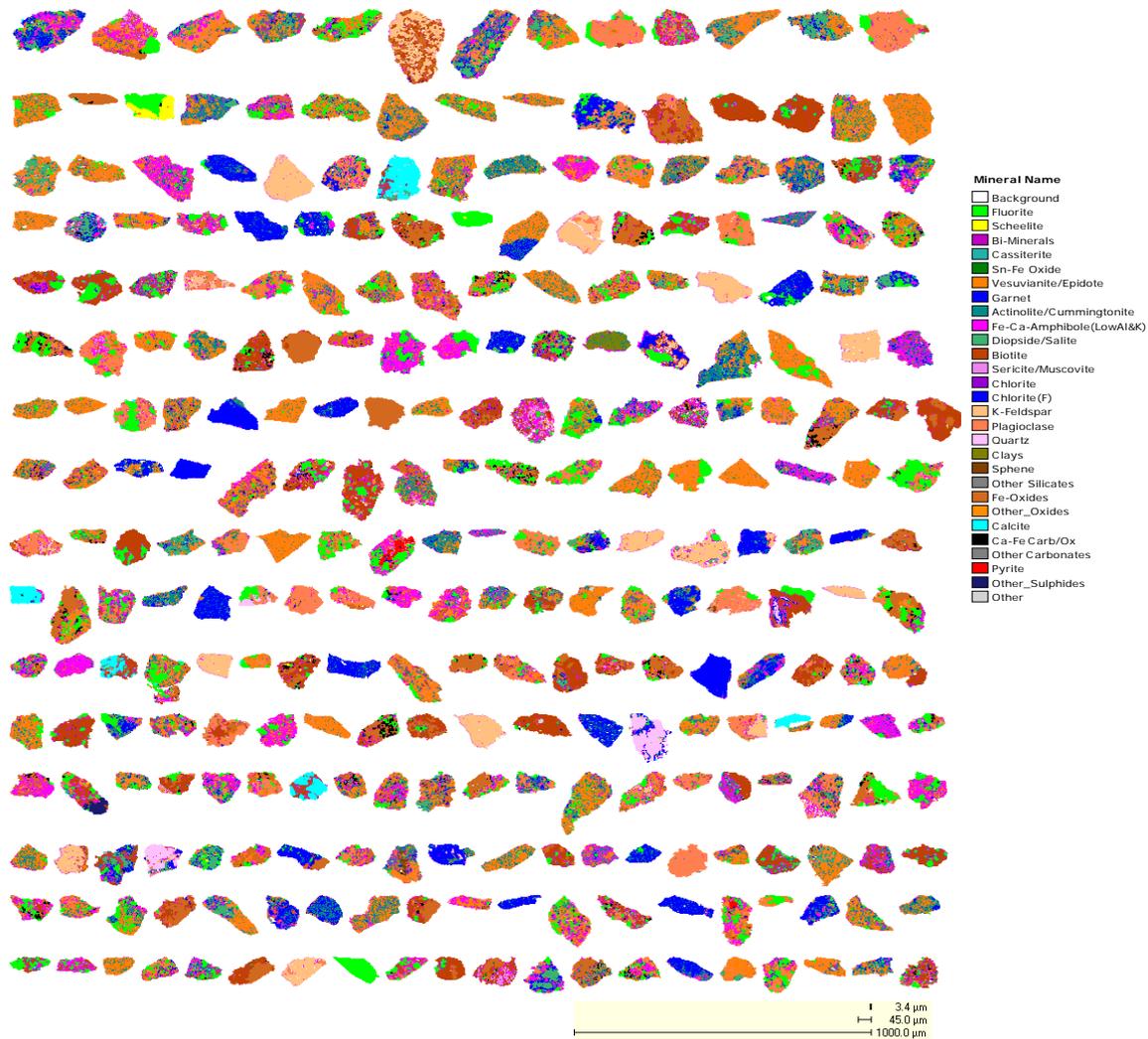
It is important to note that with regards to SMS and TMS modes, results pertain only to the target minerals. PMA must be selected if quantitative gangue characterization is required. For example, in some sulphide ores, it may be more efficient to reject barren pyrites in favour of copper-bearing minerals. However, it must be noted that data captured in this manner will not reflect the true characteristics of pyrite, as only the pyrite associated with the copper-bearing minerals will be represented.

The Field Stitch (FS) mode of measurement maps a core sample that has been mounted in the polished section. It collects a chemical spectrum at a set interval within the field of view. Each field of view is then processed offline and a pseudo image of the core sample is produced.

Appendix H – Particle Maps

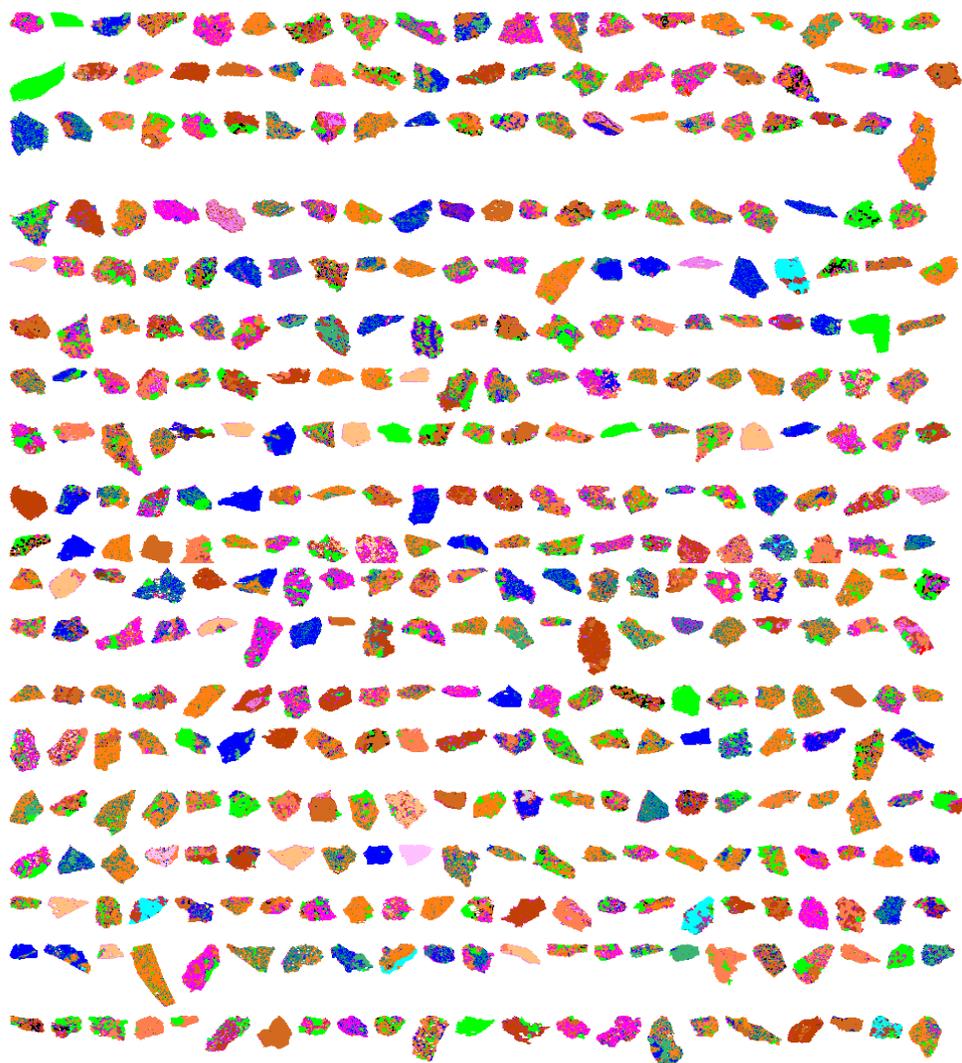
Minemakers
12547-001
M15031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)



Minemakers
12547-001
MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)

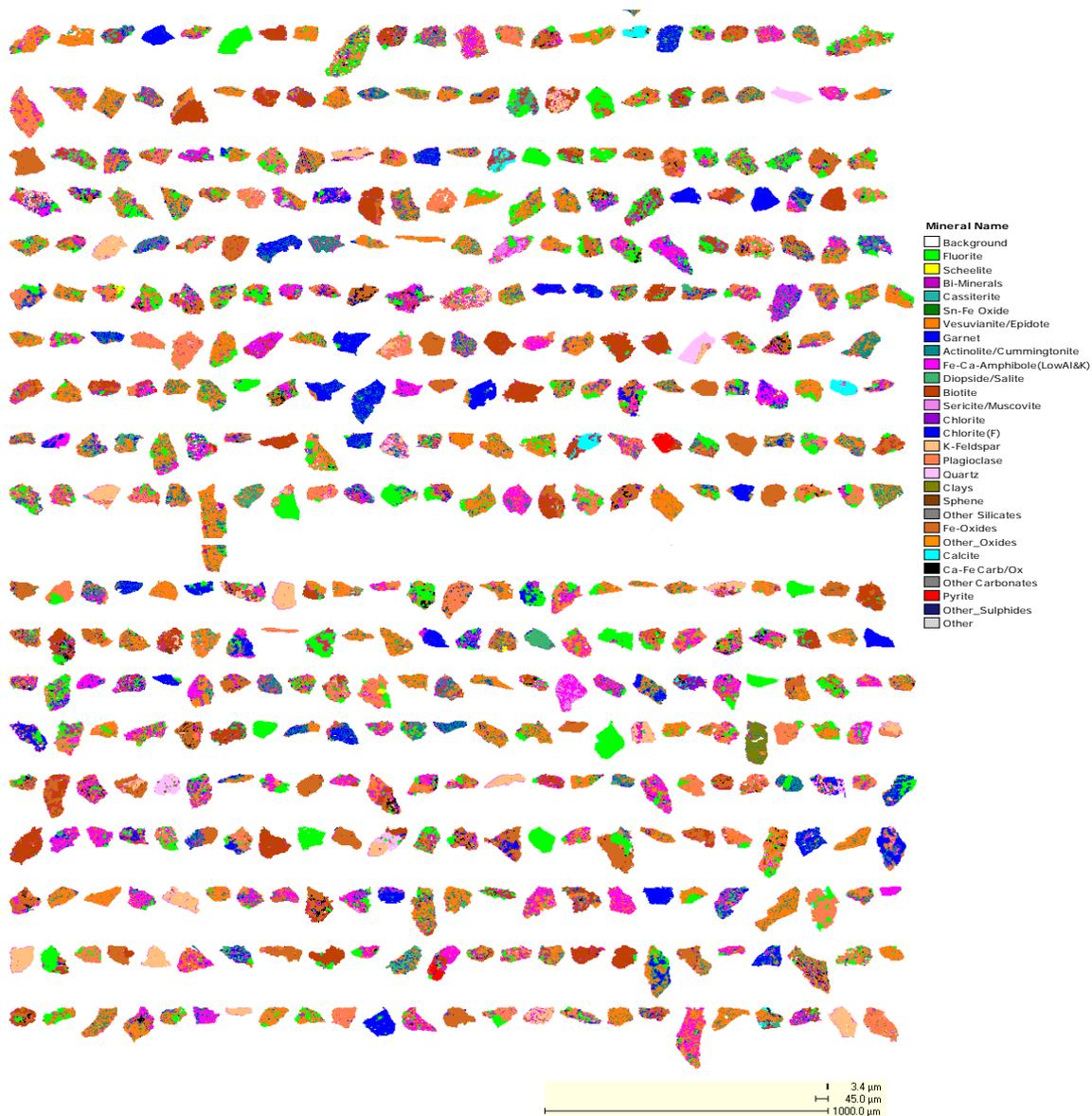


- Mineral Name**
- Background
 - Fluorite
 - Scheelite
 - Bi-Minerals
 - Cassiterite
 - Sn-Fe Oxide
 - Vesuvianite/Epidote
 - Garnet
 - Actinolite/Cummingtonite
 - Fe-Ca-Amphibole(LowAl&K)
 - Diopside/Saite
 - Biotite
 - Sericite/Muscovite
 - Chlorite
 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other Sulphides
 - Other



