Center for Advanced Materials Processing (CAMP)
Montana Technological University (Montana Tech)
1300 West Park Street
Butte, MT 59701
(406) 496-4145

TIMA Mineralogy on Ore

May 27, 2022

Prepared for:
Silver Bullet Mines
Attn: Nick Barr

Table of Contents

List of Tables 3
List of Figures 3
EXECUTIVE SUMMARY 4
Scope of Work (Overview) 6
Mechanical Sieve Analysis 6
TIMA Sample Preparation and Image Analysis 6
TIMA Particle Size Distribution 7
TIMA Modal Mineralogy 8
TIMA-Calculated Elemental Composition 11
Elemental Distribution by Mineral 12
Mineral Grain Size Distribution 13
Mineral Liberation 14
Mineral Associations 18
TIMA Images 19
Ore 19
Elemental Distribution by Mineral per Sieve Fraction 21
Liberation by Sieve Fraction 23
BSE Particle Images 26
Appendix 28

List of Tables

Table 1. Mass distribution..... 6
Table 2. TIMA particle size distribution statistics for the ore sample..... 7
Table 3. Modal mineralogy..... 8
Table 4. Mineralogy by chemical group..... 10
Table 5. TIMA-calculated elemental composition..... 11
Table 6. Silver distribution by mineral (%)..... 12
Table 7. Arsenic distribution by mineral (%)..... 12
Table 8. TIMA particle size distribution statistics for the silver sulfosalts, acanthite, arsenopyrite, scorodite and sewardite (μm)..... 13
Table 9. Mineral associations for the Ore..... 18
Table 10. Silver distribution by sieve fraction for the Ore..... 21
Table 11. Arsenic distribution by sieve fraction for the Ore..... 22
Table 12. Ore modal mineralogy by size fraction..... 28

List of Figures

Figure 1. TIMA particle size distribution of the ore sample..... 7
Figure 2. Grain size distributions for acanthite, Ag sulfosalts and arsenopyrite of the Ore sample..... 13
Figure 3. Mineral liberation by volume..... 14
Figure 4. Graphical liberation of the silver sulfosalts by volume..... 15
Figure 5. Graphical liberation of acanthite by volume..... 16
Figure 6. Graphical liberation of arsenopyrite by volume..... 17
Figure 7. False color TIMA image from the Ore..... 19
Figure 8. BSE image from the Ore..... 20
Figure 9. Ag-Sulfosalts liberation by volume per sieve fraction..... 23
Figure 10. Acanthite liberation by volume per sieve fraction..... 24
Figure 11. Arsenopyrite liberation by volume per sieve fraction..... 25
Figure 12. Acanthite and pearceite rimming quartz in voids in sphalerite (A), pearceite with galena (B) and argentiferous bornite associated with arsenopyrite and galena (C)..... 26
Figure 13. BSE image (A) and elemental map (B), showing the distribution of silver (green) arsenic (red) and lead (blue) in the sulfide grain hosted in quartz..... 27

EXECUTIVE SUMMARY

The Center for Advanced Materials Processing (CAMP) received one (1) ore sample for automated mineralogical analysis.

The as-received sample was dry and wet sieved using 50, 100, 200 and 400 US mesh screens. The specimens were analyzed by the automated mineralogical technique, Tescan Integrated Mineralogical Analysis (TIMA). TIMA uses scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDS) to quantitatively determine the mineralogy of the specimens. The modal mineralogy is derived by using the mineralogical content from analysis of each fraction, weighted by the mass distribution from the mechanical sieve analysis.

The ore sample was composed of 95% silicates (88% quartz, 6% muscovite and 1% others) and approximately 4% sulfides that included 1.8% arsenopyrite, 1.1% sphalerite, 0.7% pyrite, 0.2-0.3% silver sulfosalts and sulfides and 0.11% galena. Oxides/hydroxides, carbonates and others were collectively less than approximately 1%.

Silver occurred primarily as sulfosalts, with argentiferous tetrahedrite the predominant phase. Miargyrite, pyrargyrite, pearceite, diaphorite and zoubekite were some of the additional sulfosalts encountered. The sulfosalts accounted for approximately 85% of the silver in the ore. Acanthite was a minor silver carrier as were the argentiferous copper sulfides and mixed oxide phases that contained highly variable amounts of lead, antimony, arsenic and silver.

Arsenopyrite was the primary arsenic carrier, accounting for 86% of the total arsenic. Scorodite and sewardite were two of the more common oxide arsenic phases in the ore, but several other arsenic oxide phases were noted.

The TIMA-calculated silver content was 0.16% and arsenic was 2.1%.

Liberation improved with decreasing particle size for the silver sulfosalts, acanthite and arsenopyrite. The +400 and -400 mesh fractions indicated a great improvement in liberation over the coarser fraction for these minerals. Approximately 63% of the total silver and 46% of the total arsenic occurred in these sieve fractions. An additional 24% of the arsenic was determined to be in the +50 mesh fraction.

The silver sulfosalts and acanthite were associated with arsenopyrite. The amount of liberated particles of each mineral was approximately one-third or more.

Gary F. Wyss
Laboratory/Equipment Specialist
May 27, 2022

Qualifying Statement

This confidential report was prepared for Nick Barr (Silver Bullet Mines) and is based on information available at the time of the report preparation. It is believed the information, estimates, conclusions and recommendations contained herein are reliable under the conditions and subject to the qualifications set forth. Furthermore, the information, estimates, conclusions and recommendations are based on the experience of CAMP and data supplied by others, but the actual result of the work is dependent, in part, on factors over which CAMP has no control.

Scope of Work (Overview)

After the sample was wet-sieved, transverse polished particle epoxy mounts were prepared for modal mineralogy. Automated mineral analysis by scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDS) was conducted on all specimens using TESCAN's Integrated Mineral Analysis (TIMA) software. The specimens were also manually examined by SEM-EDS "spot" analysis to confirm the elemental chemistry and to verify mineralogical analysis and mineral associations.

Mechanical Sieve Analysis

The sample was wet-sieved through 100, 200, 400 and 500 US mesh screens. The mass distribution for the sieved material used for data reduction of the TIMA analysis are presented in **Table 1**.

Table 1. Mass distribution

Sieve Fraction (US mesh)	Ore (As-analyzed) (%)
+50	28.3
+100	22.8
+200	19.7
+ 400	11.7
-400	17.5
Total	100

TIMA Sample Preparation and Image Analysis

Cross-sectional (transverse) particle mounts were prepared from each sieve fraction. The sieved material was blend with carbon to disperse the particles, mixed with epoxy and poured into cubic forms. Once cured, the cubic specimens were vertically sectioned to generate a representative cross-sectional specimen, to account for preferential settling of the particles during curing of the epoxy. The cross-sectional specimens were then placed in a 30 mm cylindrical mold (face down) and set in epoxy once again. Once cured, the cylindrical epoxy particle mounts were ground with silicon carbide abrasive pads, polished with alumina suspensions and conductively coated with carbon for TIMA analysis and manual SEM-EDS examination. The TIMA phase/mineralogical analysis is an SEM-EDS-based method where the phases are differentiated (segmented) based on their gray level intensity in the backscattered electron (BSE) image. Simultaneously, X-ray spectra are gathered by energy dispersive spectroscopy (EDS) from the specimen at points in a grid-like manner, at a spacing prescribed by the operator. Phase

identification is achieved by a spectral identification protocol derived from a phase-specific X-ray profile and elemental intensity selection rules for qualitative mineral identification. The surface area data and density for the individual phases are used to generate weight percentage data for quantification.

TIMA Particle Size Distribution

The TIMA-determined particle size distribution P_{80} (the size of the aperture through which 80% of the particles will pass) was 310 µm and the median was 117 µm for the ore sample. The distribution is plotted in **Figure 1** and the statistics are tabulated in **Table 2.**

