MOINA QEMSCAN INTERPRETATION
For Mineral Processing

- Head and Available Metal
- Grade-Recovery
- Gravity Separation
- Flowsheet Simulation

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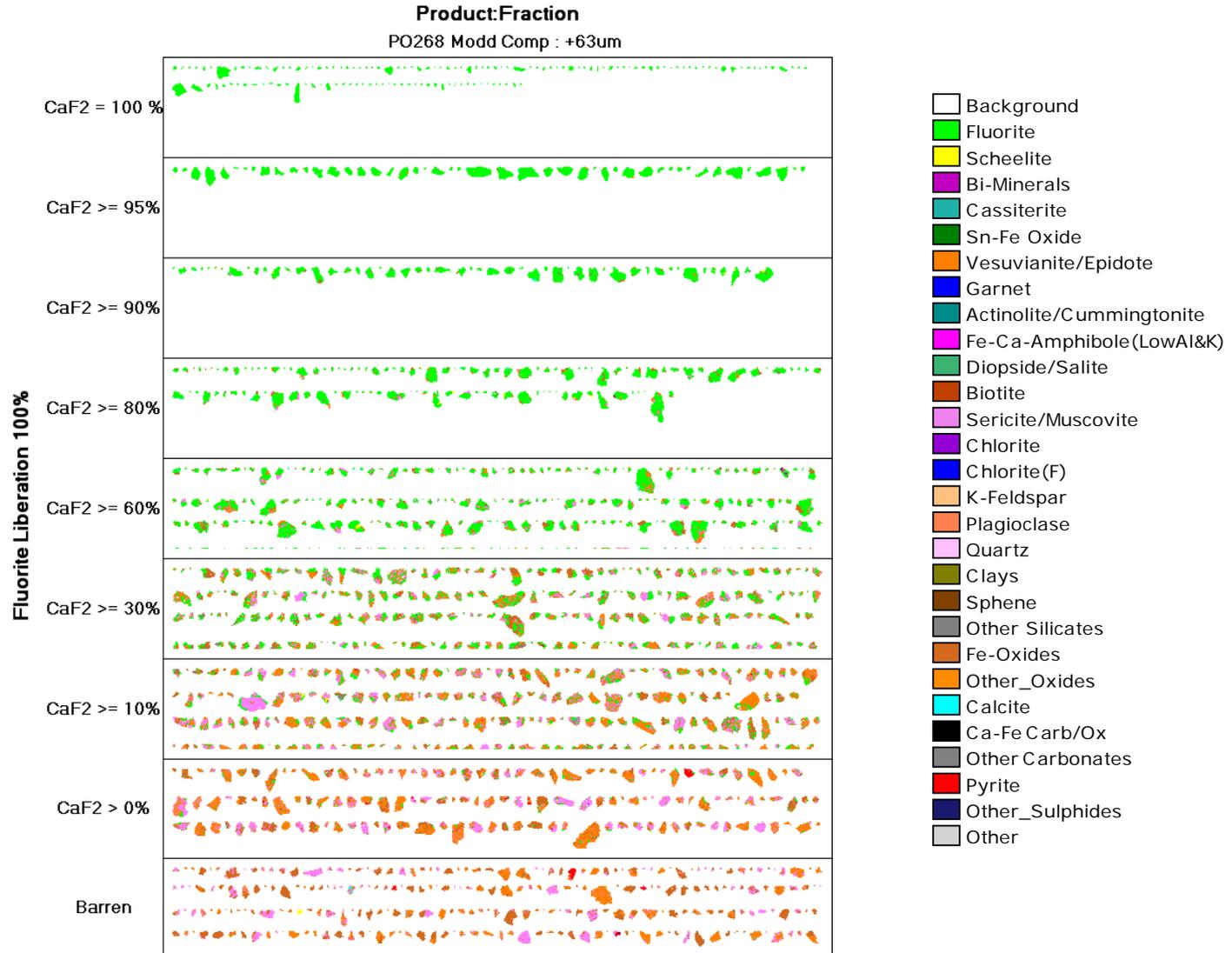# QEMSCAN Sample – Head Assay Recoverable Minerals

Head Assay	
	%
F	7.92
W	0.070
Sn	0.20
Bi	0.046

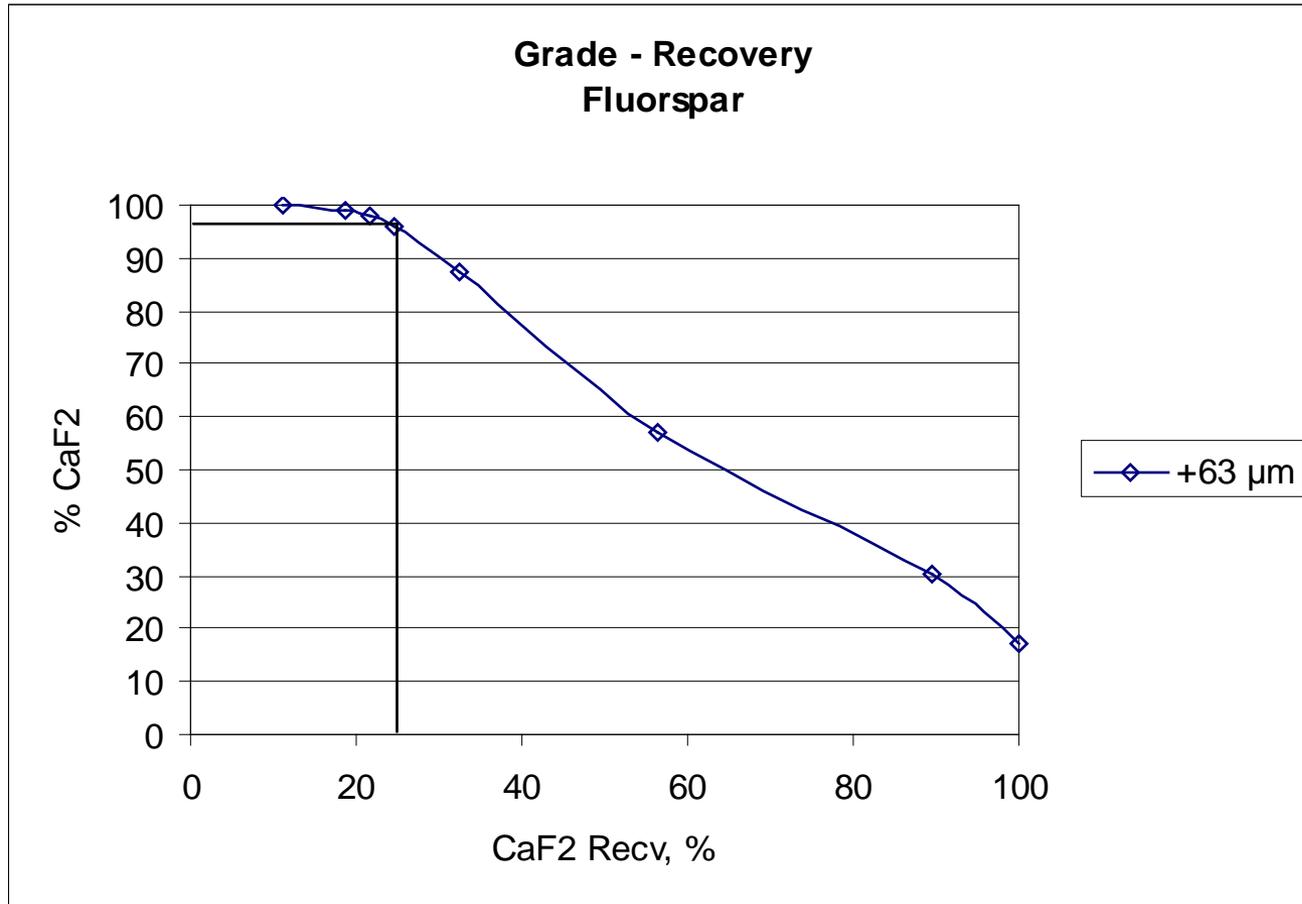|	F	W	Sn	Bi
Fluorite	92.1			
Scheelite		94.8		
Cassiterite			48.3	
Bi-Minerals				100.0
Actinolite/Cummingtonite	0.80			
Biotite	1.25			
Ca-Fe Carb/Ox				
Calcite				
Chlorite	0.15			
Chlorite(F)	0.53			
Clays				
Diopside/Salite	0.082			
Fe-Ca-Amphibole(LowAl&K)	2.07			
Garnet			36.8	
K-Feldspar				
Plagioclase				
Pyrite				
Quartz				
Sericite/Muscovite	0.36			
Sn-Fe Oxide			14.9	
Sphene				
Vesuvianite/Epidote	2.67			
Other	0.001	5.23		
Other Silicates				
Other_Sulphides				
Other Carbonates				
TOTAL	100.0	100.0	100.0	100.0