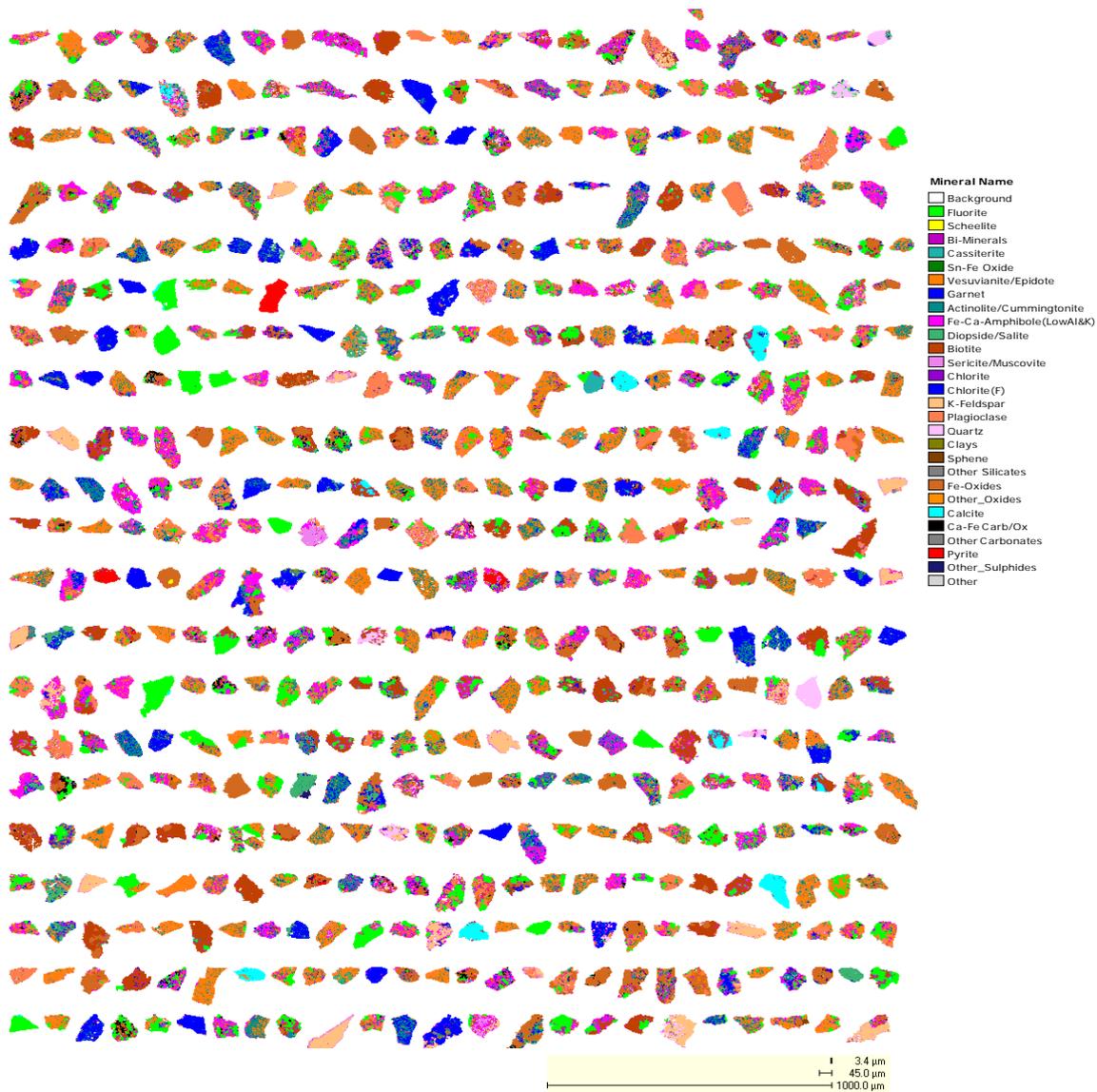
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Particle Maps - +63 µm Size Fraction (Sorted by Size)



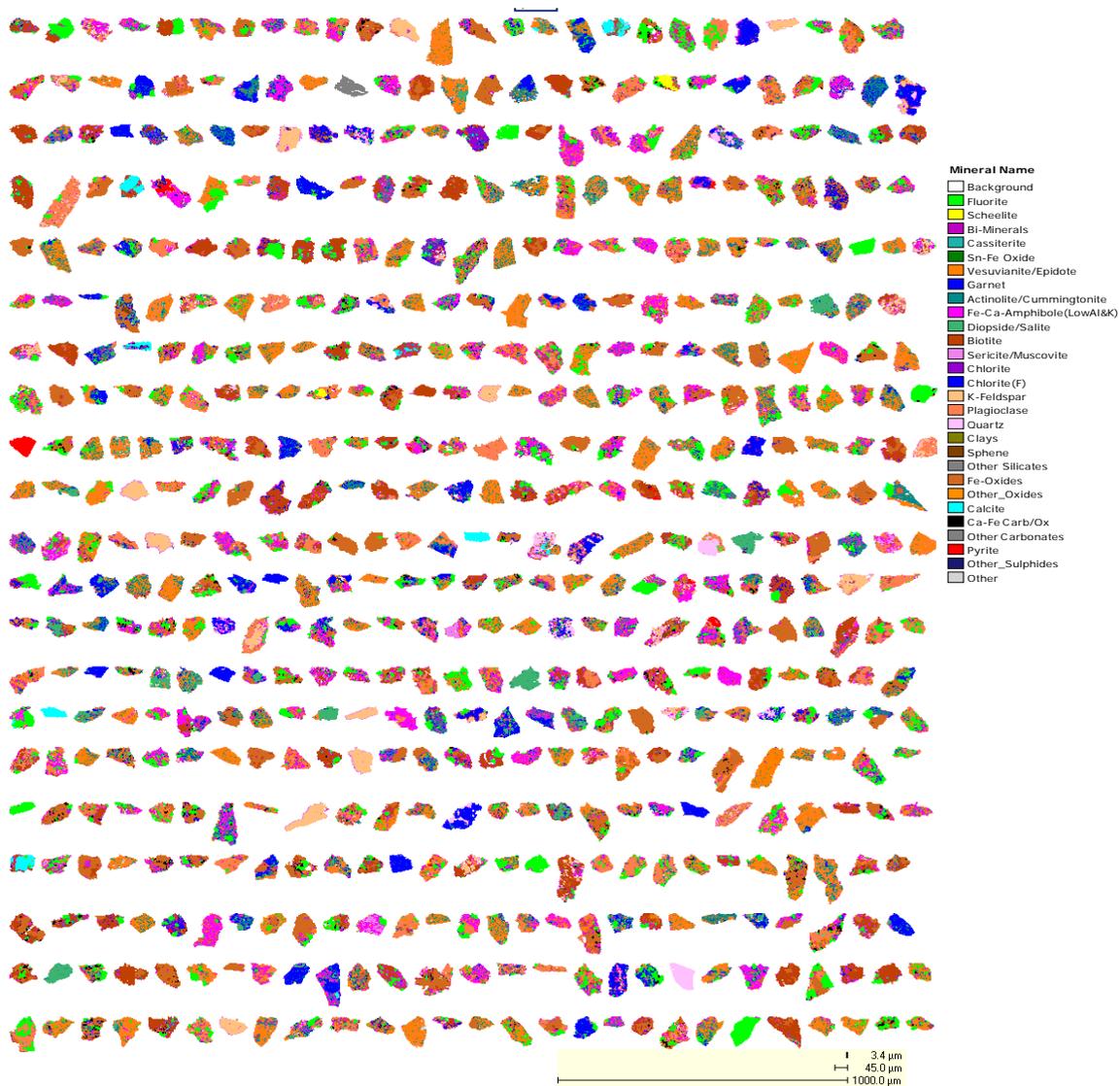
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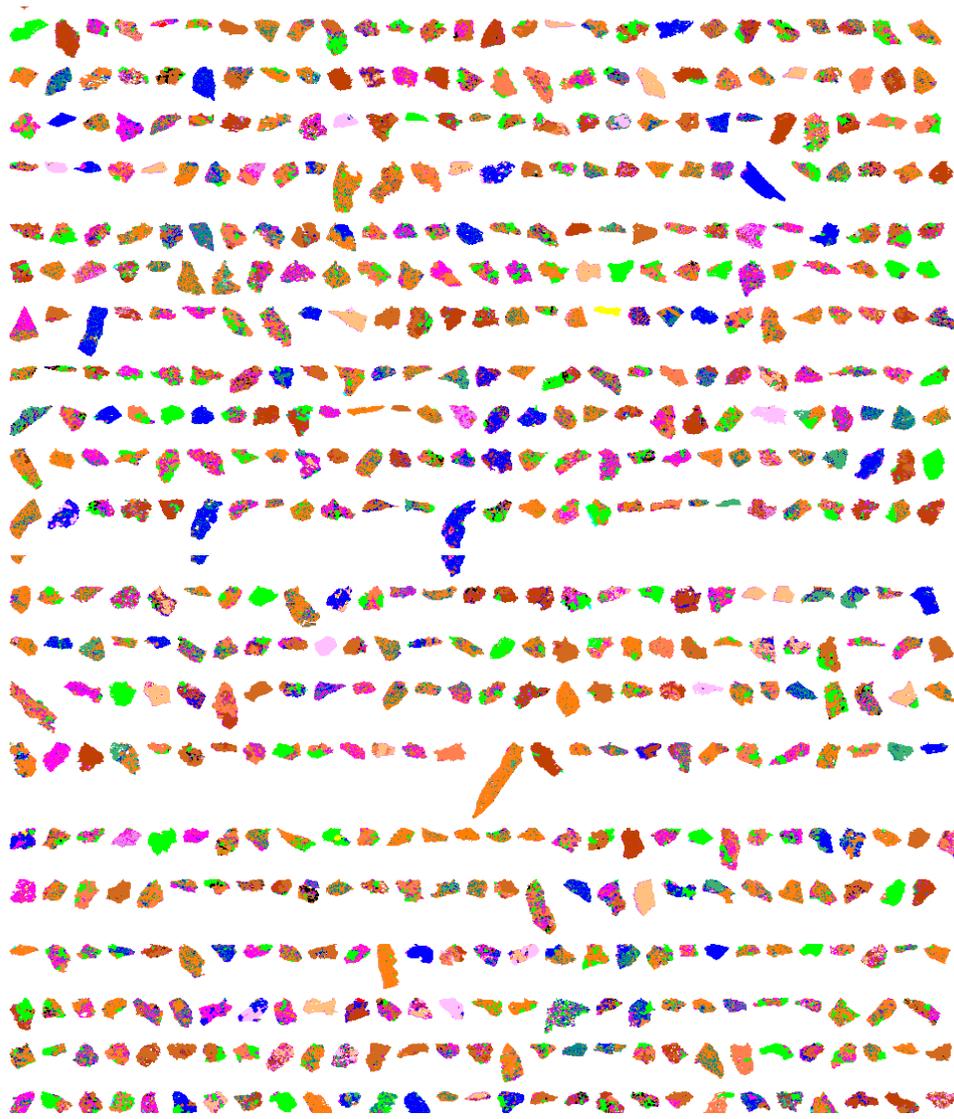
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Particle Maps - +63 µm Size Fraction (Sorted by Size)