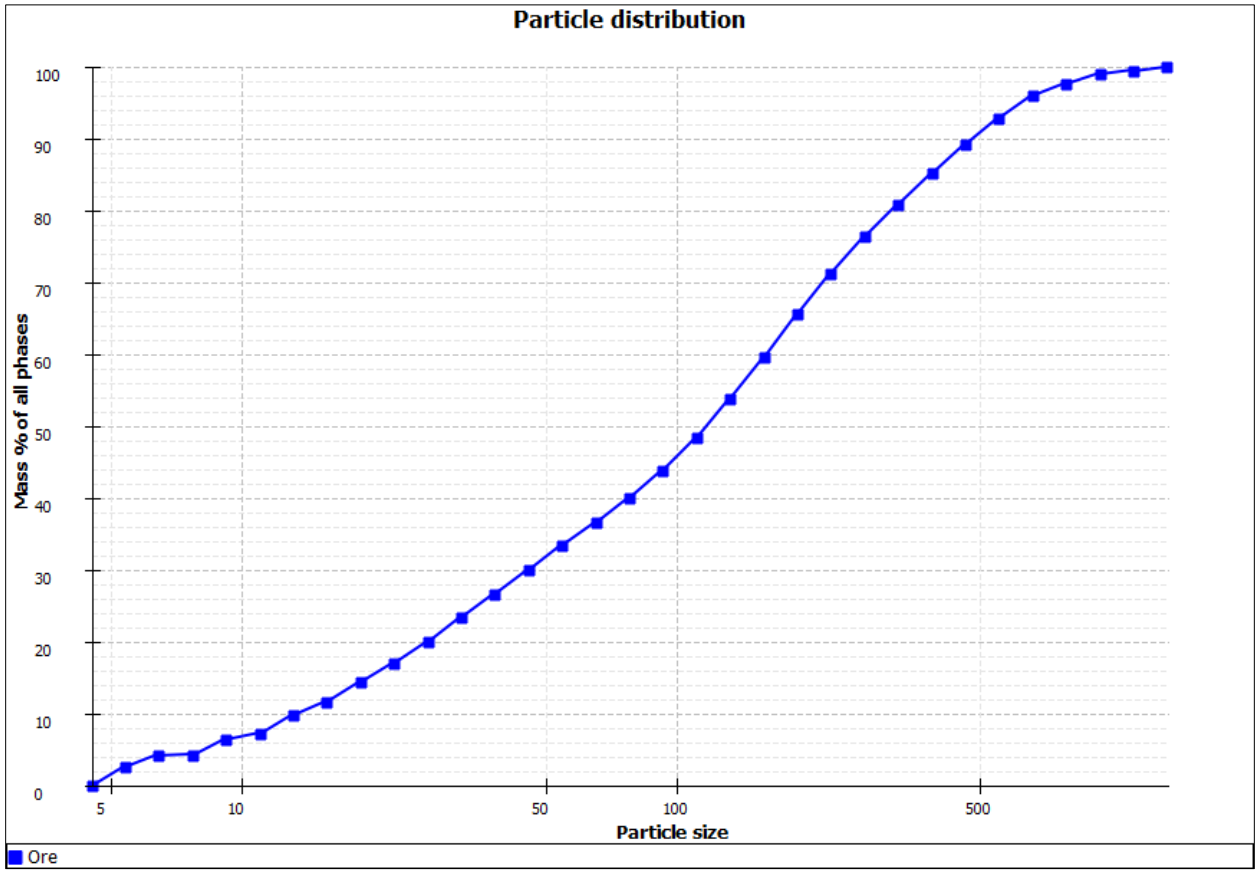

Figure 1. TIMA particle size distribution of the ore sample.

Table 2. TIMA particle size distribution statistics for the ore sample

Sample	Ore (µm)
Median	117
P_{80}	310

TIMA Modal Mineralogy

The primary silver minerals of interest in the ore were the silver sulfosalts, with the most common being argentiferous tetrahedrite that had an approximate silver content of 20% Ag. Other silver sulfosalts encountered were miargyrite, pyrargyrite and diaphorite. Undistinguished alteration phases of lead-antimony-arsenic also harbored minor and trace amounts of silver. Acanthite occurred at 0.01% often associate with the sulfosalts.

Arsenopyrite was the primary arsenic mineral at 1.83%. Numerous altered/oxidized phases of arsenic were identified with scorodite (0.20%) and sewardite (0.13%) the most common.

The sulfides sphalerite, pyrite and galena were present at 1.2%, 0.69% and 0.11%, respectively.

Gangue mineralogy was comprised mainly of quartz (88%) and muscovite (5.9%). Iron oxides were found at 0.30%

Numerous other minor and trace minerals were identified and their modal amounts are tabulated in **Table 3**.

Table 3. Modal mineralogy

Mineral	**Formula**	**Ore (Wt. %)**
Quartz	SiO_2	88.2
Muscovite	$KAl_2(Si_3Al)O_{10}(OH)_2$	5.92
Arsenopyrite	**FeAsS**	**1.83**
Sphalerite	ZnS	1.19
Pyrite	FeS_2	0.69
K-Feldspar	$KAlSi_3O_8$	0.55
Hematite/Magnetite	Fe_2O_3/Fe_3O_4	0.30
Ag Sulfosalts	**Ag(Sb,As,Zn,Cu)S**	**0.25**
Scorodite	$FeAsO_4 . 2H_2O$	0.20
Sewardite	$CaFe_2(AsO_4)(OH)_2$	0.13
Galena	PbS	0.11
Biotite	$K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH)_2$	0.09
Lead-Iron Antimony Arsenate	Pb,Fe(Sb,AsO)	0.06
Arsenbrackebuschite	$Pb_2(Fe,Zn)(AsO_4)_2(OH,H_2O)$	0.06
Mimetite	$Pb_5(AsO_4)_3Cl$	0.05
Bindheimite	$Pb_2Sb_2O_6(O,OH)$	0.05
Tsumcorite	$Pb(Zn,Fe)_2(AsO_4)_2(OH,H_2O)_2$	0.04
Bornite	Cu_5FeS_4	0.02
Hemimorphite	$Zn_4Si_2O_7(OH) . H_2O$	0.02
Lead Argento-arseno-antimonide	**(Pb,Ag)(As,Sb)O**	**0.02**
Pyroxenes	$(Ca,Mg,Fe)_2Si_2O_6$	0.01
Spinel	$(Fe,Mg)(Cr,Al)_2O_4$	0.01

Mineral	Formula	Ore (Wt. %)
Monimolite	$(Pb,Ca)_3Sb_2O_8$	0.01
Amphiboles	$Ca_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$	0.01
Acanthite	**Ag_2S**	**0.01**
Kaolinite	$Al_2Si_2O_5(OH)_2$	0.01
Chlorite	$(Fe,Mg)_5Al(Si_3Al)O_{10}(OH)_8$	0.01
Arsendescloizite	$PbZn(AsO_4)(OH)$	0.01
Rutile	TiO_2	0.01
Albite	$NaAlSi_3O_8$	P
Tetrahedrite	$(Cu,Fe,Zn)_{12}(Sb,As)_4S_{13}$	P
Calcite	$CaCO_3$	P
Anorthoclase	$(K,Na)AlSi_3O_8$	P
Chalcopyrite	CuFeS2	P
Monazite	$(Ce,La,Nd)PO_4$	P
Dolomite	$CaMg(CO_3)_2$	P
Zircon	$ZrSiO_4$	P
Apatite	$Ca5(PO4)_3(OH,F)$	P
Plagioclase	$(Ca,Na)(Al)_{1-2}Si_{2-3}O_8$	P
CuS-Ag	**(Cu,Ag)S**	**P**
Andalusite	Al_2SiO_5	P
Covellite	CuS	P
Chalcocite	Cu_2S	P
Barite	$BaSO_4$	P
Molybdenite	MoS_2	P
Garnet	$(Fe,Ca,Mg)_3(Fe,Al)(SiO_4)_3$	P

P = Present at less than 0.01%
ND = Not detected

The ore sample contained 0.26% silver minerals in the form of sulfides and sulfosalts with total sulfides at 4.2%. Total arsenic-bearing minerals were 2.3% comprised of arsenopyrite and oxidized arsenic phases.

The non-sulfide gangue mineralogy was 95% silicates that included 6.0% phyllosilicates, 3.9% oxides, 0.8% and 0.06% of carbonates and others. The mineralogy by chemical group is shown in **Table 4**.

Table 4. Mineralogy by chemical group

Chemical Group	**Ore (Wt. %)**
Total Silicates	**94.8**
Silicates	88.8
Phyllosilicates	6.02
Total Sulfides	**4.17**
Total As Minerals	**2.26**
Arsenopyrite	1.83
Misc. As Minerals	0.43
Ag Sulfosalts + Acanthite	**0.26**
Misc. Sulfides	2.08
Oxides/hydroxides	0.39
Carbonates, Sulfates, Phosphates + Others	0.06

TIMA-Calculated Elemental Composition

Silver was 0.16% and arsenic was 2.1% according to TIMA-calculated values (**Table 5**).

Total sulfur was calculated at 2.3%.

Table 5. TIMA-calculated elemental composition

Elements	**Ore (%)**
Oxygen	48.1
Silicon	40.3
Iron	2.69
Sulfur	2.29
Arsenic	**2.09**
Aluminum	1.35
Zinc	1.15
Potassium	0.70
Lead	0.67
Silver	**0.16**
Antimony	0.13
Fluorine	0.06
Copper	0.04
Hydrogen	0.03
Calcium	0.03
Magnesium	0.02
Titanium	0.01
Chlorine	P
Zirconium	P
Cerium	P
Phosphorus	P
Sodium	P
Carbon	P
Barium	P
Molybdenum	P
Lanthanum	P
Neodymium	P
Tin	P

P = Present at less than 0.01%, ND = Not detected

Elemental Distribution by Mineral

The silver sulfosalts (mainly argentiferous tetrahedrite) accounted for 85% of the total silver with acanthite providing 13% and minor amounts from the alteration phases of lead-antimony-arsenic and substitution in the copper sulfides as shown in **Table 6**.

Table 6. Silver distribution by mineral (%)

Mineral	**Ore**
Ag Sulfosalts	85.0
Acanthite	13.1
Lead Argento-arseno-antimonides	1.8
Covellite-Ag	0.1
Total Silver (Wt.%)	0.16

Arsenic was predominantly found as arsenopyrite which accounted for 86% of the total arsenic. Scorodite and sewardite contained a combined 8% of the total arsenic. Several other phases also contributed to the arsenic in the ore and are presented in **Table 7**.