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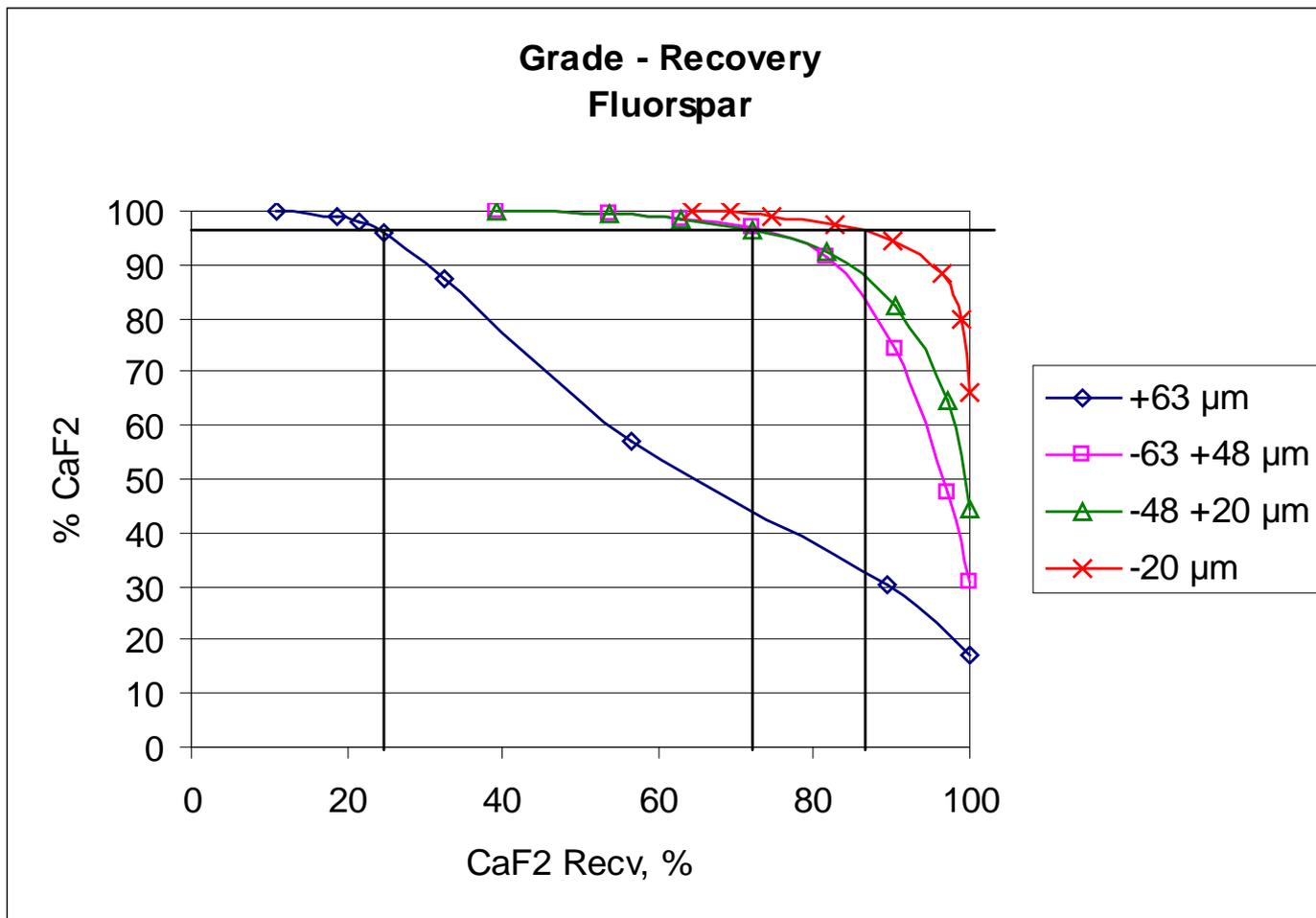- Grade-Recovery
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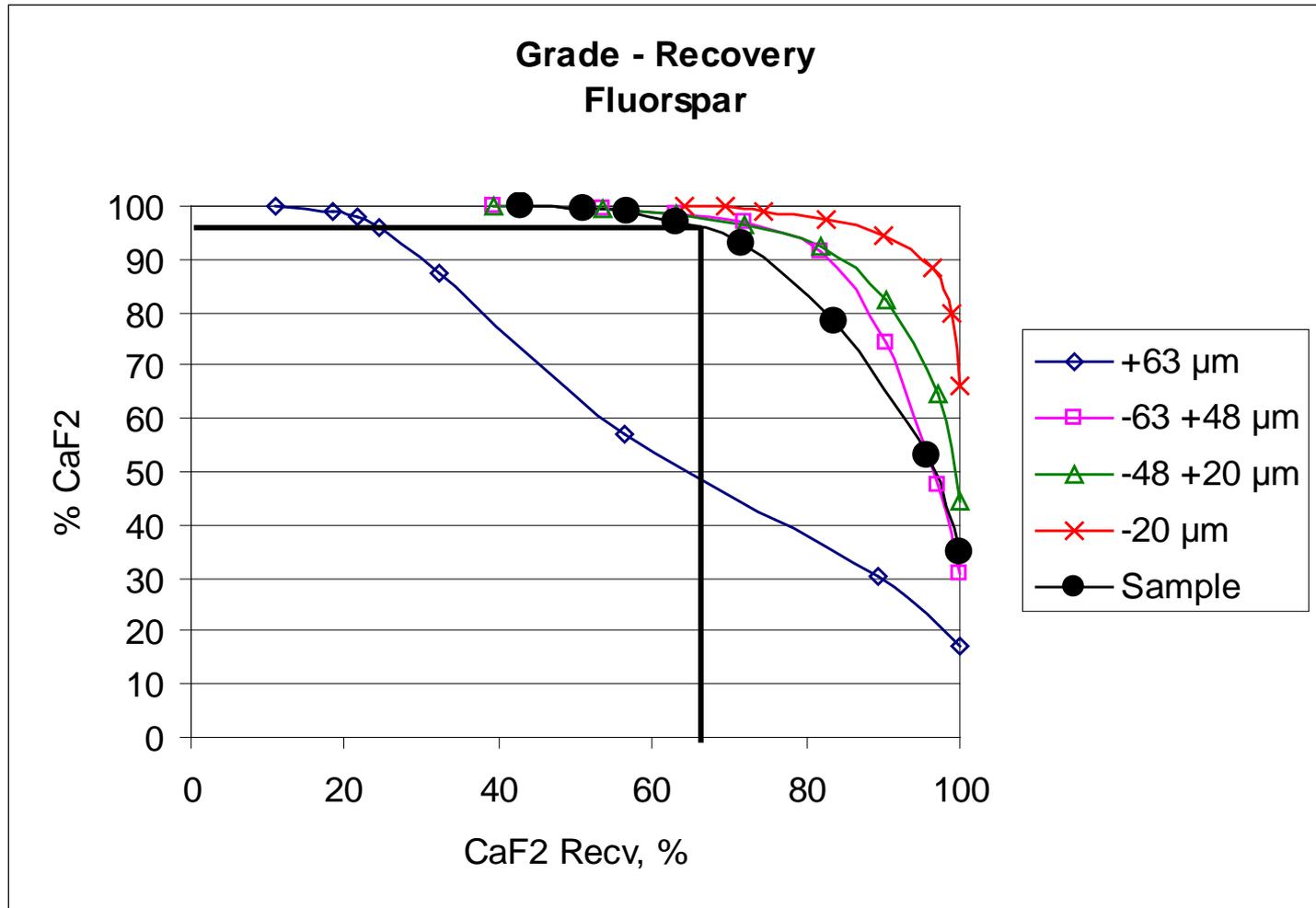
SGS