Minemakers
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Particle Maps - +63 µm Size Fraction (Sorted by Size)

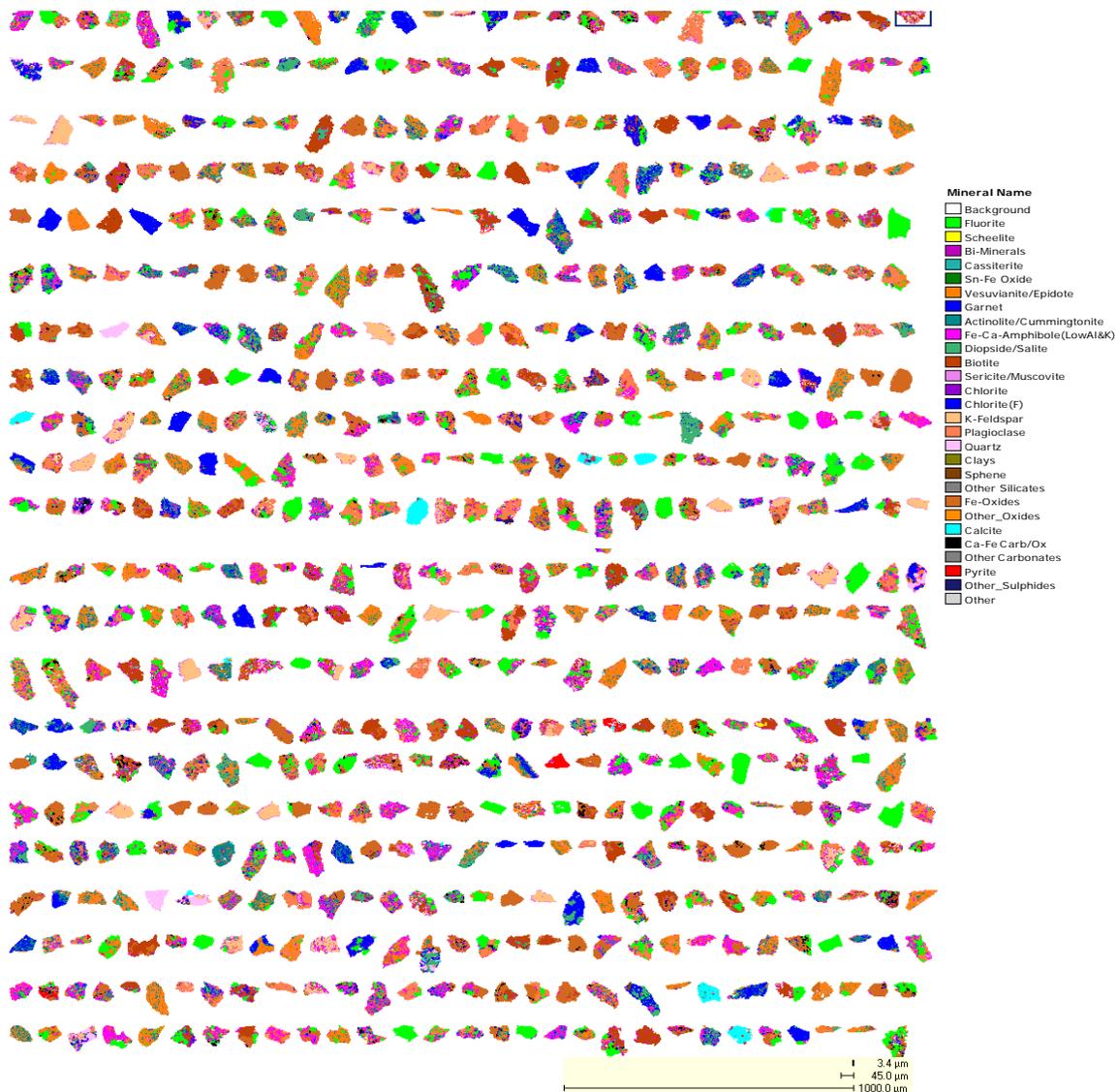


- Mineral Name
- Background
 - Fluorite
 - Scheelite
 - Bi-Minerals
 - Cassiterite
 - Sn-Fe Oxide
 - Vesuvianite/Epidote
 - Garnet
 - Actinolite/Cummingtonite
 - Fe-Ca-Amphibole(LowAl&K)
 - Diopside/Salite
 - Biotite
 - Sericite/Muscovite
 - Chlorite
 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other



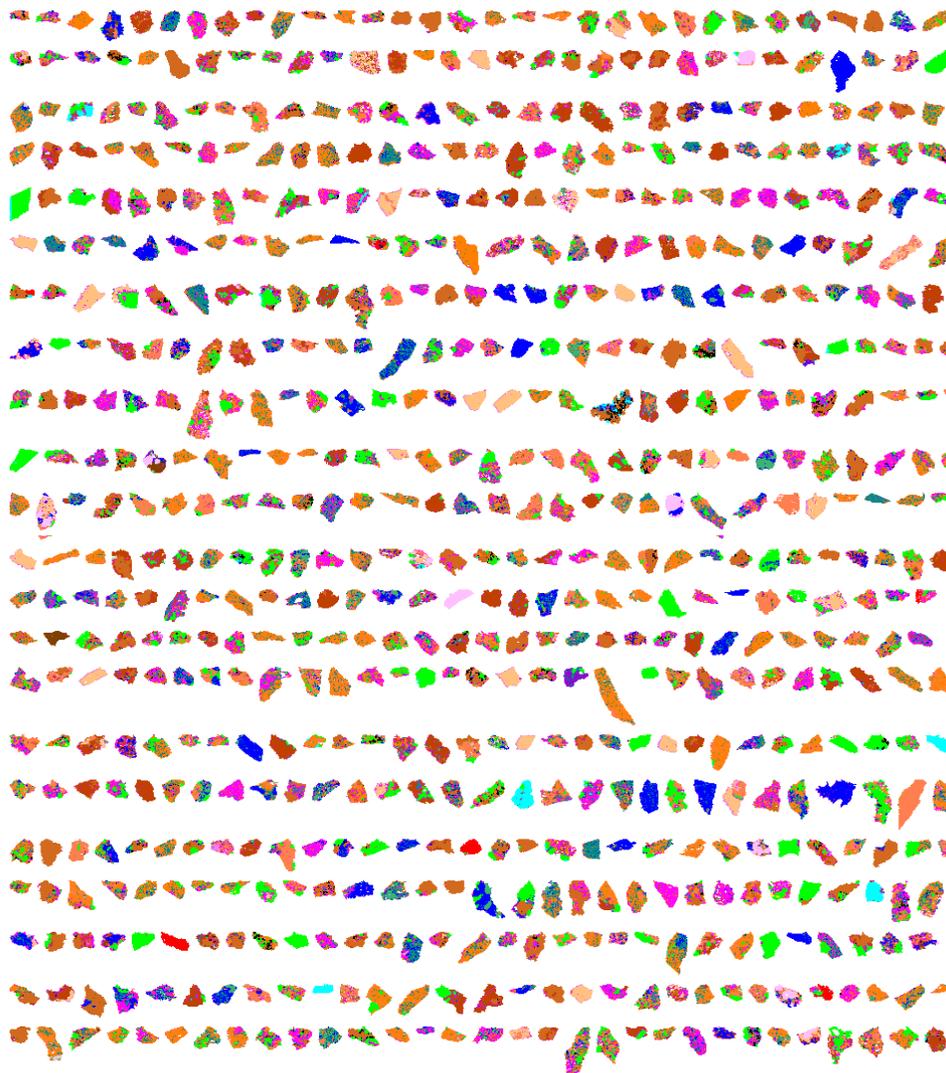
Minemakers
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Particle Maps - +63 µm Size Fraction (Sorted by Size)



Minemakers
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Particle Maps - +63 µm Size Fraction (Sorted by Size)

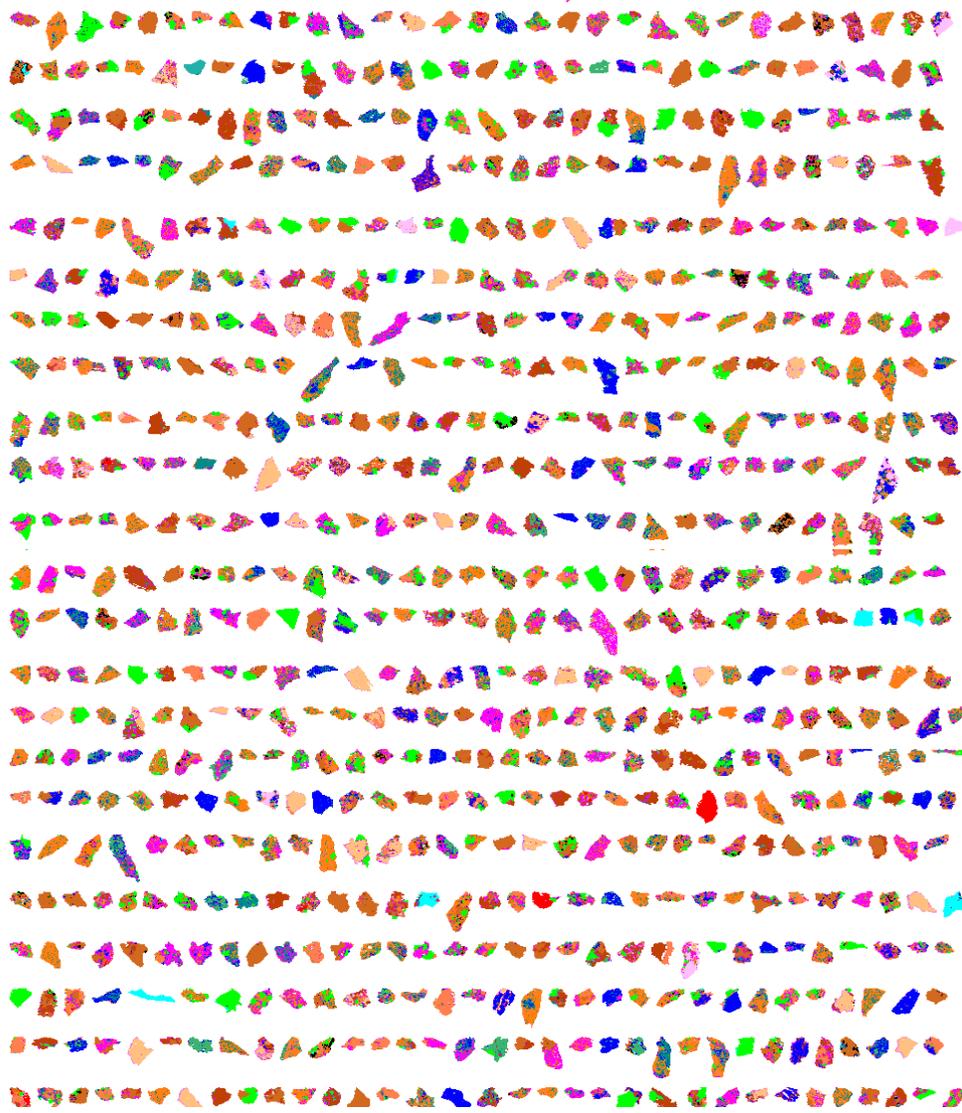


- Mineral Name**
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 - Scheelite
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 - Other_Oxides
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 - Other



Minemakers
12547-001
MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)



- Mineral Name**
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 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other