Table 7. Arsenic distribution by mineral (%)

Mineral	**Ore**
Arsenopyrite	86.2
Scorodite	4.1
Sewardite	4.0
Arsenbrackebuschite	1.3
Lead-Iron Antimony Arsenate	1.1
Ag Sulfosalts	1.1
Mimetite	1.1
Tsumcorite	0.9
Lead Argento-arseno-antimonide	0.2
Arsendescloizite	0.1
Total Arsenic (Wt.%)	2.09

Mineral Grain Size Distribution

Arsenopyrite was the most coarsely-grained mineral listed in **Table 8** with a grain size distribution P_{80} of 94 µm and a median of 48 µm. Scorodite and sewardite had P_{80}'s of 72 µm and 63 µm, respectively. The silver sulfosalts' P_{80} was 38 µm and acanthite was 14 µm. The grain size differences are evident in the grain size distribution plot in **Figure 2**.

Table 8. TIMA particle size distribution statistics for the silver sulfosalts, acanthite, arsenopyrite, scorodite and sewardite (µm)

Sample	Acanthite	Ag Sulfosalts	Arsenopyrite	Scorodite	Sewardite
Median	10	19	48	30	36
P_{80}	14	38	94	72	63

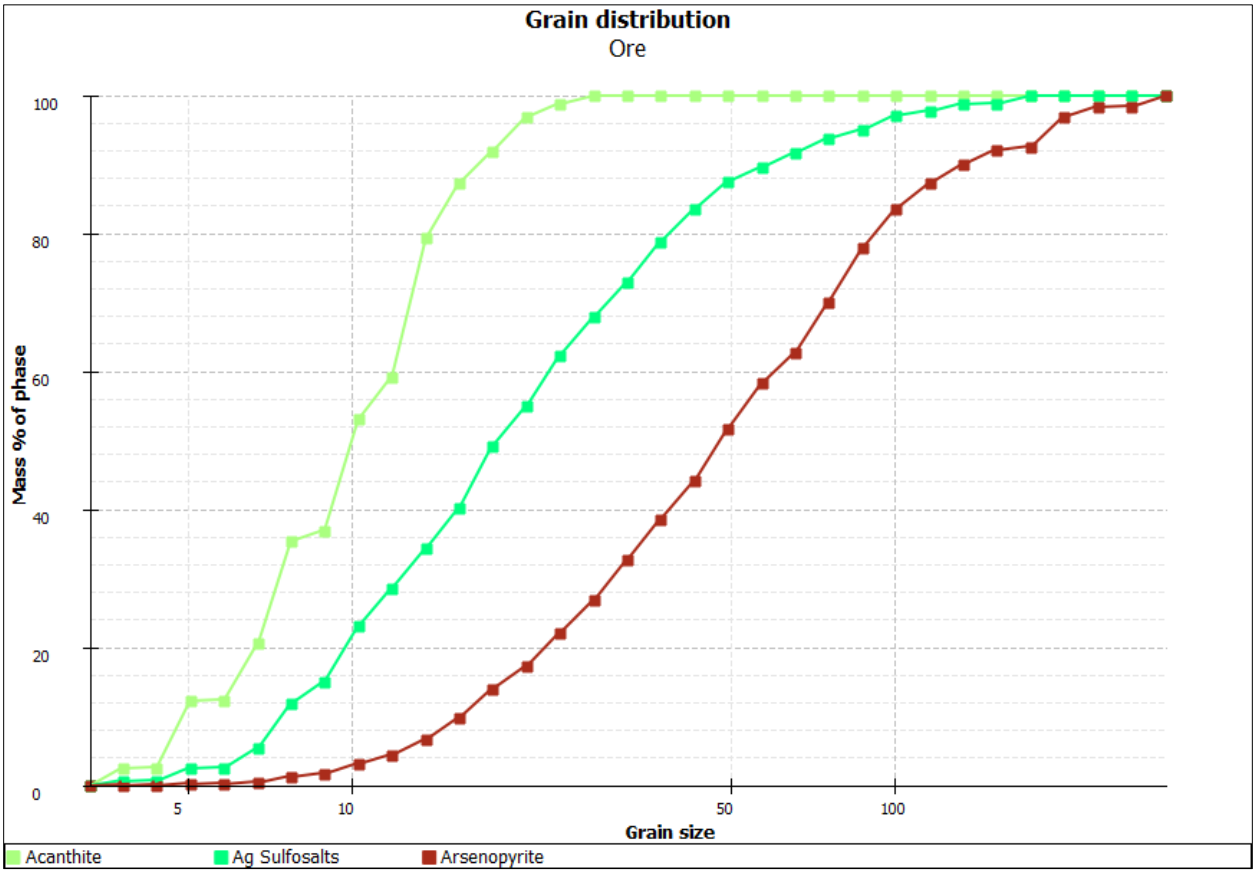

Figure 2. Grain size distributions for acanthite, Ag sulfosalts and arsenopyrite of the Ore sample.

Mineral Liberation

Mineral liberation was nearly identical between the silver sulfosalts and arsenopyrite. Acanthite was more poorly liberated as shown in **Figure 3**.

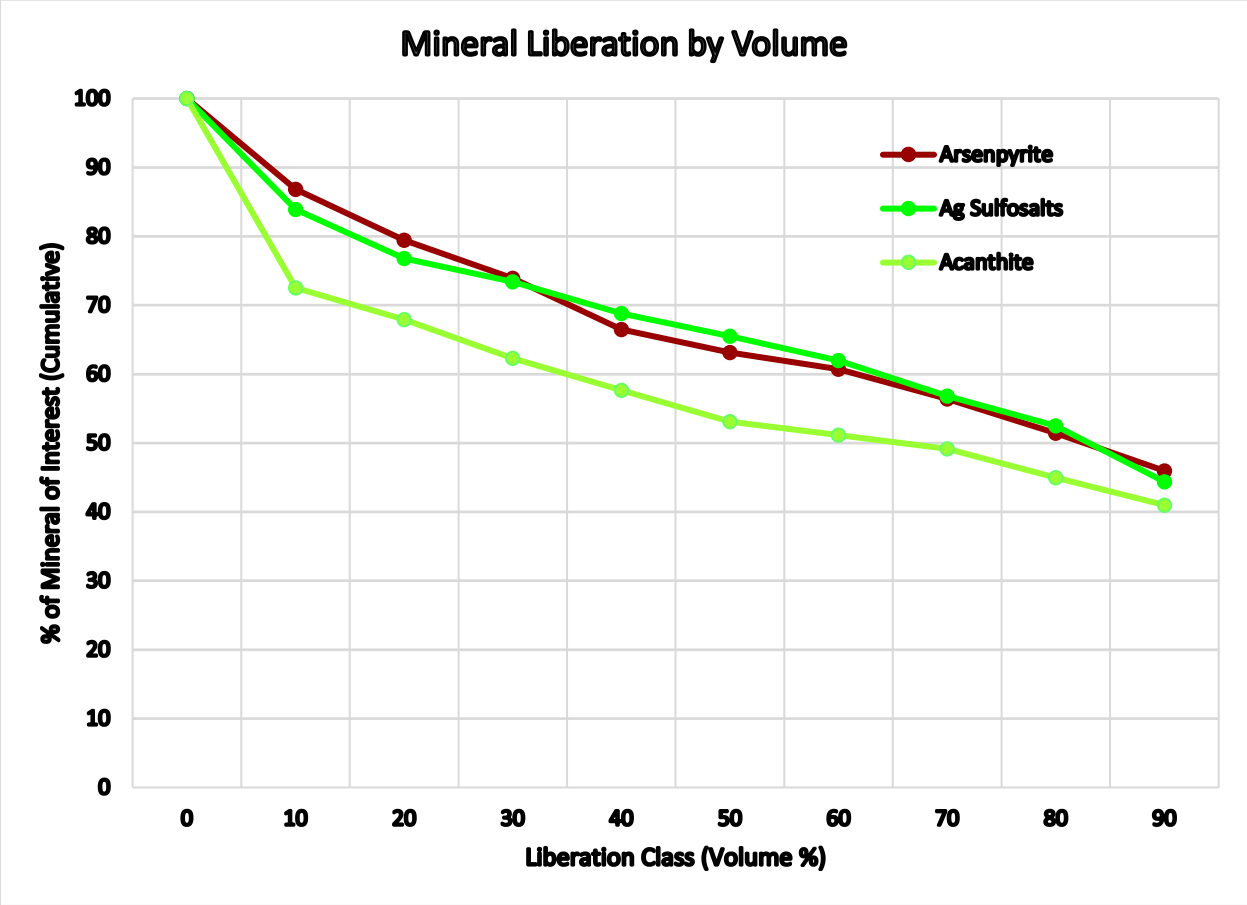

Figure 3. Mineral liberation by volume.

Liberation is also shown graphically in the following figures using false color particle images. The silver sulfosalts in **Figure 4** show numerous liberated particles in the 90% to 100% and 60% to 90% liberation classes. The liberated acanthite particles are difficult to see in Figure 5 due to the fine size and the few number of particles. Arsenopyrite is well liberated as presented by the large number of particles in the 60% and greater liberation classes in Figure 6.