Grade-Recovery - Particle Sorting (+63 µm)

Product:Fraction

PO268 Modd Comp : +63um

Legend:
- 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

Fluorite Liberation 100%

- CaF2 = 100 %
- CaF2 >= 95%
- CaF2 >= 90%
- CaF2 >= 80%
- CaF2 >= 60%
- CaF2 >= 30%
- CaF2 >= 10%
- CaF2 > 0%
- Barren

Grade - Recovery
Fluorspar

Grade - Recovery
Fluorspar

Overall QEMSCAN date are related to the Sample after Crushing

Mass and Mineral Grain Size Distribution

$K_{80} = \sim 75 \ \mu m$
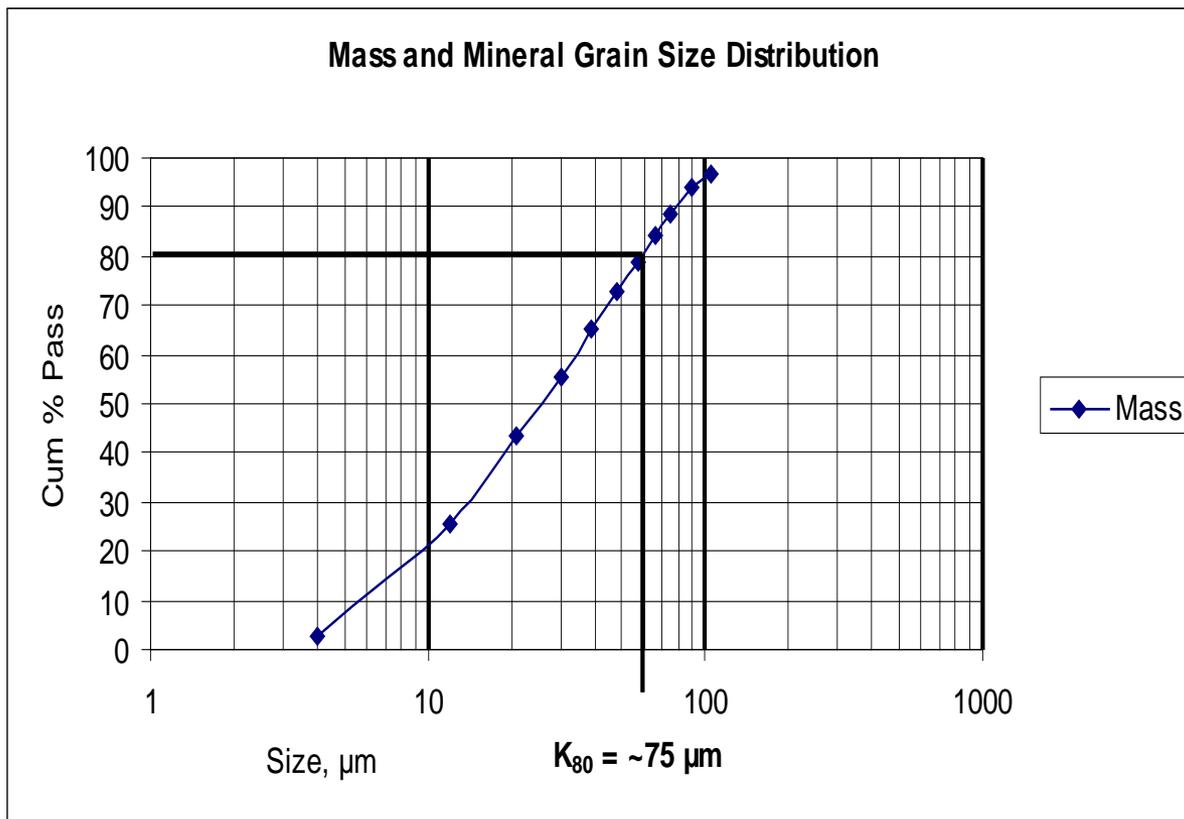
Simulation Procedure for Finer Grind