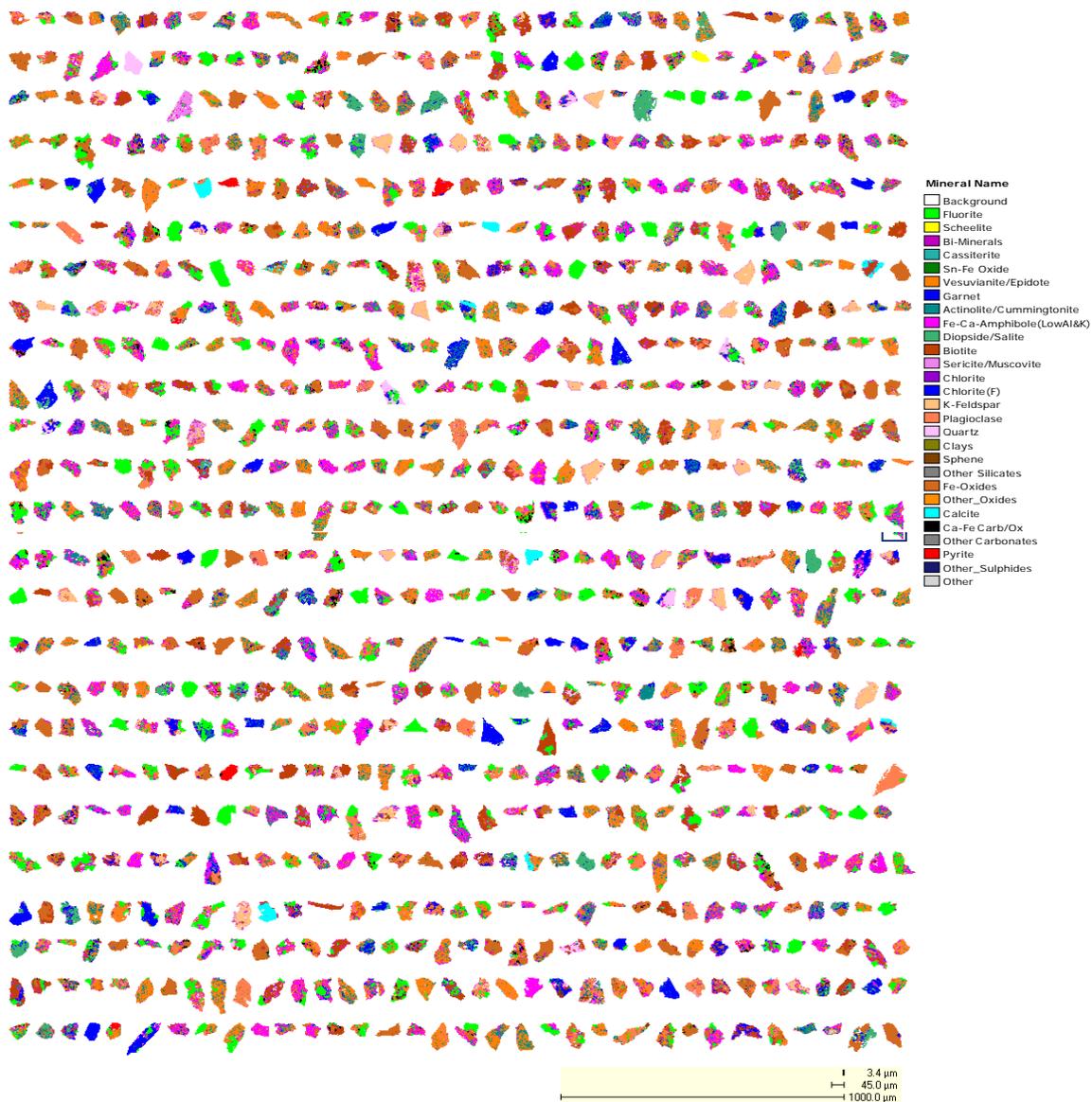
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Particle Maps - +63 µm Size Fraction (Sorted by Size)



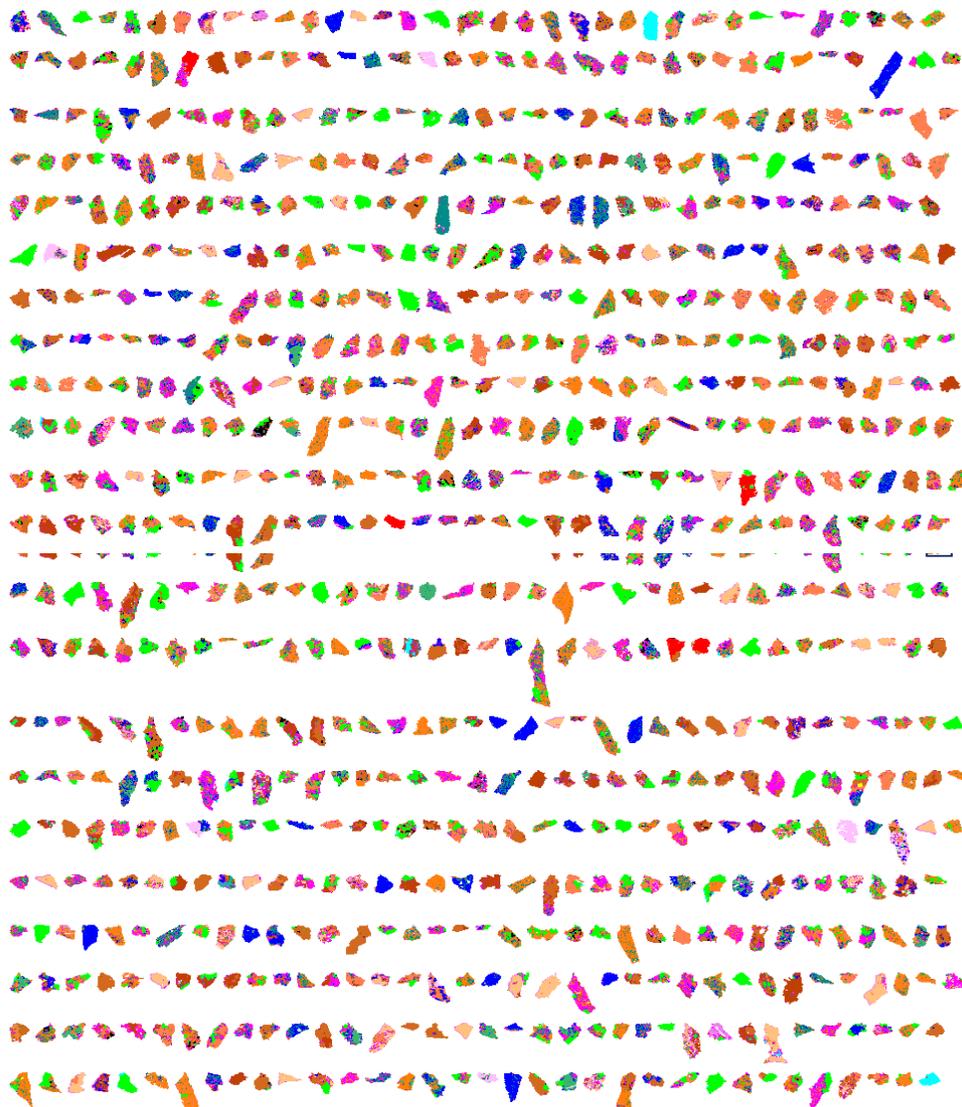
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 M15031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)



Minemakers
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MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)

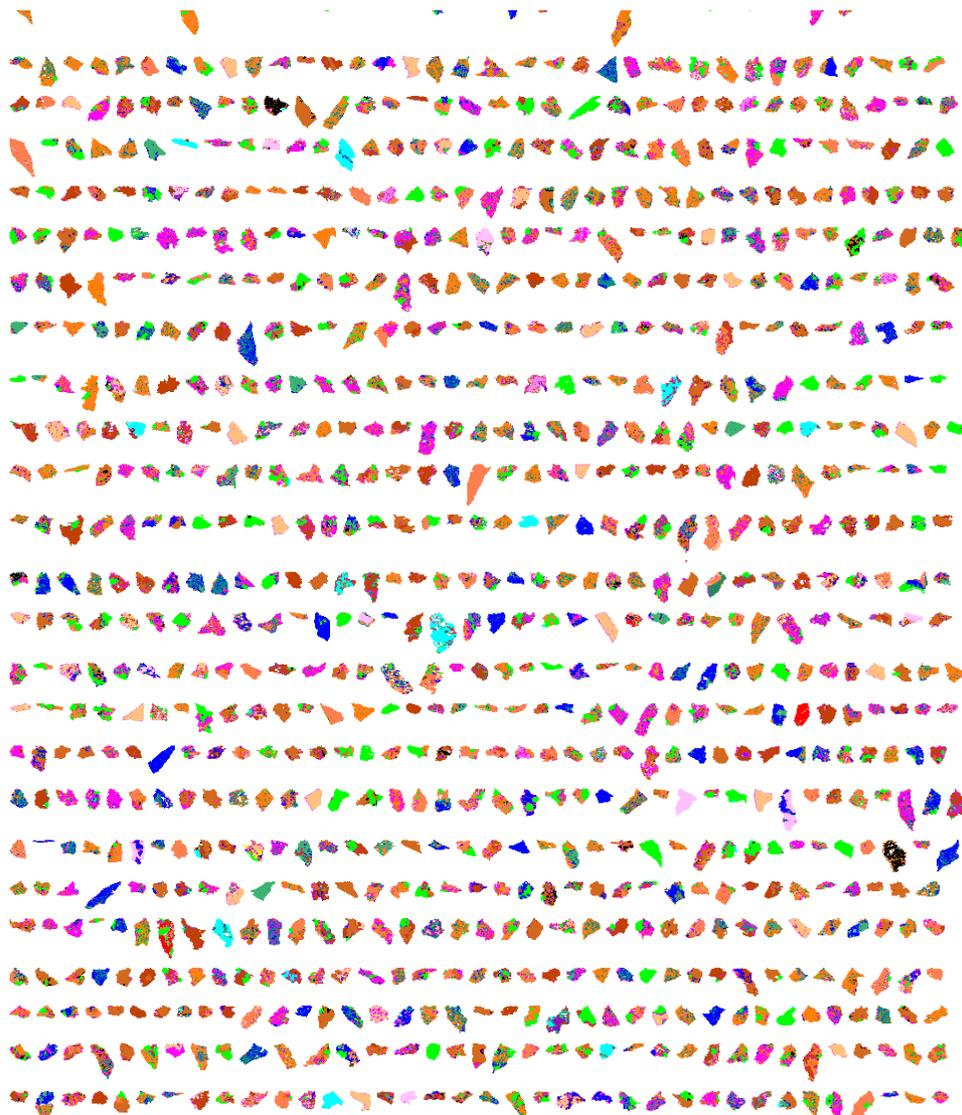


- Mineral Name**
- Background
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 - Scheelite
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 - Cassiterite
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 - Sericite/Muscovite
 - Chlorite
 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other



Minemakers
12547-001
MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)