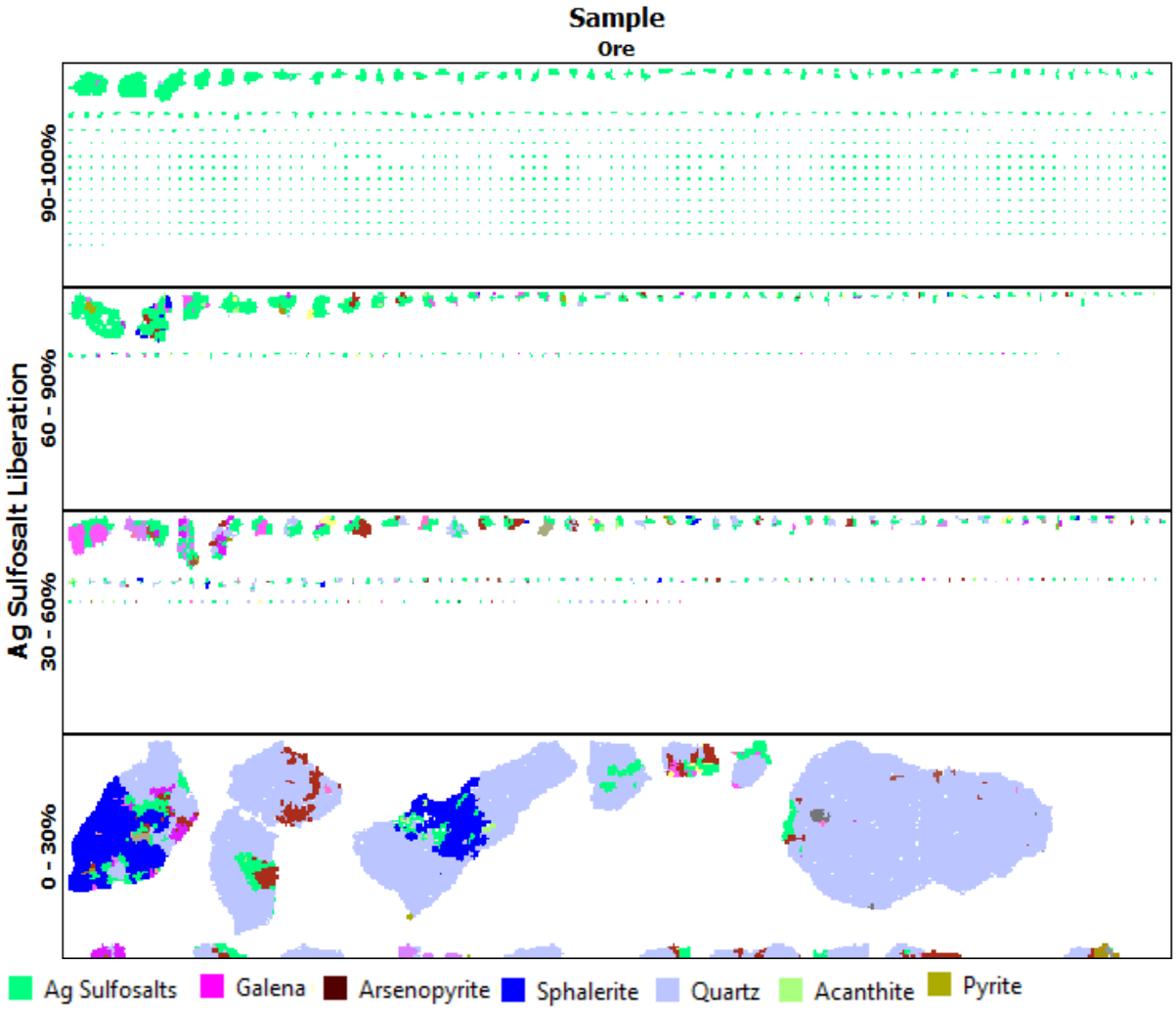

Figure 4. Graphical liberation of the silver sulfosalts by volume.

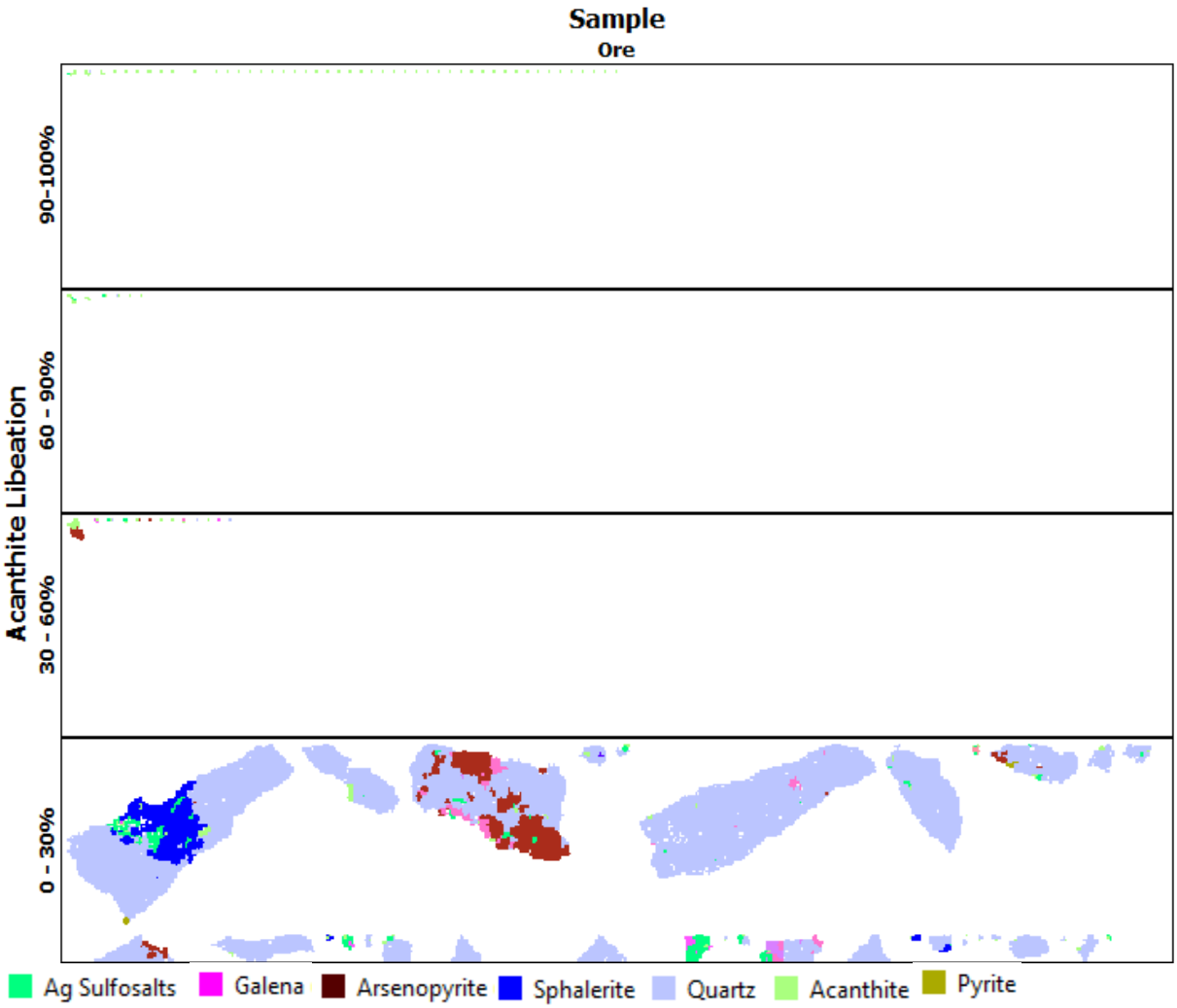

Figure 5. Graphical liberation of acanthite by volume.