	Mass %	Simulated Finer Grinding					
	QS Feed	-63 µm		-45 µm		-20 µm	
+63um	29.8						
-63/+45um	12.9	12.9	18.3				
-45/+20um	19.0	19.0	27.0	19.0	33.1		
-20um	38.4	38.4	54.7	38.4	66.9	38.4	100.0
Total	100.0	70.2	100.0	57.4	100.0	38.4	100.0

Mass and Mineral Grain Size Distribution
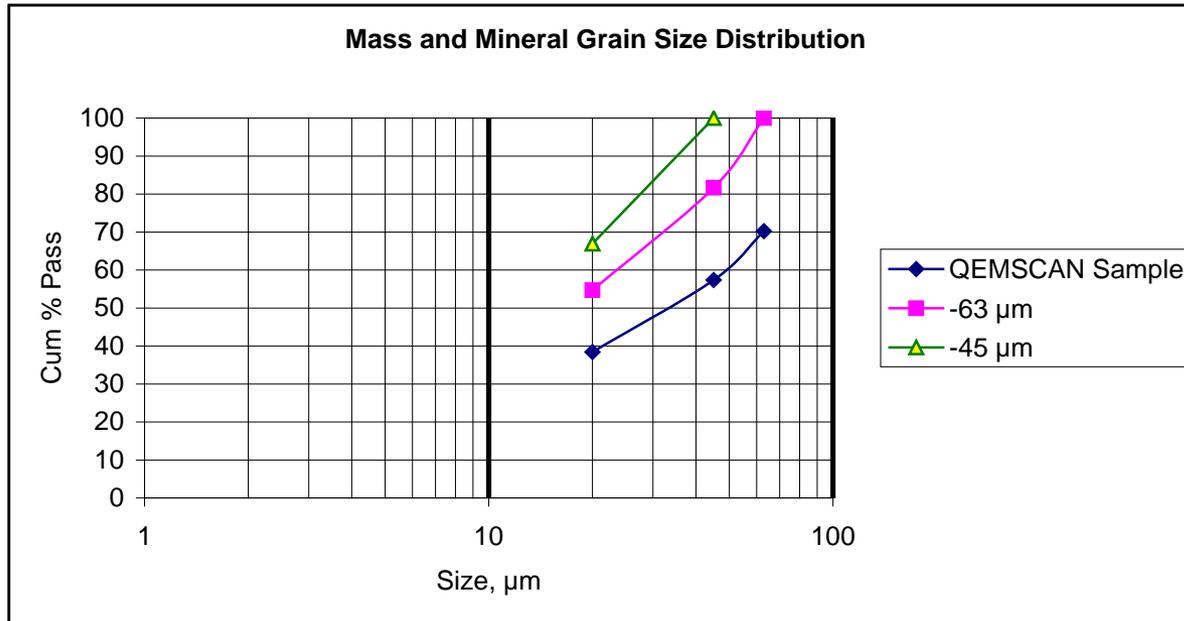
Assumption that after more grinding:

Coarser fractions will be the same as finer fractions

Simulation Procedure for Finer Grind

Grade - Recovery
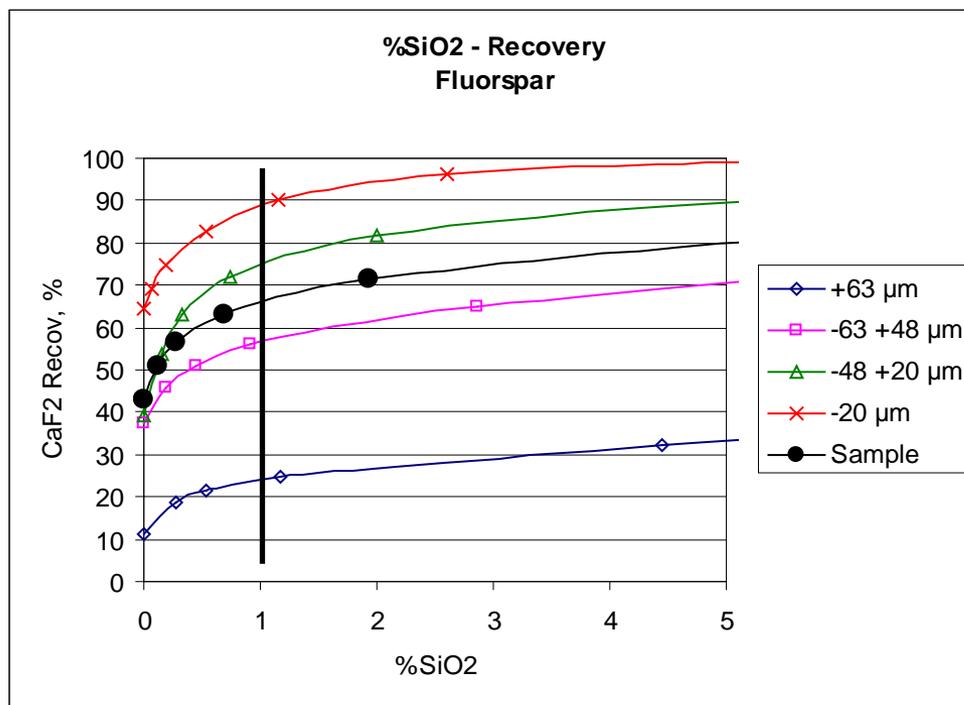**Fluorspar**
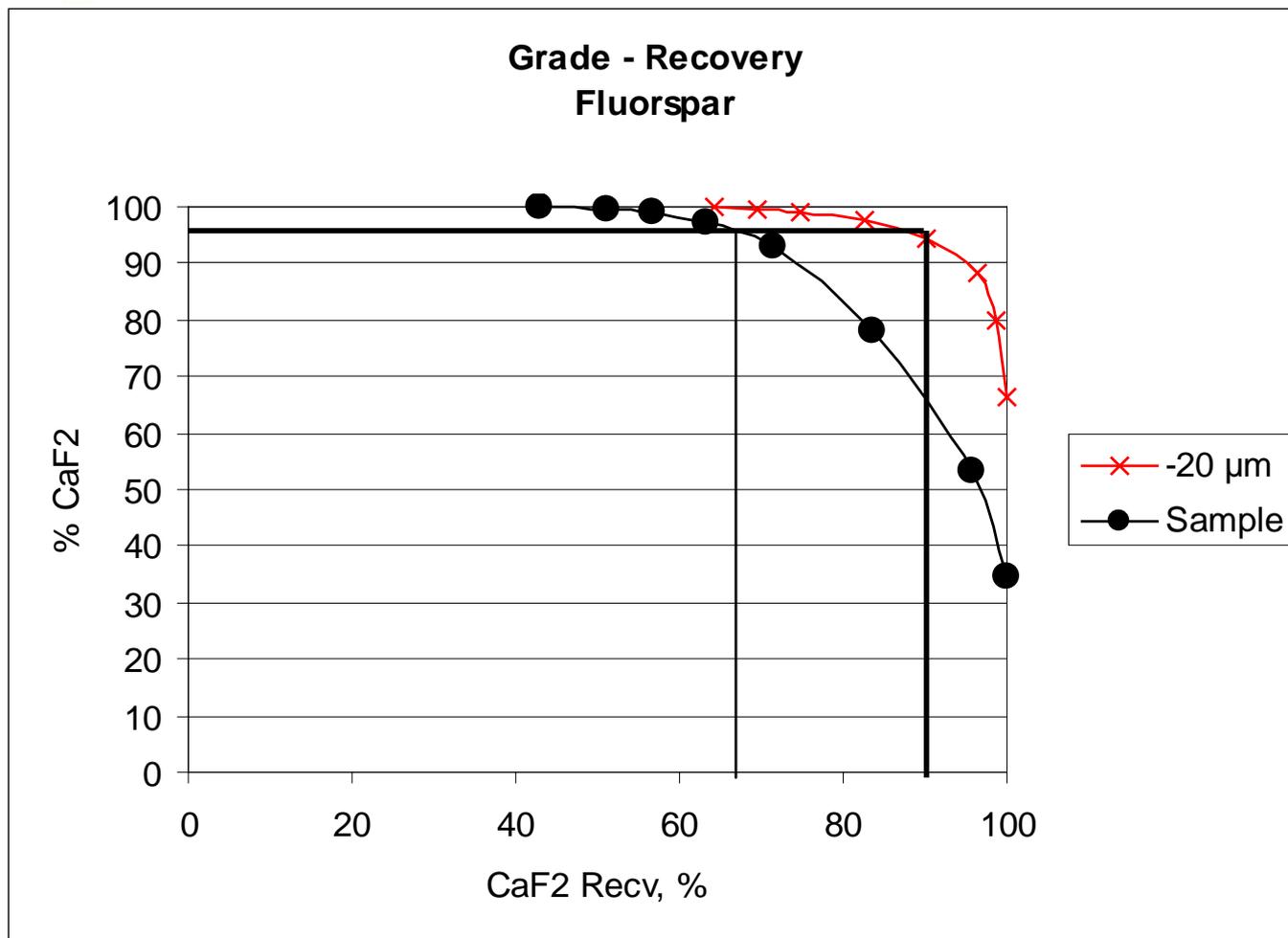
After finer grinding: Recovery improves from 65% to 90%

Fluorspar Grade and Contaminants

Fluorspar Grade is limited by:

%SiO2 - Recovery
Fluorspar

$CaF_2 > 97\%$

$SiO_2 < 1\%$

$CaCO_3 < 1\%$

$S_T < 0.02\%$

$Fe_2O_3 < 1\%$

Fluorspar Grade and Recovery Mineralogically Limiting (Best Possible)

Grade and Recovery
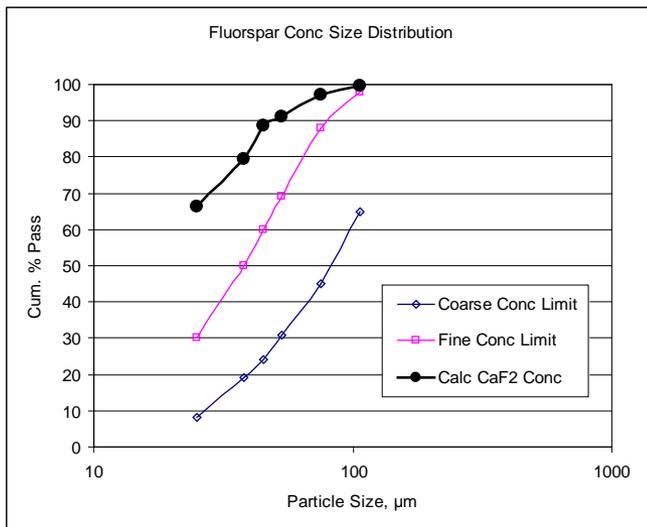
K80 = 75 μm

	Assay, %	Recovery, %
$CaCO_3$	1	
CaF_2	**97**	**65**
SiO_2	0.9	
S	0.01	
WO_3	0.05	
Sn	0.01	
Fe_2O_3	0.43	

-20 μm

	Assay, %	Recovery, %
$CaCO_3$	1	
CaF_2	**97.2**	**83**
SiO_2	0.6	
S	0.005	
WO_3	0.0252	
Sn	0.013	
Fe_2O_3	0.286	