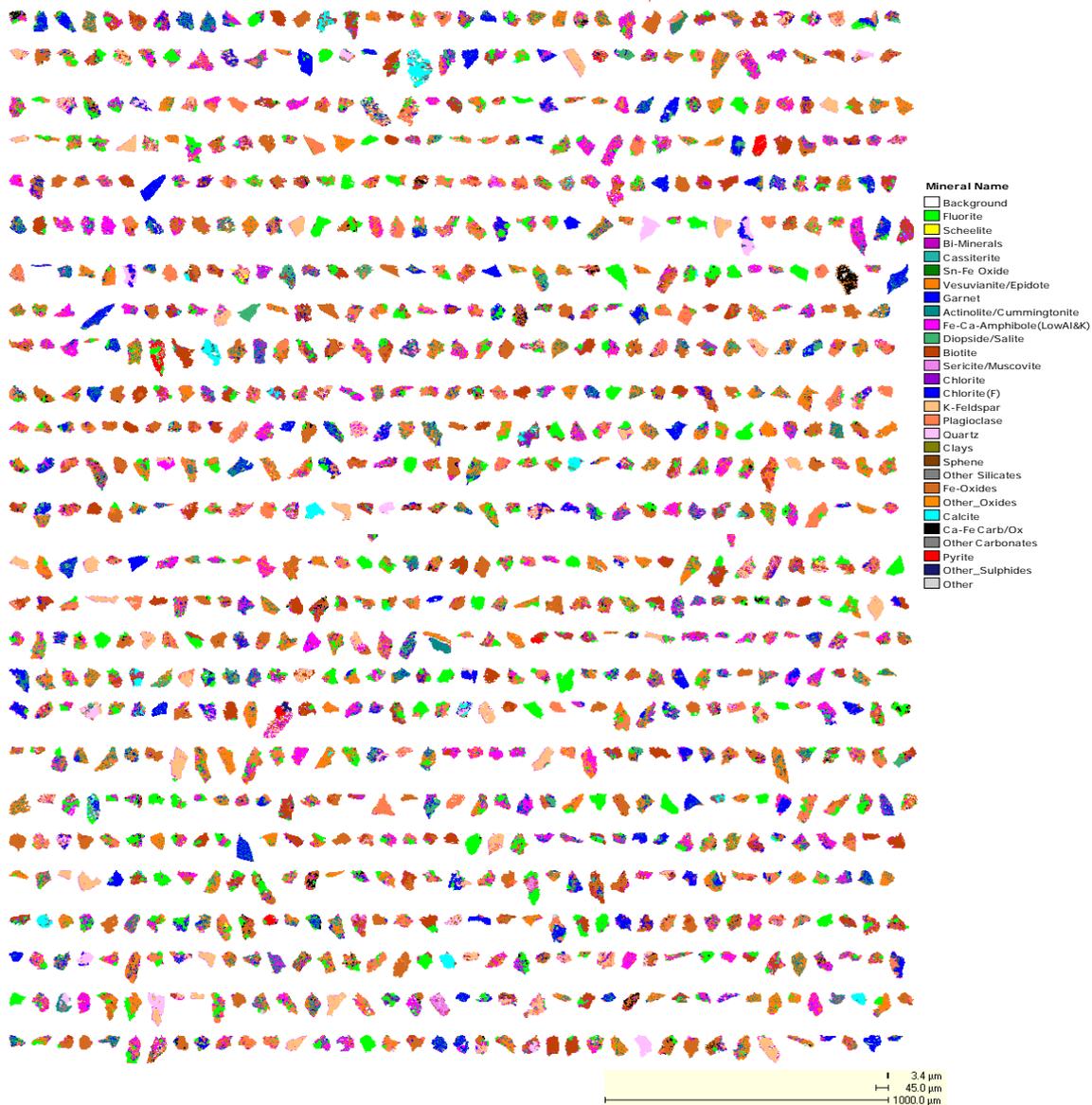


- Mineral Name
- Background
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 - Scheelite
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 - Cassiterite
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 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other



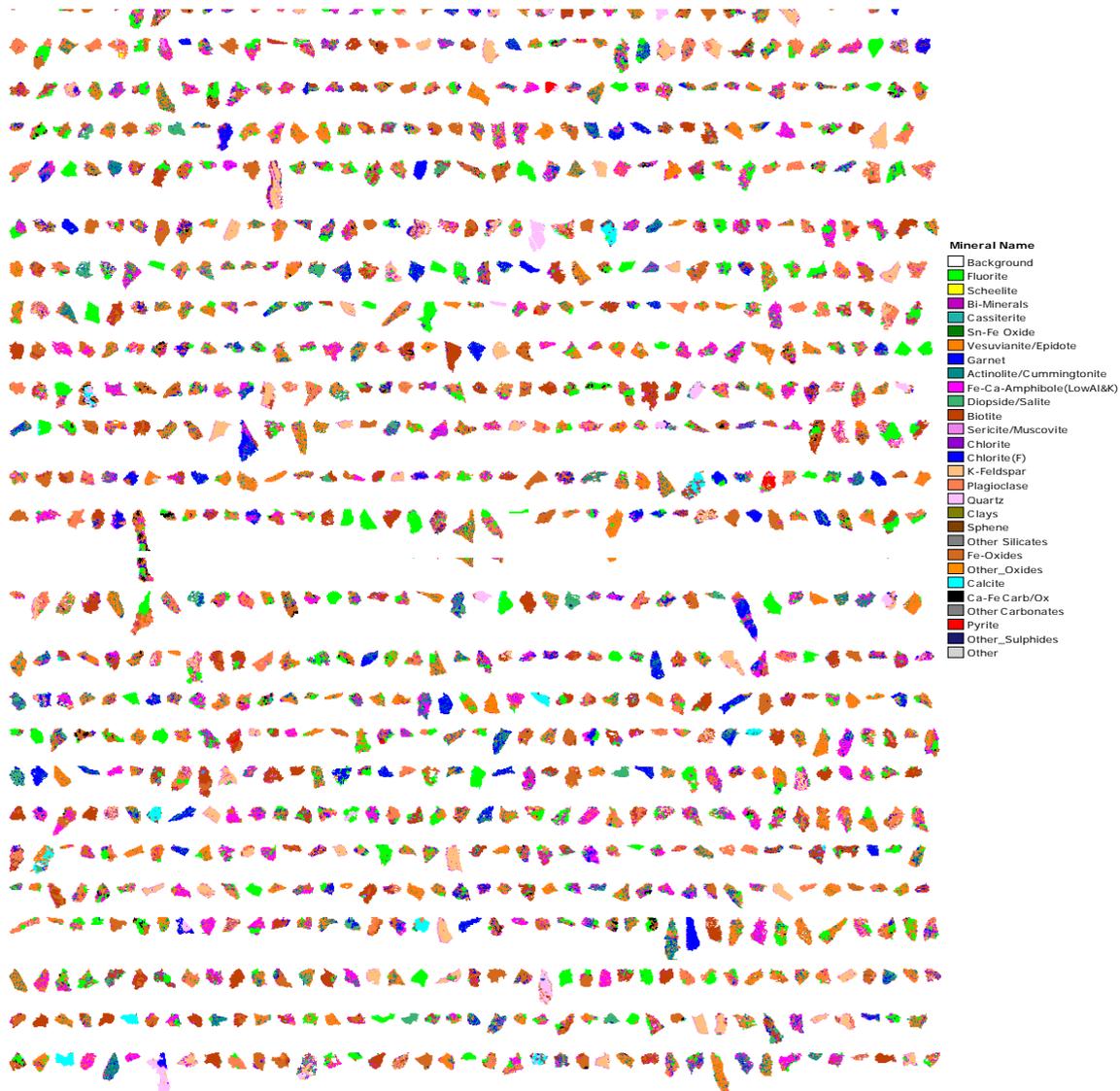
Minemakers
 12547-001
 MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)



Minemakers
12547-001
MI5031-OCT10

Particle Maps - +63 µm Size Fraction (Sorted by Size)



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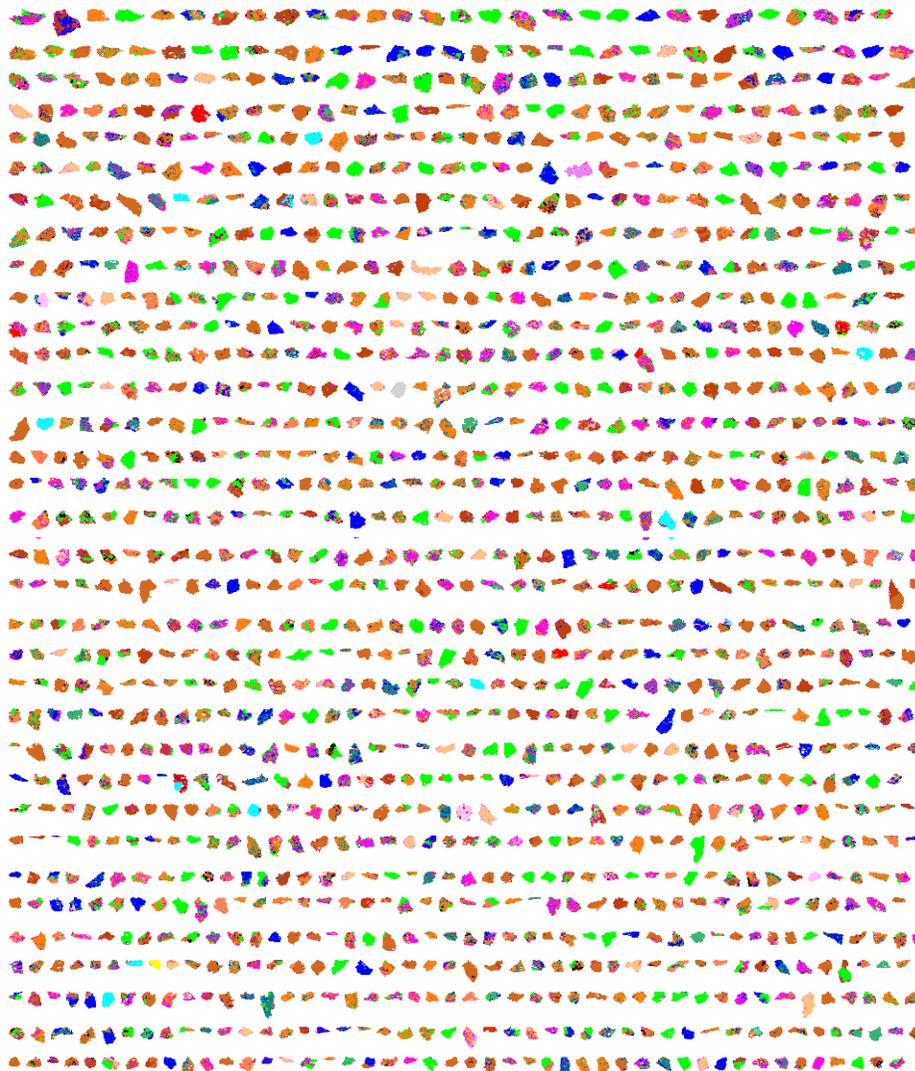
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Minemakers
12547-001
MI5031-OCT10

Particle Maps - +45 µm Size Fraction (Sorted by Size)



- Mineral Name**
- Background
 - Fluorite
 - Scheelite
 - Bi-Minerals
 - Cassiterite
 - Sn-Fe Oxide
 - Vesuvianite/Epidote
 - Garnet
 - Actinolite/Cummingtonite
 - Fe-Ca Amphibole (LowAl&K)
 - Diopside/Saite
 - Biotite
 - Sericite/Muscovite
 - Chlorite
 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other Sulphides
 - Other

I 3.5 µm
H 20.0 µm
425.0 µm

Minemakers
 12547-001
 M15031-OCT10

Particle Maps - +45 µm Size Fraction (Sorted by Size)