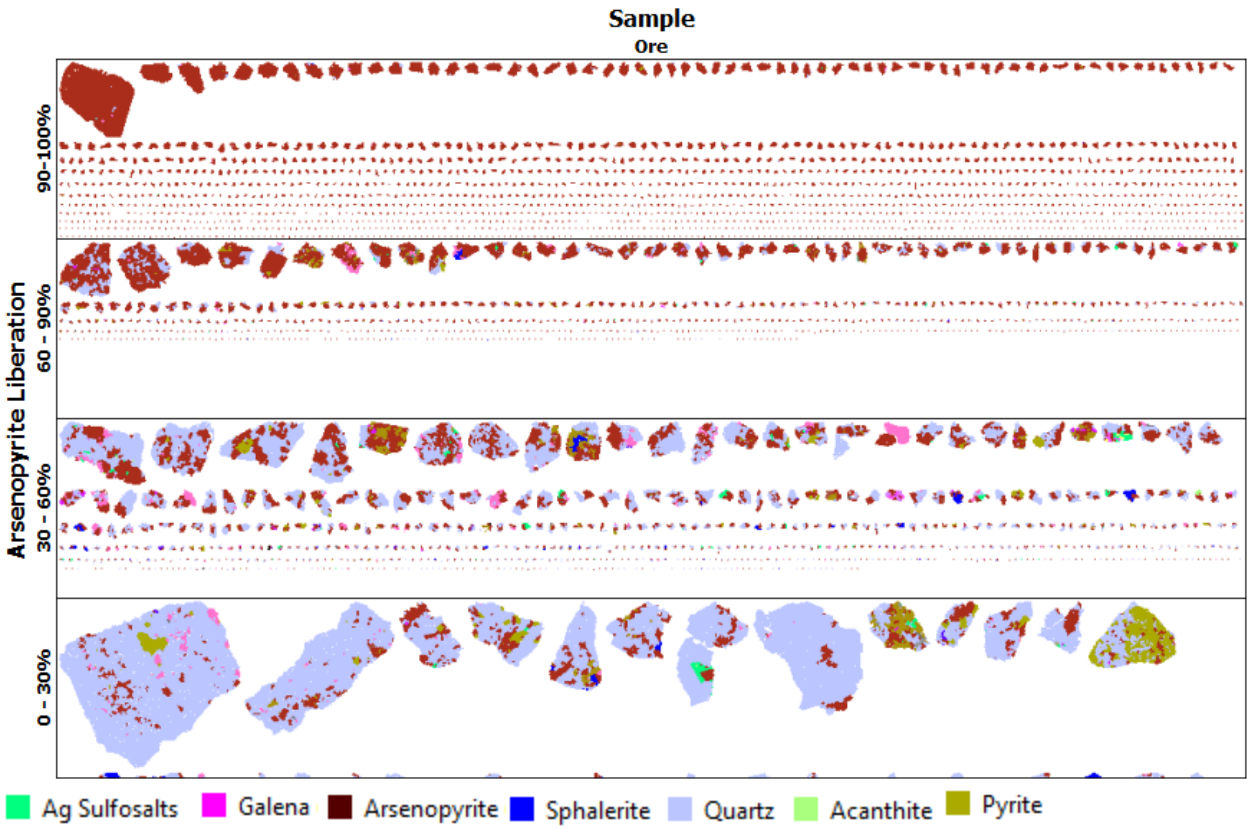

Figure 6. Graphical liberation of arsenopyrite by volume.

Mineral Associations

Mineral associations in **Table 9** show that each mineral listed is highly associated with the host and major gangue mineral, quartz. Acanthite was strongly associated with the silver sulfosalts. Both, the silver sulfosalts and acanthite were associated with arsenopyrite; however, approximately one-third was liberated. Arsenopyrite was weakly associated with the silver sulfosalts and acanthite.

Table 9. Mineral associations for the Ore

Mineral	Acanthite	Ag Sulfosalts	Arsenopyrite
Quartz	31.9	26.1	44.0
Ag Sulfosalts	21.1		1.5
Arsenopyrite	6.5	6.1	
Sphalerite	5.1	2.7	1.1
Muscovite	1.3	1.4	4.8
Galena	1.3	5.1	0.5
Bindheimite	0.0	4.6	0.3
Pyrite	0.0	2.4	2.4
Acanthite		1.5	0.1
Free particles	31.2	38.6	36.2

TIMA Images

Ore

A particle of quartz (lavender) and sphalerite (blue) contain silver sulfosalt (lime green) inclusions in the TIMA false color image presented in **Figure 7**. The gangue is primarily quartz with some muscovite (light pink). Pyrite is shown in olive and arsenopyrite is red-brown.

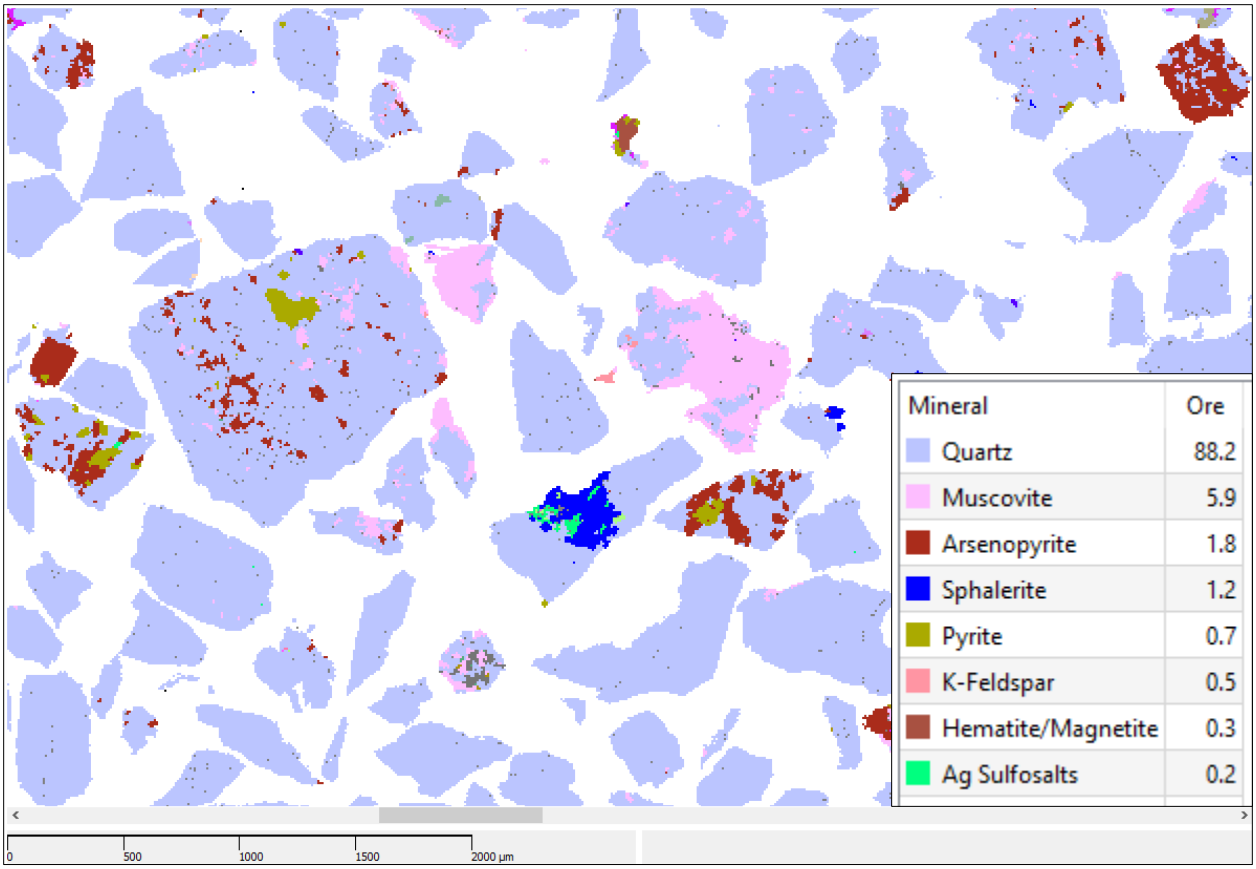

Figure 7. False color TIMA image from the Ore.

The silver sulfosalts (Ag-SS) are the bright streaks in sphalerite (Sp) in the quartz (Qtz) particle in the BSE image in **Figure 8**. Arsenopyrite (Apy) and pyrite (Py) are bright when in contrast with the gangue mineral of quartz.