Fluorspar Conc Size Distribution

Cum. % Pass vs Particle Size, μm
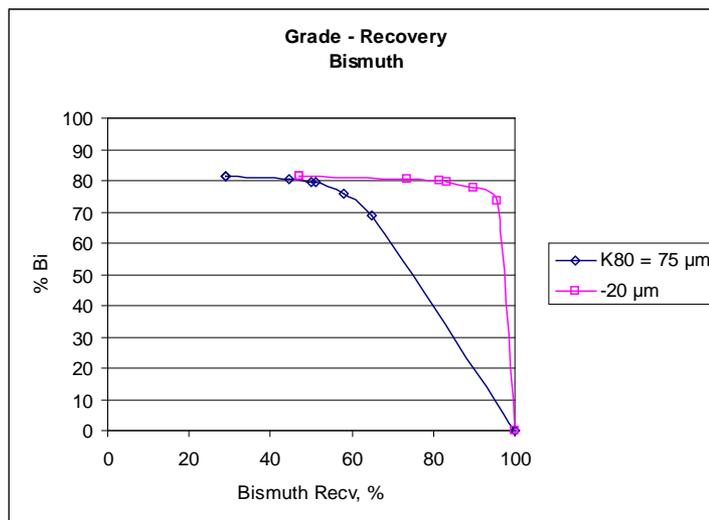- Coarse Conc Limit
- Fine Conc Limit
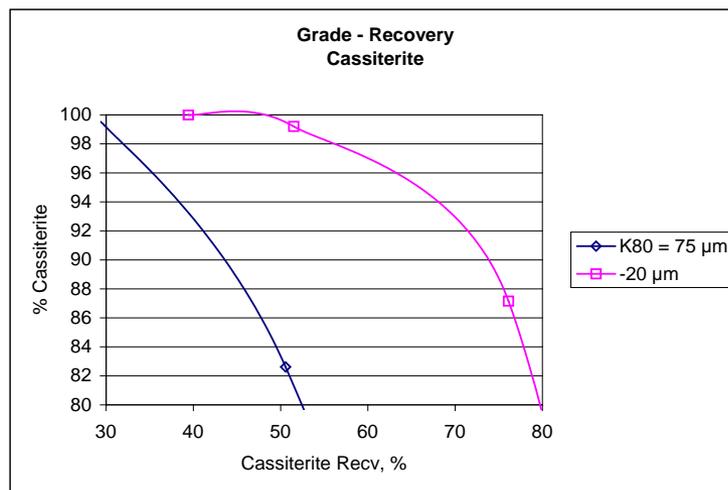- Calc CaF2 Conc

Agglomeration Will be Required

Grade and Recovery
Scheelite, Cassiterite, Bismuth
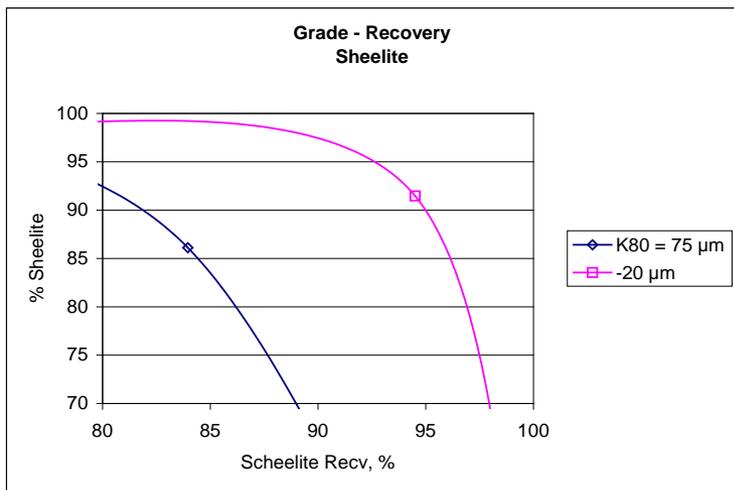
Grade - Recovery Sheelite — % Sheelite vs Scheelite Recv, %; series K80 = 75 µm and -20 µm

Grade - Recovery Cassiterite — % Cassiterite vs Cassiterite Recv, %; series K80 = 75 µm and -20 µm

Grade - Recovery Bismuth — % Bi vs Bismuth Recv, %; series K80 = 75 µm and -20 µm

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Gravity Recovery at K80 = 75 µm
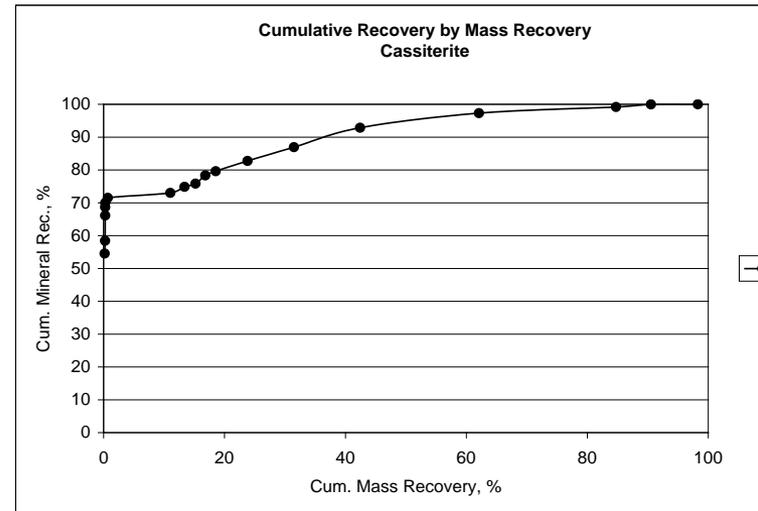
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Flowsheet