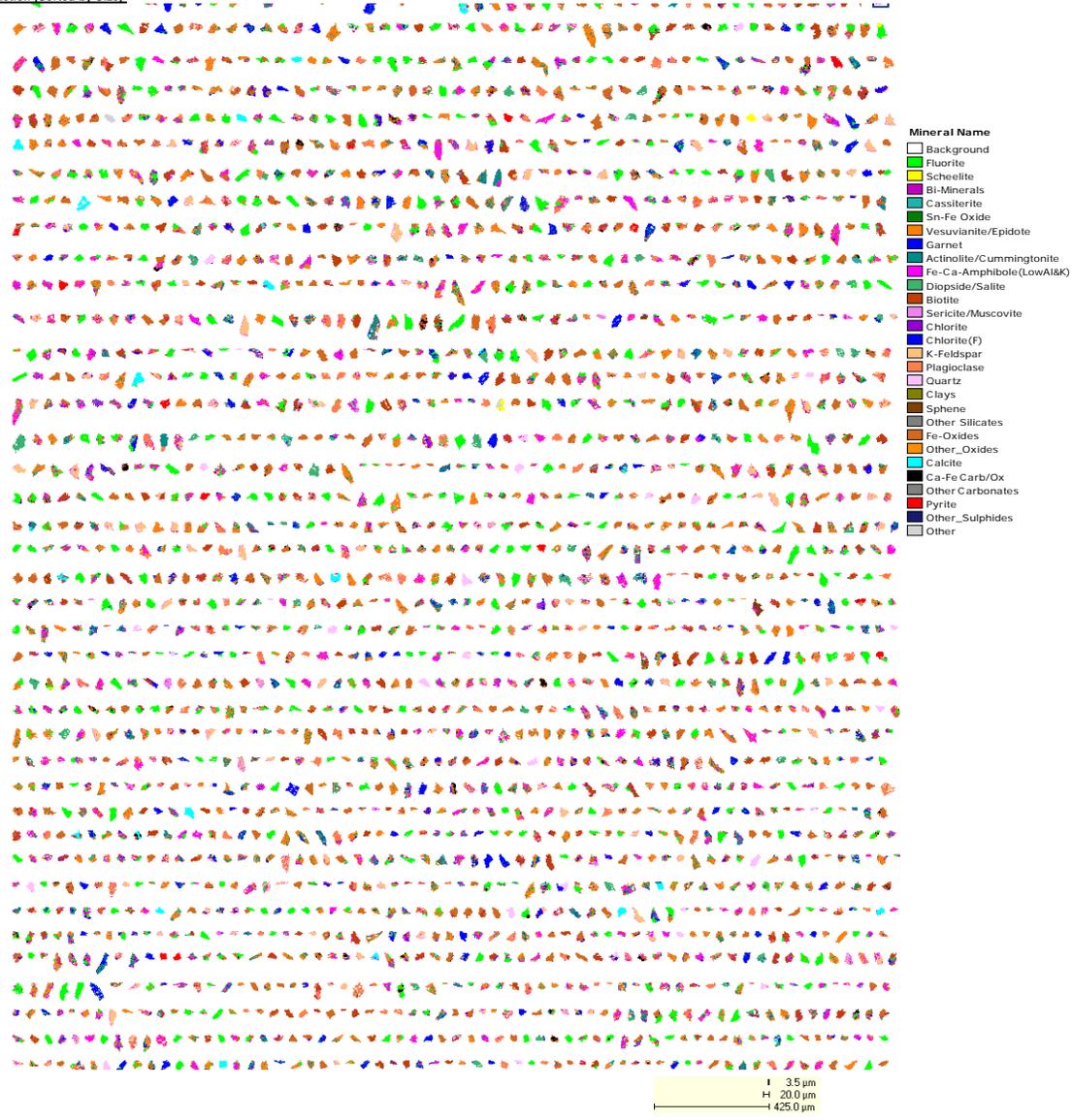


- Mineral Name**
- Background
 - Fluorite
 - Scheelite
 - Bi-Minerals
 - Cassiterite
 - Sn-Fe Oxide
 - Vesuvianite/Epidote
 - Garnet
 - Actinolite/Cummingtonite
 - Fe-Ca-Amphibole (LowAl&K)
 - Diopside/Salite
 - Biotite
 - Sericite/Muscovite
 - Chlorite
 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Spene
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other

L 3.5 µm
 H 20.0 µm
 425.0 µm

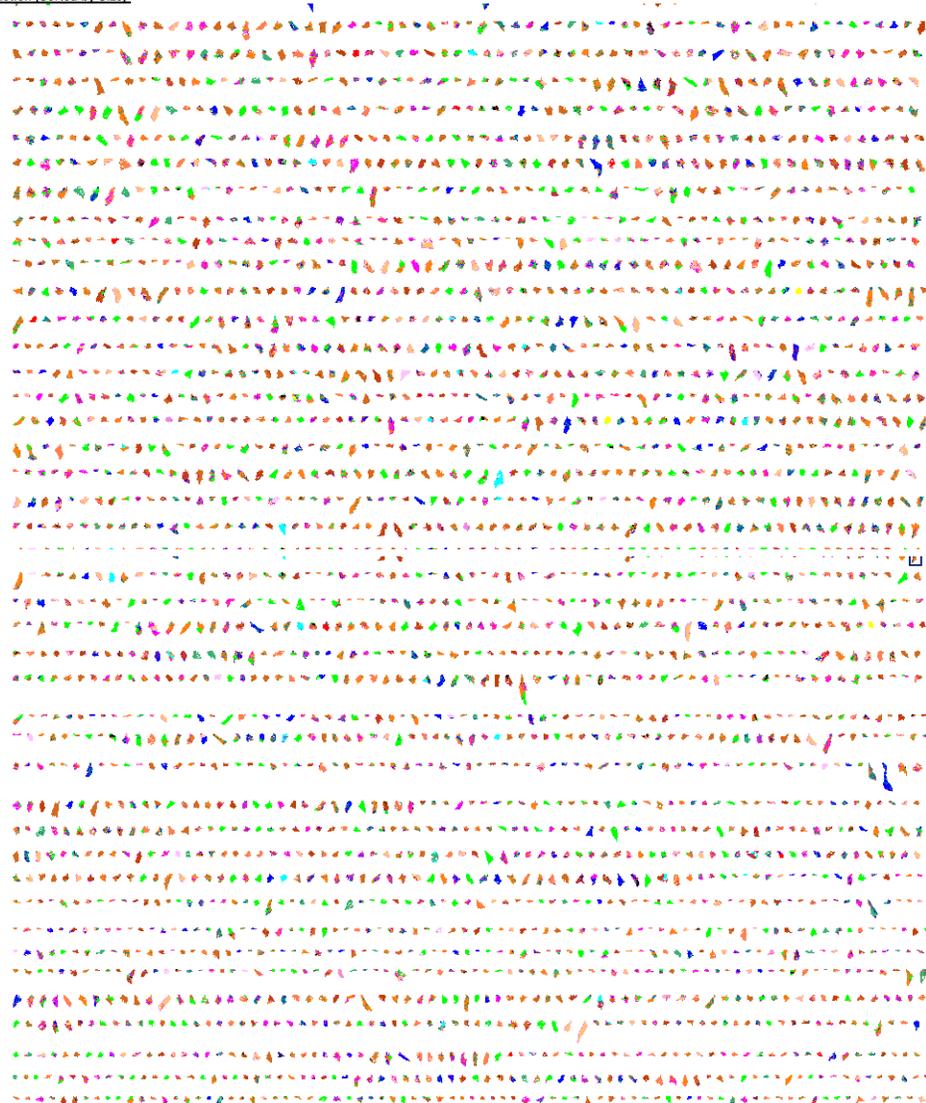
Minemakers
12547-001
MI5031-OCT10

Particle Maps - +45 µm Size Fraction (Sorted by Size)



Minemakers
 12547-001
 MI5031-OCT10

Particle Maps - +45 µm Size Fraction (Sorted by Size)



- Mineral Name**
- Background
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 - Scheelite
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 - Chlorite (F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Spinel
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other

I 3.5 µm
 H 20.0 µm
 425.0 µm

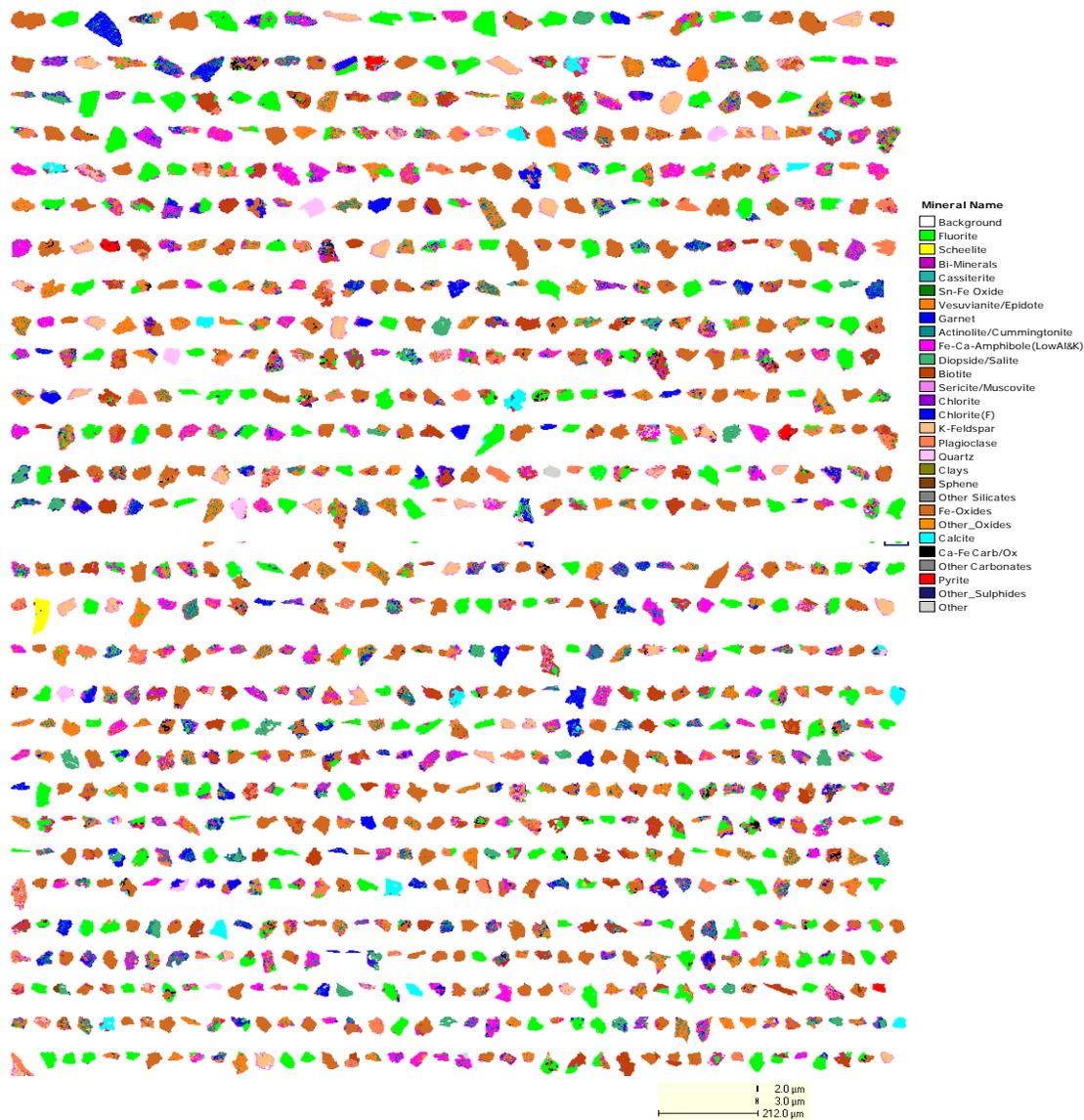
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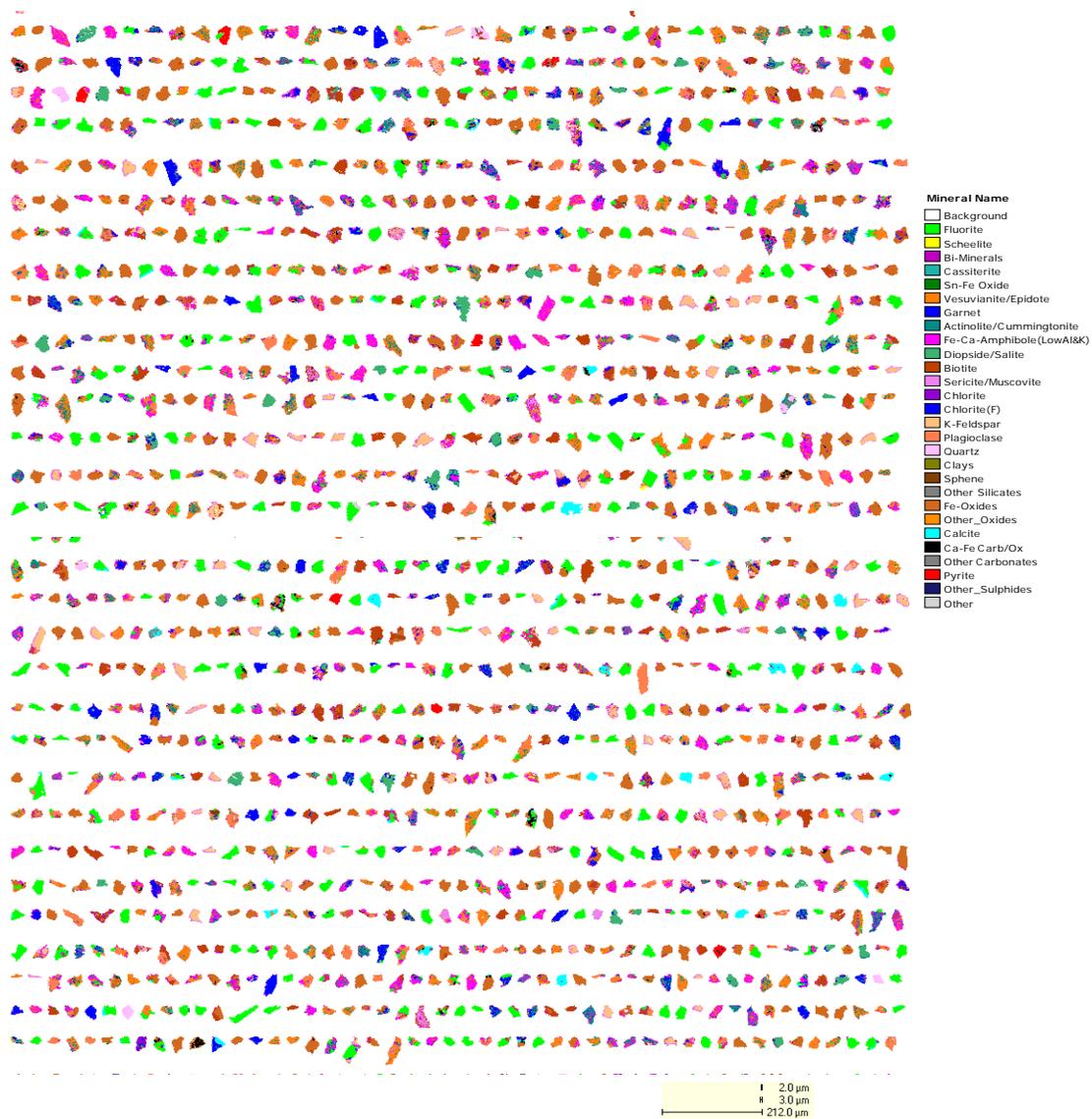
Minemakers
 12547-001
 MI5031-OCT10