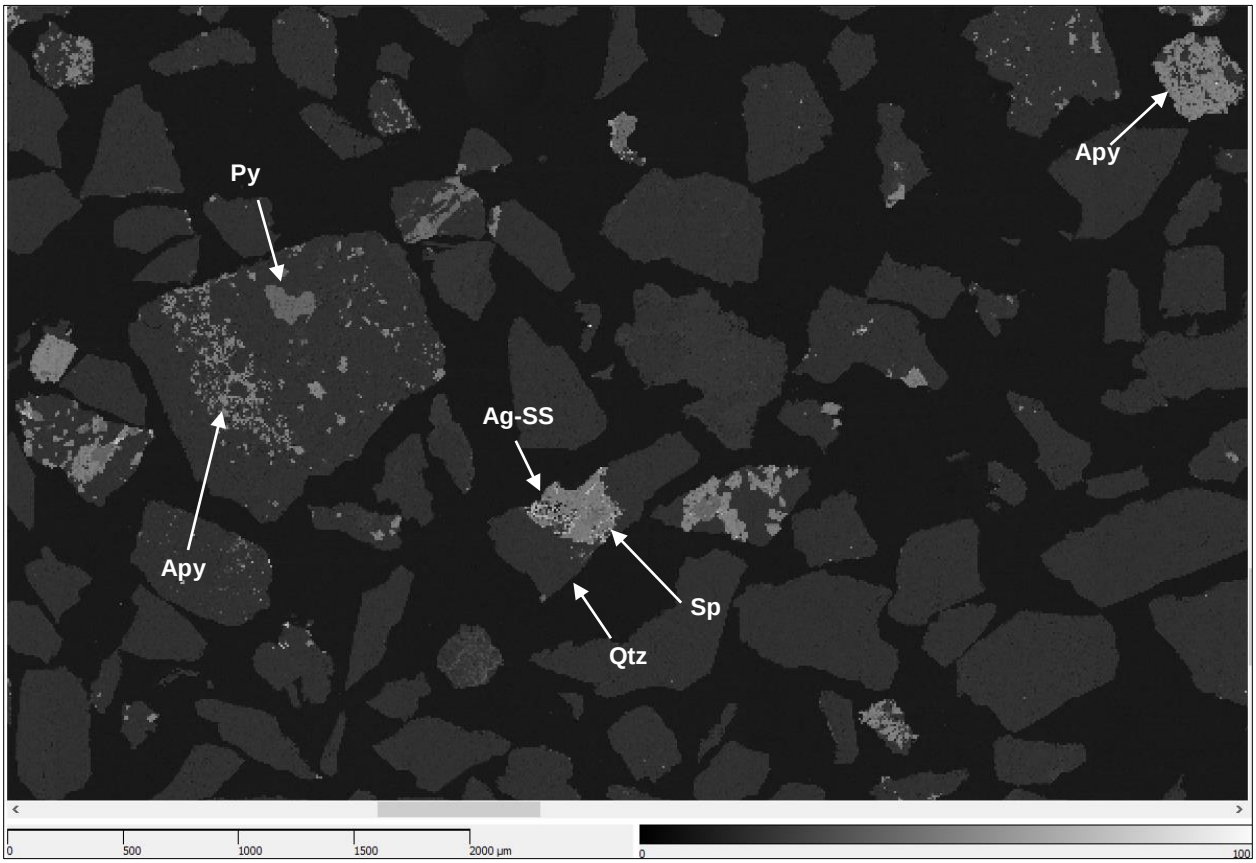

Figure 8. BSE image from the Ore.

Elemental Distribution by Mineral per Sieve Fraction

Overall, the silver sulfosalts accounted for 85% of the total silver and acanthite 13%. The silver grade increased in the finer fractions (+400 and -400 mesh) and collectively accounted for 63% of the silver in the sample as shown in **Table 10**.

Table 10. Silver distribution by sieve fraction for the Ore.

Mineral / Fraction (US mesh)	+50	+100	+200	+400	-400	Total
Ag Sulfosalts	84.5	90.4	83.8	87.7	83.7	85.0
Acanthite	14.4	7.6	14.6	10.5	14.3	13.1
Lead Argento-arseno-antimonide	1.0	1.9	1.5	1.8	2.0	1.8
Covellite-Ag	0.0	0.0	0.2	0.0	0.1	0.1
Silver grade (% Ag)	0.08	0.07	0.11	0.26	0.41	0.16
Silver Distribution (% of Total)	14.3	10.0	13.0	18.6	44.1	100
Mass Distribution (Wt. %)	28.3	22.8	19.7	11.7	17.5	100

The arsenic grade was highest in the -400 mesh fraction at 3.9% As. The two finest fractions (+400 and -400 mesh) accounted for 46% of the total arsenic with 24% of the total arsenic in the +50 mesh fraction as noted in **Table 11**.

Table 11. Arsenic distribution by sieve fraction for the Ore.

Mineral / Fraction (US mesh)	+50	+100	+200	+400	-400	Total
Arsenopyrite	87.5	87.8	86.1	85.7	84.9	86.2
Scorodite	4.0	4.2	4.0	3.1	4.4	4.1
Sewardite	3.1	3.8	4.7	4.5	4.2	4.0
Arsenbrackebuschite	2.3	0.6	0.9	1.1	1.1	1.3
Lead-Iron Antimony Arsenate	1.3	1.0	1.1	0.9	1.2	1.1
Ag Sulfosalts	0.8	1.2	1.1	1.2	1.2	1.1
Mimetite	0.3	0.7	0.9	1.6	1.6	1.1
Tsumcorite	0.5	0.8	0.8	1.5	0.9	0.9
Lead Argento-arseno-antimonide	0.0	0.1	0.1	0.3	0.3	0.2
Arsendescloizite	0.1	0.0	0.2	0.2	0.1	0.1
Tetrahedrite	0	0	0.1	0	0.02	0.0
Arsenic grade (% As)	1.73	1.32	1.71	2.35	3.92	2.09
Arsenic Distribution (% of Total)	23.5	14.4	16.1	13.2	32.8	100
Mass Distribution (Wt. %)	28.3	22.8	19.7	11.7	17.5	100

Liberation by Sieve Fraction

Liberation increased with decreasing particle size for the minerals of interest. A notable improvement in the liberation for the silver sulfosalts, acanthite and arsenopyrite was seen in the +400 and -400 mesh fractions as shown in **Figure 9** through **Figure 11**.

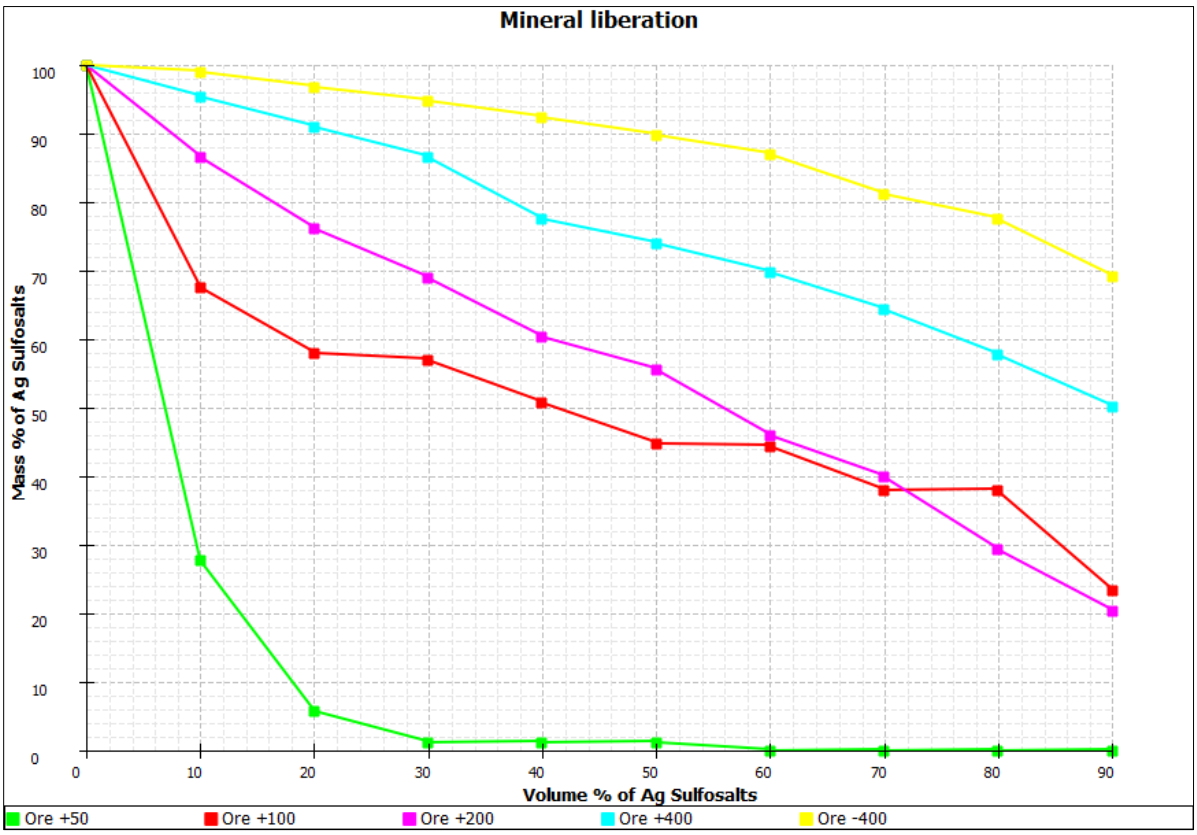

Figure 9. Ag-Sulfosalts liberation by volume per sieve fraction.