Primary Grind: K80 = 75 µm

Regrind: K80 ~ 20-30 µm
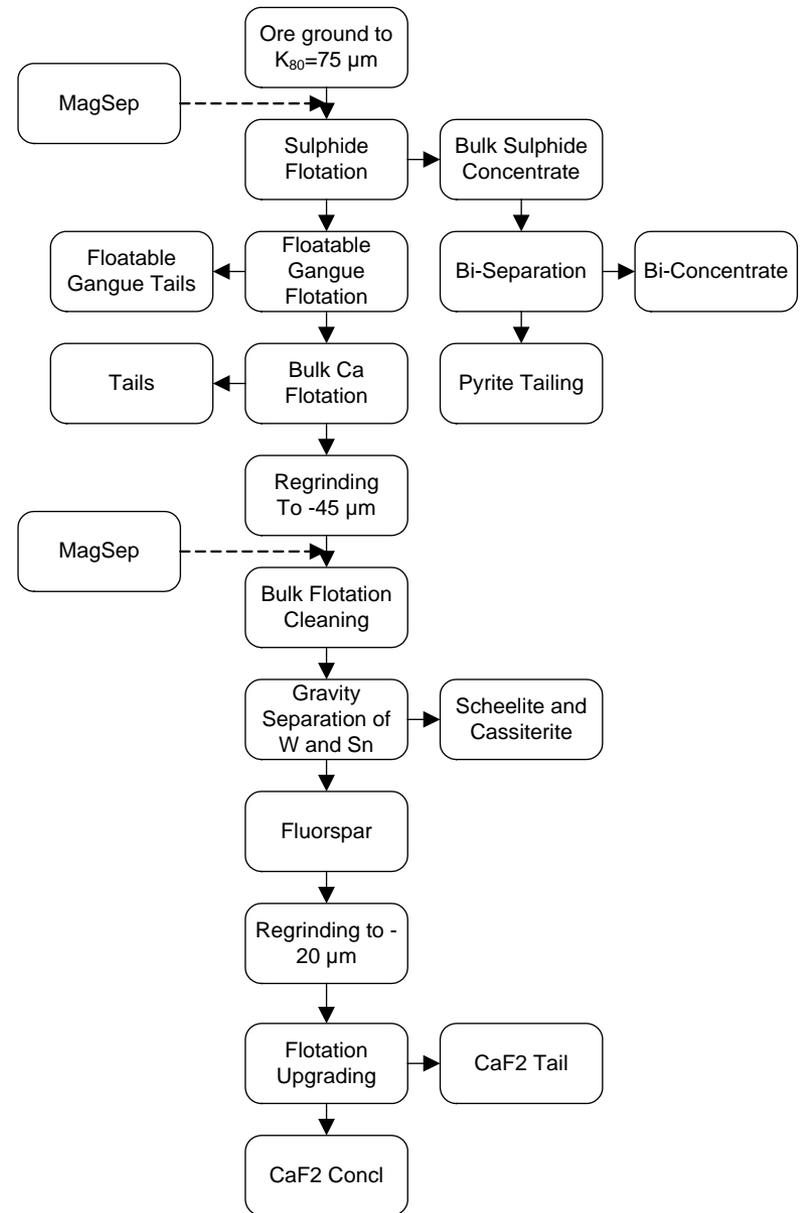
S-Flotation

% S in Particle:

>= 10% :	Float
5-10% :	Likely Float
1-5%:	Needs Aggressive Flotation
<1%:	Will not Float

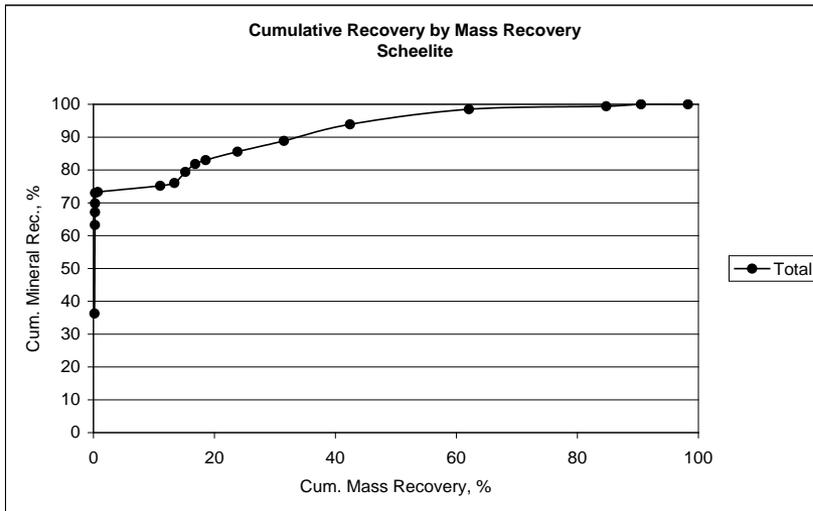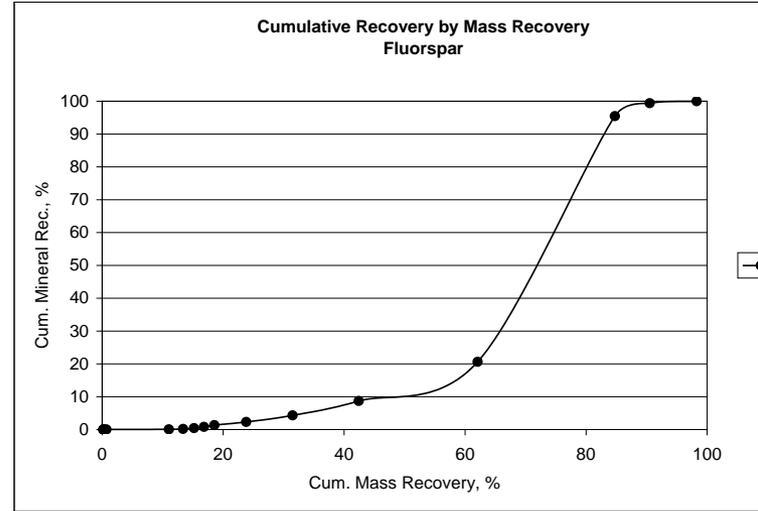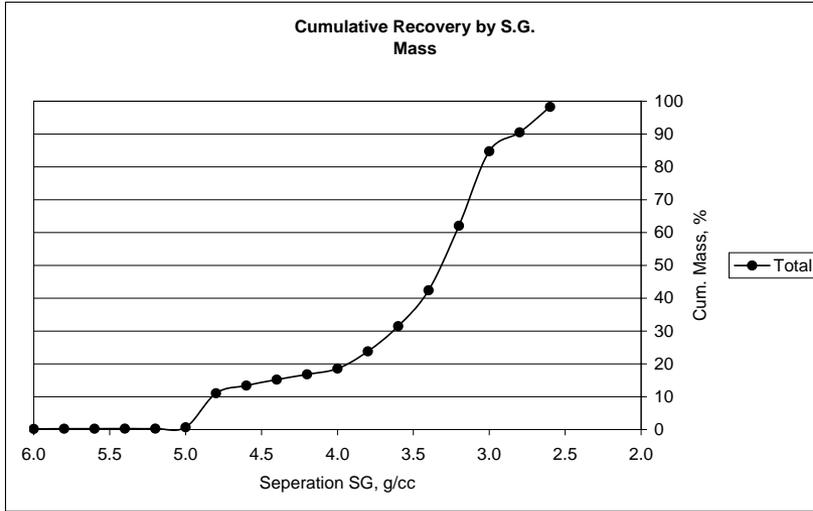| Mass Recovery, %					
	+63um	**-63/+45um**	**-45/+20um**	**-20um**	Total
S=0%	94.0	97.1	97.8	97.3	96.4
S<1%	3.89	1.13	0.83	1.83	2.16
S<5%	1.21	0.66	0.54	0.13	0.59
S<10%	0.26	0.19	0.12	0.11	0.17
S>=10%	0.63	0.88	0.68	0.67	0.69
Total	100.0	100.0	100.0	100.0	100.0
S-Recovery, %					
S=0%					
S<1%	3.15	1.26	1.04	0.93	1.59
S<5%	11.5	4.40	3.92	1.03	4.91
S<10%	7.35	4.30	3.18	2.86	4.34
S>=10%	78.0	90.0	91.9	95.2	89.2
Total	100.0	100.0	100.0	100.0	100.0
Bi-Recovery, %					
S=0%					
S<1%	18.9	10.8	6.83	0.62	5.89
S<5%	61.4	45.7	39.5	1.66	21.8
S<10%	17.5	28.4	18.5	5.82	11.7
S>=10%	2.17	15.1	35.1	91.9	60.6
Total	100.0	100.0	100.0	100.0	100.0