Particle Maps - $\lt; 20 \mu\text{m}$ Size Fraction (Sorted by Size)



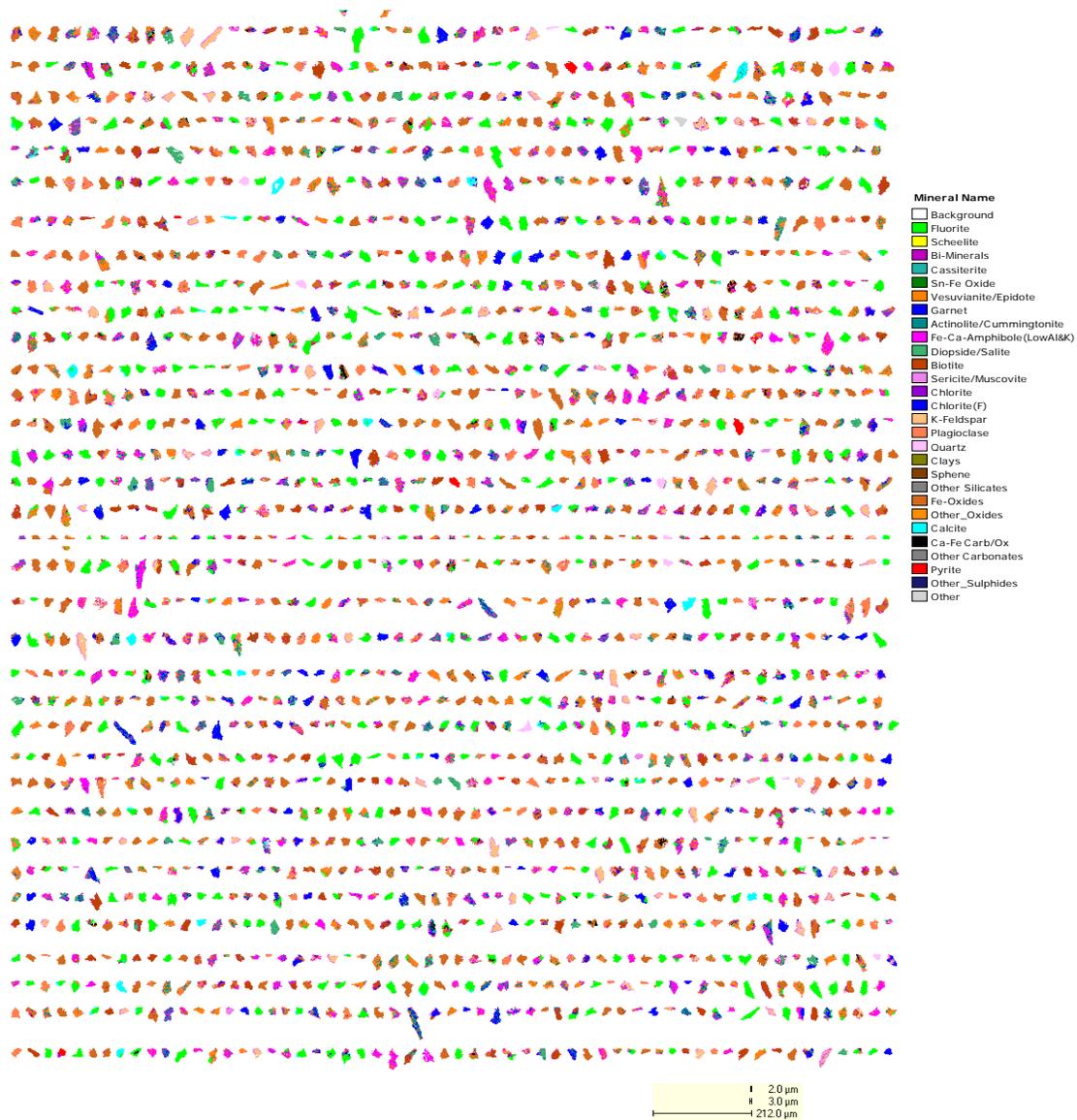
Minemakers
12547-001
MI5031-OCT10

Particle Maps - $\pm 20 \mu\text{m}$ Size Fraction (Sorted by Size)



Minemakers
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Particle Maps - $\lt; 20 \mu\text{m}$ Size Fraction (Sorted by Size)



Minemakers
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Particle Maps - <20 µm Size Fraction (Sorted by Size)



Minemakers
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Particle Maps - 20 µm Size Fraction (Sorted by Size)



Minemakers
12547-001
MI5031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)



Minemakers
12547-001
MI5031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)



Minemakers
12547-001
MI5031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)



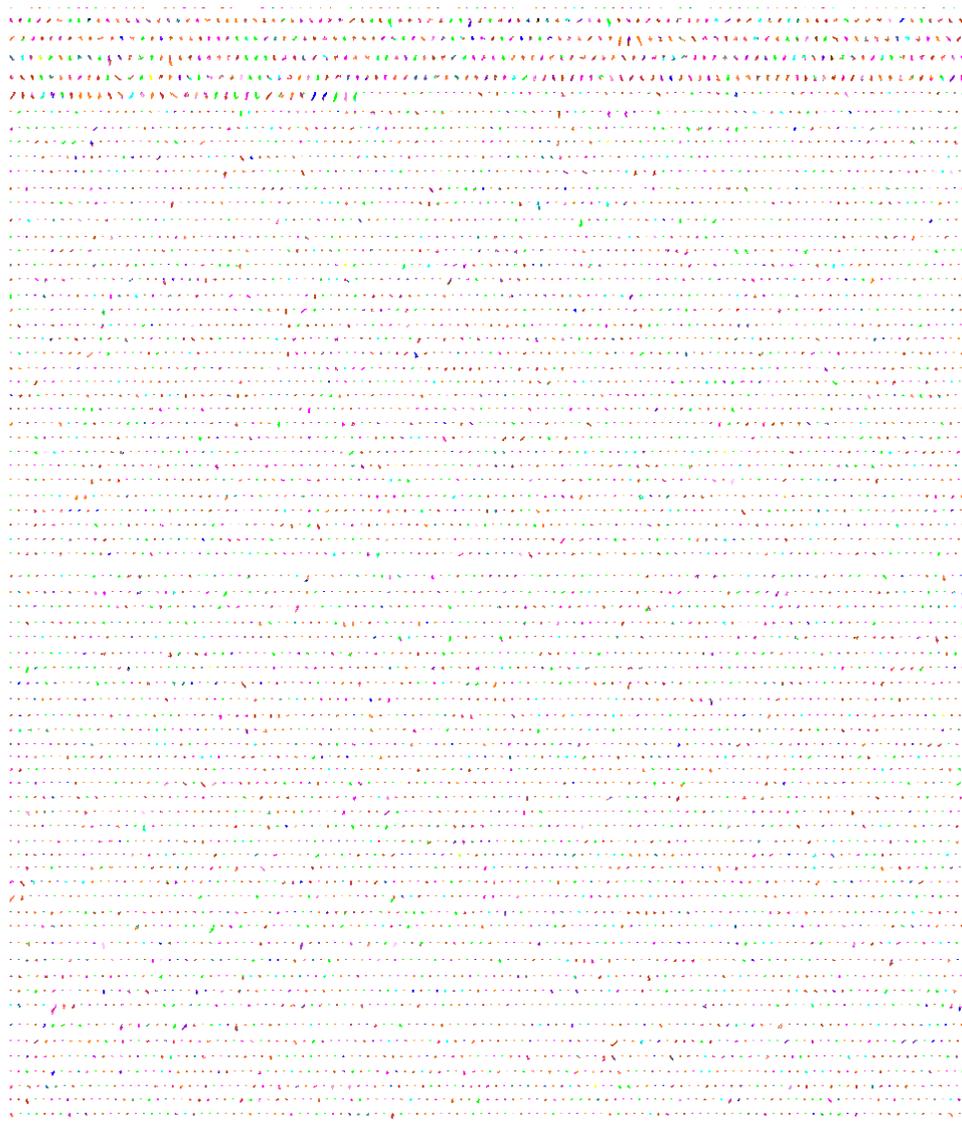
Minemakers
12547-001
M15031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)