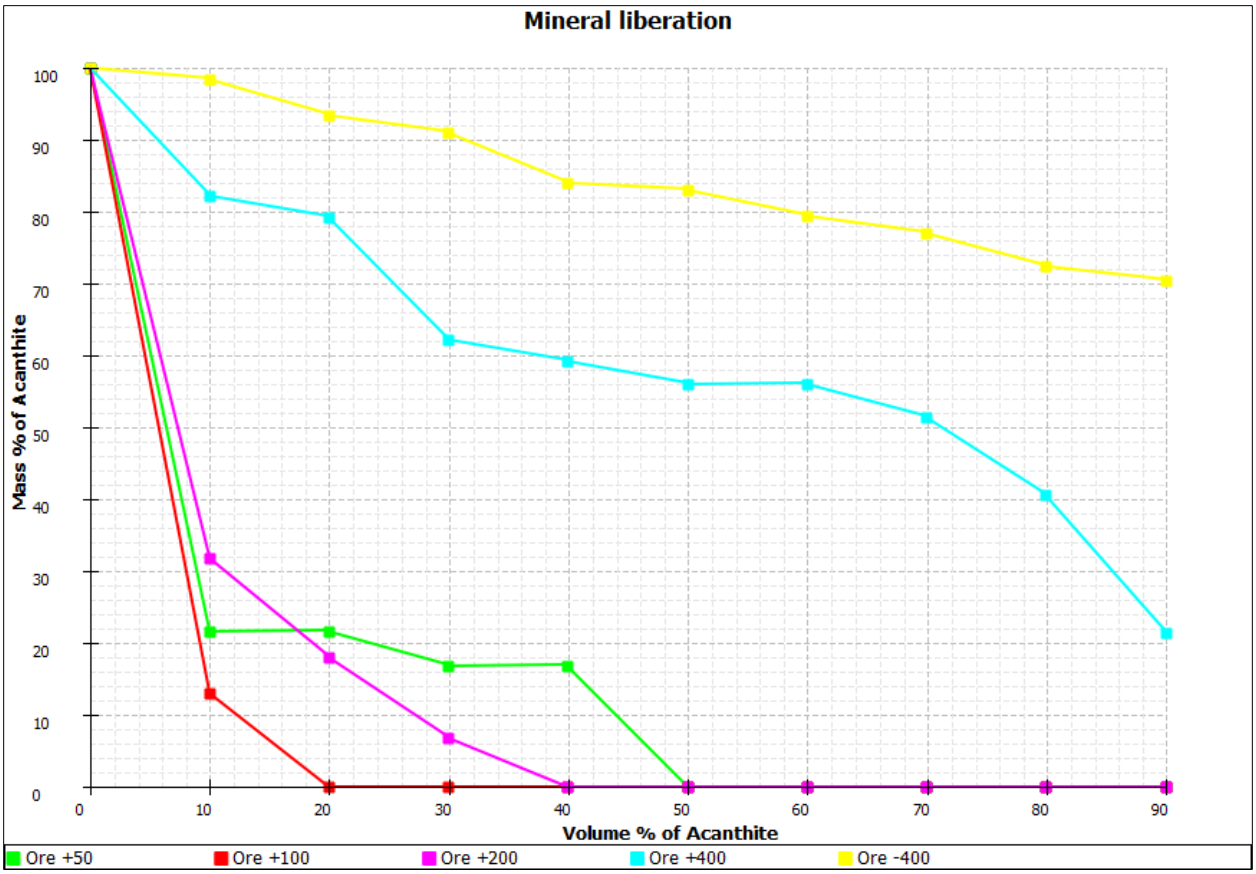

Figure 10. Acanthite liberation by volume per sieve fraction.

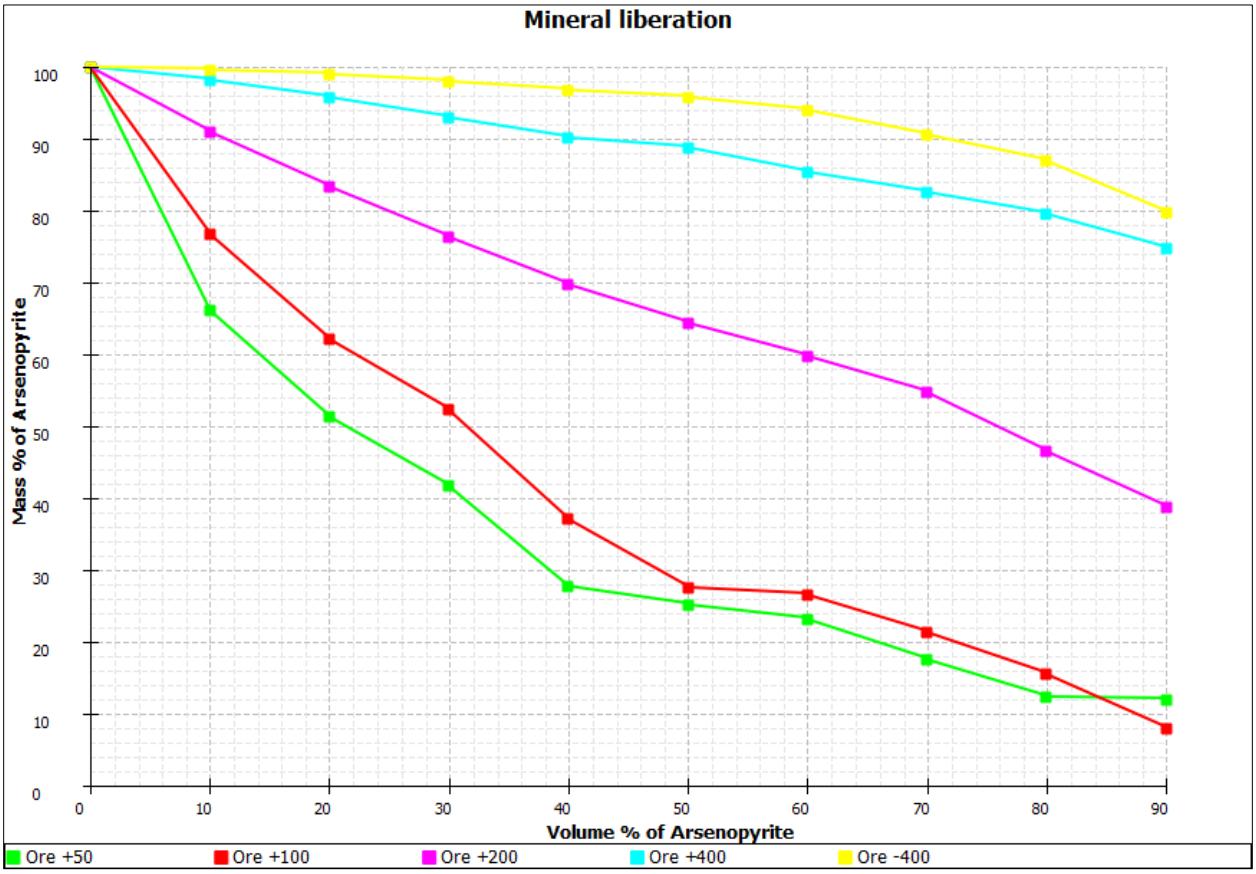

Figure 11. Arsenopyrite liberation by volume per sieve fraction.

BSE Particle Images

The BSE image in **Figure 12A** displays acanthite (Ac) and pearceite (Pc) coating quartz (Qtz) in the voids in sphalerite (Sp). Pearceite contains galena (Gn) inclusions in **Figure 12B**. Argentiferous bornite (Bo-Ag) contains a galena inclusion and is associated with arsenopyrite (Asp) in **Figure 12C.**

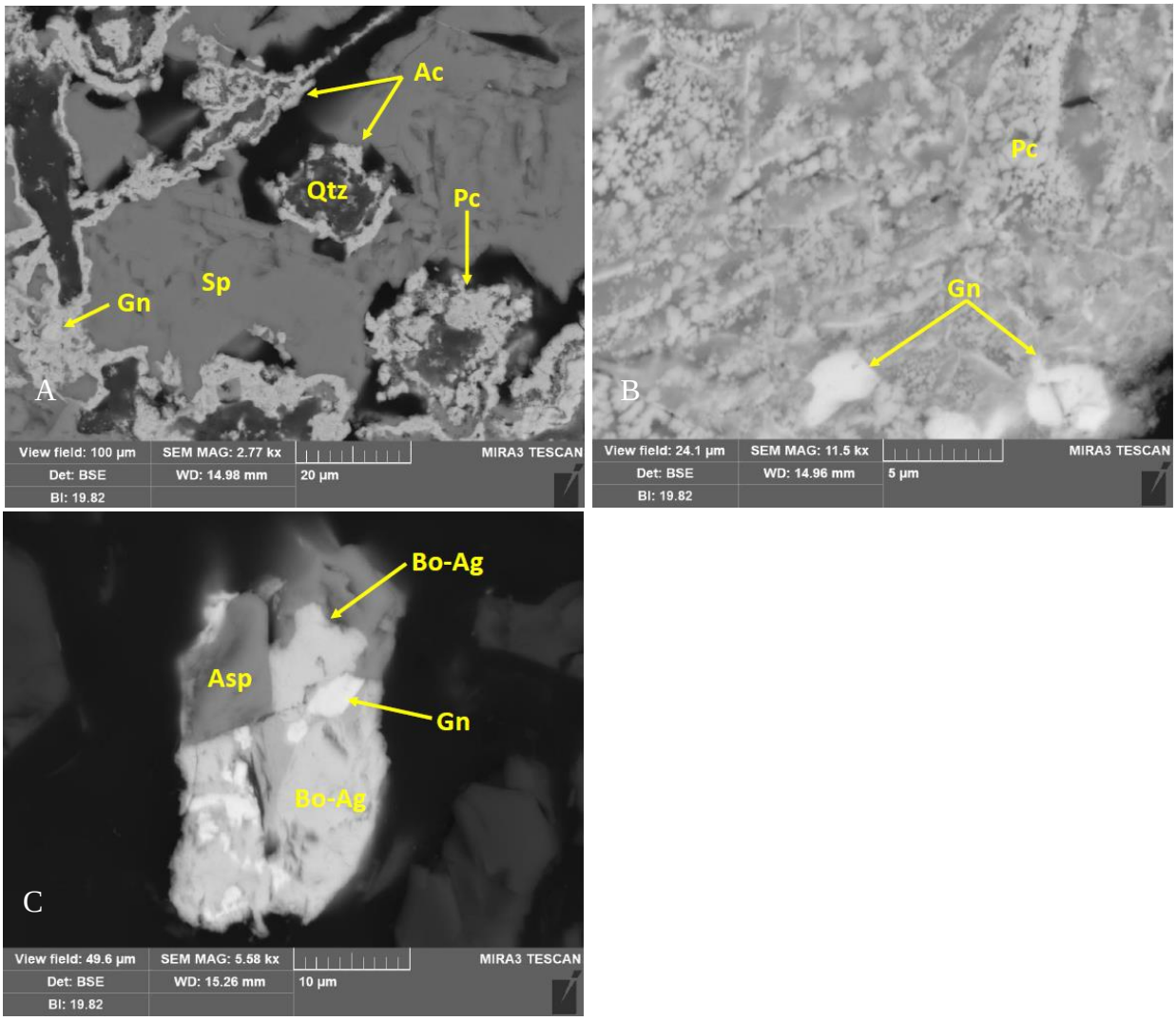

Figure 12. Acanthite and pearceite rimming quartz in voids in sphalerite (A), pearceite with galena (B) and argentiferous bornite associated with arsenopyrite and galena (C).

An oxidized grain, presumably of a sulfide, in quartz is shown in the BSE image in **Figure 13A**. The elemental map in **Figure 13B** shows the intimate association of silver, arsenic and lead.

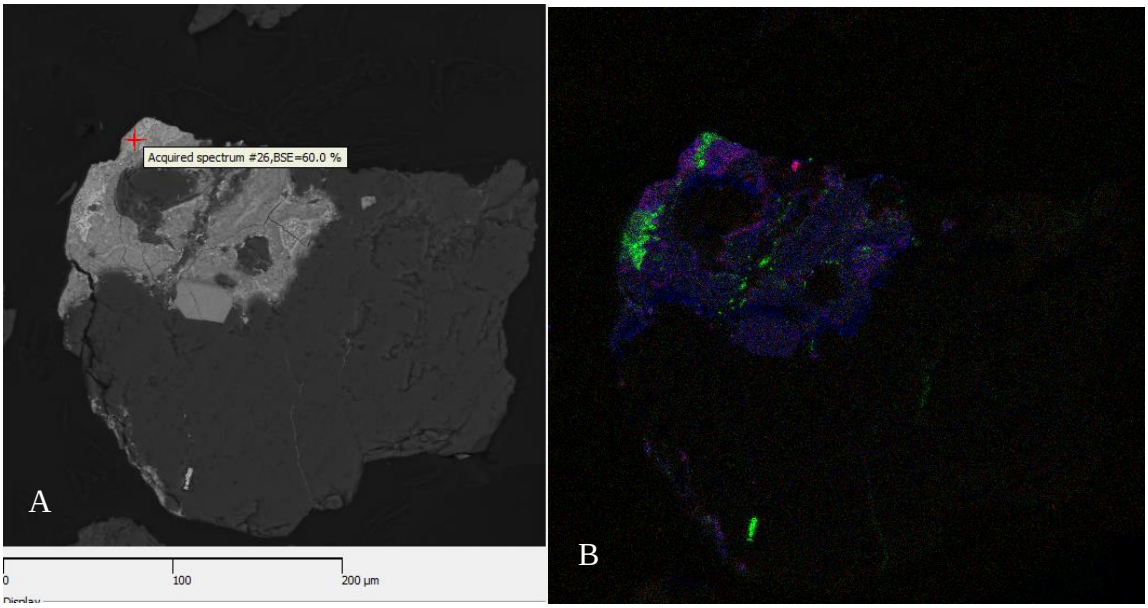

Figure 13. BSE image (A) and elemental map (B), showing the distribution of silver (green) arsenic (red) and lead (blue) in the sulfide grain hosted in quartz.

Appendix

Modal mineralogy by size fraction for the Ore sample is presented in **Table 18**.

Table 12. Ore modal mineralogy by size fraction

Mineral	Formula	+50	+100	+200	+400	-400	Modal
Quartz	SiO_2	90.8	91.7	89.3	86.0	75.9	88.2
Muscovite	$KAl_2(Si_3Al)O_{10}(OH)_2$	5.15	4.44	4.96	6.31	12.2	5.92
Arsenopyrite	**FeAsS**	**1.60**	**1.22**	**1.56**	**2.18**	**3.73**	**1.83**
Sphalerite	ZnS	0.51	0.73	1.37	1.94	2.31	1.19
Pyrite	FeS_2	0.44	0.59	0.88	0.89	0.82	0.69
K-Feldspar	$KAlSi_3O_8$	0.44	0.43	0.56	0.60	0.94	0.55
Hematite/Magnetite	Fe_2O_3/Fe_3O_4	0.27	0.18	0.24	0.40	0.63	0.30
Ag Sulfosalts	**Ag(Sb,As,Zn,Cu)S**	**0.11**	**0.15**	**0.21**	**0.38**	**0.67**	**0.25**
Scorodite	$FeAsO_4 . 2H_2O$	0.17	0.14	0.17	0.19	0.46	0.20
Sewardite	$CaFe_2(AsO_4)(OH)_2$	0.08	0.08	0.13	0.17	0.28	0.13
Galena	PbS	0.02	0.04	0.14	0.19	0.24	0.11
Biotite	$K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH)_2$	0.08	0.07	0.09	0.09	0.12	0.09
Lead-Iron Antimony Arsenate	Pb,Fe(Sb,AsO)	0.07	0.04	0.05	0.06	0.14	0.06
Arsenbrackebuschite	$Pb_2(Fe,Zn)(AsO_4)_2(OH,H_2O)$	0.09	0.02	0.04	0.06	0.10	0.06
Mimetite	$Pb_5(AsO_4)_3Cl$	0.01	0.02	0.04	0.10	0.17	0.05
Bindheimite	$Pb_2Sb_2O_6(O,OH)$	0.01	0.04	0.04	0.07	0.16	0.05
Tsumcorite	$Pb(Zn,Fe)_2(AsO_4)_2(OH,H_2O)_2$	0.02	0.02	0.03	0.08	0.08	0.04
Bornite	Cu_5FeS_4	0.08	ND	ND	0.01	ND	0.02
Hemimorphite	$Zn_4Si_2O_7(OH) . H_2O$	P	0.01	0.03	0.03	0.03	0.02
Lead Argento-arseno-antimonide	(Pb,Ag)(As,Sb)O	P	0.01	0.01	0.04	0.06	0.02
Pyroxenes	$(Ca,Mg,Fe)_2Si_2O_6$	P	0.03	0.02	0.01	0.01	0.01
Spinel	$(Fe,Mg)(Cr,Al)_2O_4$	0.02	0.01	P	0.01	0.03	0.01
Monimolite	$(Pb,Ca)_3Sb_2O_8$	P	P	0.01	0.01	0.03	0.01
Amphiboles	$Ca_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$	0.01	0.01	P	P	0.02	0.01
Acanthite	**Ag_2S**	**0.01**	**P**	**P**	**0.01**	**0.03**	**0.01**
Kaolinite	$Al_2Si_2O_5(OH)_2$	P	P	0.01	P	0.03	0.01
Chlorite	$(Fe,Mg)_5Al(Si_3Al)O_{10}(OH)_8$	P	P	0.01	0.01	0.01	0.01

Mineral	Formula	+50	+100	+200	+400	-400	Modal
Arsendescloizite	$PbZn(AsO_4)(OH)$	P	P	0.01	0.01	0.01	0.01
Rutile	TiO_2	P	P	P	0.01	0.01	0.01
Albite	$NaAlSi_3O_8$	P	P	P	0.01	0.01	P
Tetrahedrite	$(Cu,Fe,Zn)_{12}(Sb,As)_4S_{13}$	P	ND	0.01	P	0.01	P
Calcite	$CaCO_3$	P	P	P	0.01	0.01	P
Anorthoclase	$(K,Na)AlSi_3O_8$	P	P	P	P	0.01	P
Chalcopyrite	CuFeS2	ND	P	P	P	P	P
Monazite	$(Ce,La,Nd)PO_4$	ND	ND	P	ND	P	P
Dolomite	$CaMg(CO_3)_2$	ND	P	ND	ND	0.01	P
Zircon	$ZrSiO_4$	P	P	P	P	P	P
Apatite	$Ca5(PO4)_3(OH,F)$	P	P	P	P	P	P
Plagioclase	$(Ca,Na)(Al)_{1-2}Si_{2-3}O_8$	P	ND	P	P	P	P
Covellite-Ag	(Cu,Ag)S	ND	P	P	ND	P	P
Andalusite	Al_2SiO_5	P	P	P	P	P	P
Covellite	CuS	ND	ND	P	P	P	P
Chalcocite	Cu_2S	P	P	ND	P	P	P
Barite	$BaSO_4$	ND	P	P	ND	P	P
Molybdenite	MoS_2	P	P	ND	P	P	P
Garnet	$(Fe,Ca,Mg)_3(Fe,Al)(SiO_4)_3$	ND	P	ND	P	P	P
Quartz	SiO_2	ND	ND	ND	P	ND	P
Muscovite	$KAl_2(Si_3Al)O_{10}(OH)_2$	P	ND	P	P	ND	P
	Mass distribution (%)	28.3	22.8	19.7	11.7	17.5	100