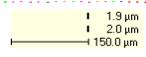


Minemakers
12547-001
M15031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)

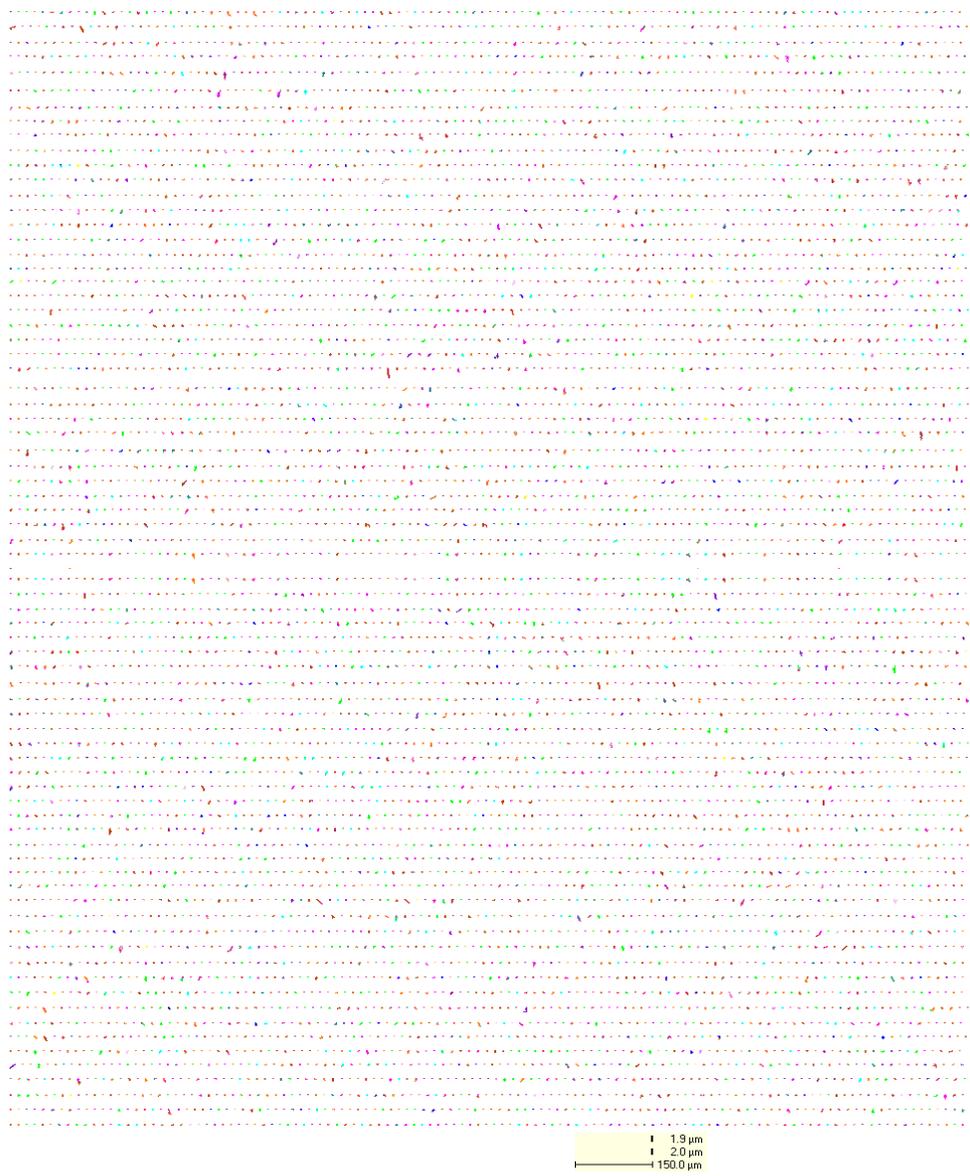


- Mineral Name**
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 - Chlorite
 - Chlorite(F)
 - K-Feldspar
 - Plagioclase
 - Quartz
 - Clays
 - Sphene
 - Other Silicates
 - Fe-Oxides
 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other

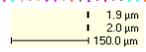


Minemakers
12547-001
M15031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)

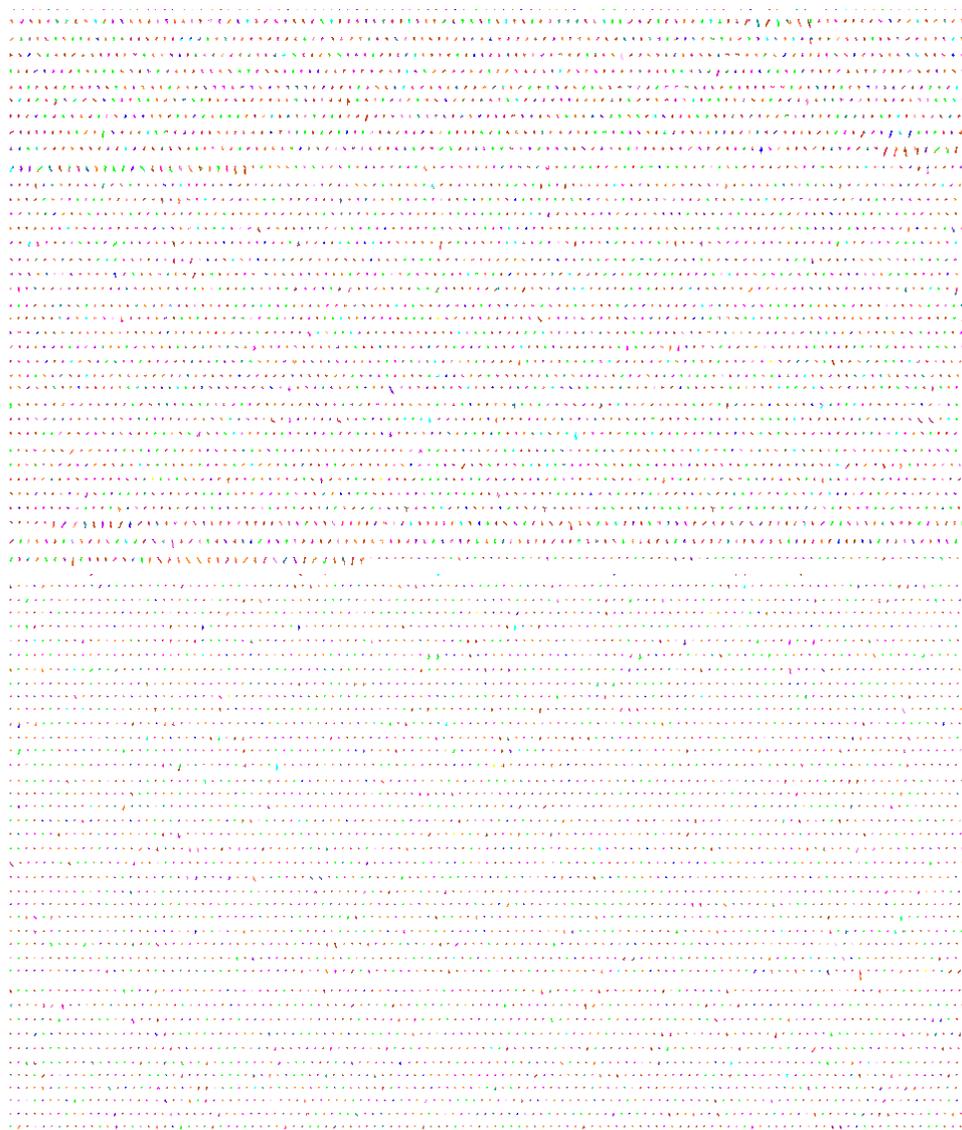


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Minemakers
12547-001
M15031-OCT10

Particle Maps - 20 µm Size Fraction (Sorted by Size)

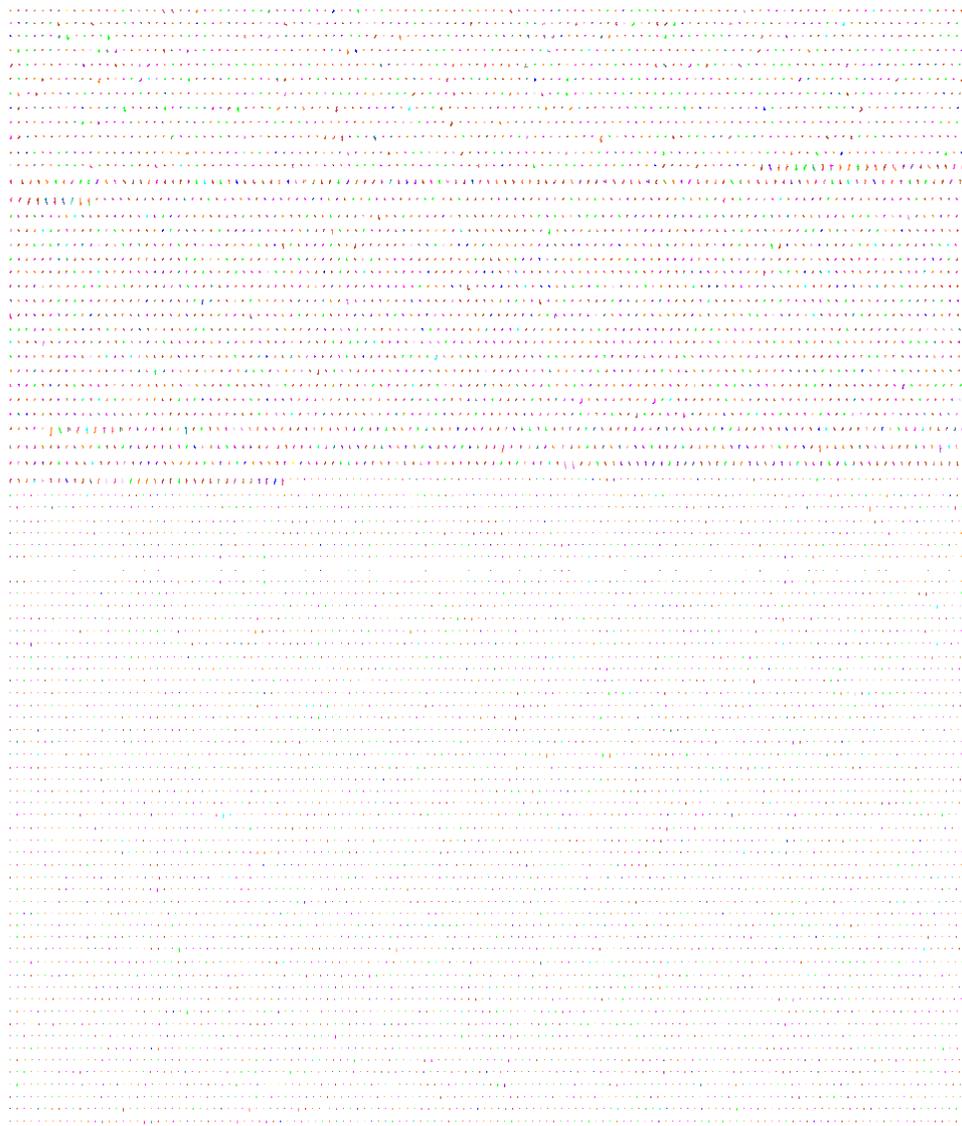


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Minemakers
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Particle Maps - 20 µm Size Fraction (Sorted by Size)



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 - Other_Oxides
 - Calcite
 - Ca-Fe Carb/Ox
 - Other Carbonates
 - Pyrite
 - Other_Sulphides
 - Other



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