S, Slimes and CaF2-Flotation

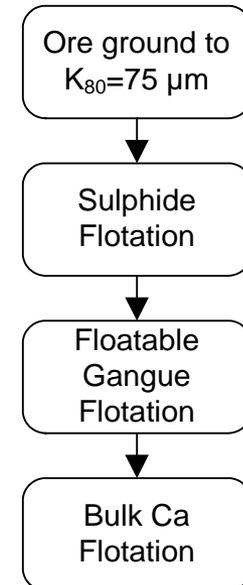## Simulation Conditions:

S>5   Particles containig more than 5% S
Si Float   Particles with a combined mass of 10% or more of: biotite+chlorite+chlorite(F)+clays+sericite/muscovite
CaF2   Particles containing 10% or more fluorspar
W   Particles containing 10% or more scheelite
Sn   Particles containing 10% or more cassiterite
Calcite   Particles containing 10% or more calcite
Ca Min   Particles containing 10% or more of fluorspar+scheelite+cassiterite+calcite
Other Ca   Particles containing 10% or more of the element Ca
Left Over   The rest

	Overall Recovery, % (Total Sample)				
	Mass	Bi-Minerals	Fluorspar	Scheelite	Cassiterite
S>5	0.86	**72.3**	0.29	0.40	0.21
Si Float	10.2	1.33	1.14	0.54	2.05

	Overall Recovery, % (Total Sample)				
	Mass	Bi-Minerals	Fluorspar	Scheelite	Cassiterite
CaF2	23.1	8.45	**94.1**	19.5	17.2
W	0.20		0.011	**76.6**	
Sn	0.079	0.036	0.006		**74.9**
Calcite	1.31		0.036		
Ca Min	0.38	0.15	0.23	0.55	0.88
Other Ca	37.0	11.9	3.08	1.71	2.08
Fatty Acid	62.1	20.5	97.5	98.3	95.1

Too Much Mass: 62.1%

Ore ground to K_{80}=75 µm

↓

Sulphide Flotation

↓

Floatable Gangue Flotation

↓

Bulk Ca Flotation

Can the Mass be reduced by Finer Grinding?

	Fatty Acid Float Recoveries, %				
	Mass	Bi-Minerals	Fluorspar	Scheelite	Cassiterite
Full Sample	62.1	20.5	97.5	98.3	95.1
-63 µm	58.9	9.42	98.7	99.2	96.9
-45 µm	58.2	4.95	99.1	99.7	98.8
-20 µm	58.3	1.46	99.5	99.7	99.7

Not Significantly

Needs Depression

Flotation with Depression

Calcite and Ca-Minerals are Depressed

But also

CaF2, W, Sn

(to a lesser degree)

	Limits for Flotation	
	No Depression	With Depression
S>5	5%	5%
Si Float	10%	10%
CaF2	10%	15%
W	10%	15%
Sn	10%	30%
Calcite	10%	80%
Ca Min	10%	20%
Other Ca	10%	22%

Ca-Flotation with Depression

Without Depression

	Mass	Bi-Minerals	Fluorspar	Scheelite	Cassiterite
		Overall Recovery, % (Total Sample) Without Depression			
S>5	0.86	**72.3**	0.29	0.40	0.21
Si Float	10.2	1.33	1.14	0.54	2.05
CaF2	23.1	8.45	**94.1**	19.5	17.2
W	0.20		0.011	**76.6**	
Sn	0.079	0.036	0.006		**74.9**
Calcite	1.31		0.036		
Ca Min	0.38	0.15	0.23	0.55	0.88
Other Ca	37.0	11.9	3.08	1.71	2.08
Left Over	26.9	5.86	1.07	0.75	2.67
Total	100.0	100.0	100.0	100.0	100.0
Sulphide	0.86	72.3	0.29	0.40	0.21
Fatty Acid	62.1	20.5	97.5	98.3	95.1

With Depression

	Mass	Bi-Minerals	Fluorspar	Scheelite	Cassiterite
		Overall Recovery, % (Total Sample) With Depression			
S>5	0.86	**72.3**	0.29	0.40	0.21
Si Float	10.2	1.33	1.14	0.54	2.05
CaF2	19.7	6.78	**91.0**	13.6	6.6
W	0.20		0.023	**80.3**	
Sn	0.060		0.007		**76.0**
Calcite	0.78		0.030	0.047	0.173
Ca Min	0.46		0.06	0.37	7.61
Other Ca	7.4	0.3	0.95	0.17	
Left Over	60.3	19.29	6.47	4.55	7.29
Total	100.0	100.0	100.0	100.0	100.0
Sulphide	0.86	72.3	0.29	0.40	0.21
Fatty Acid	28.6	7.1	92.1	94.5	90.4

Much less mass

Lower Recoveries
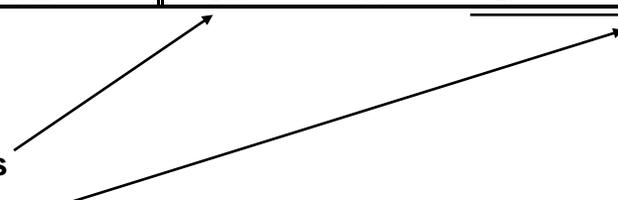
Bulk Ca-Float (with Depression) Cleaning:

Particle must contain >20% of Fluorspar+Scheelite+Cassiterite

Bulk Flotation Concentrate	
	Recovery, %
Mass	17.9
Fluorspar	88.7
Scheelite	94.2
Cassiterite	90.1

Flow diagram:

- Bulk Ca Flotation → Tails
- Bulk Ca Flotation → Regrinding To -45 µm
- Regrinding To -45 µm → Bulk Flotation Cleaning
- Bulk Flotation Cleaning → Gravity Separation of W and Sn
- Gravity Separation of W and Sn → Scheelite and Cassiterite
- Gravity Separation of W and Sn → Fluorspar
- Fluorspar → Regrinding to -20 µm
- Regrinding to -20 µm → Flotation Upgrading
- Flotation Upgrading → CaF2 Tail
- Flotation Upgrading → CaF2 Concl

Gravity Separation of Bulk Flotation Concentrate

Fine Gravity Separation:

MGS or Similar

Recovery to Heavies
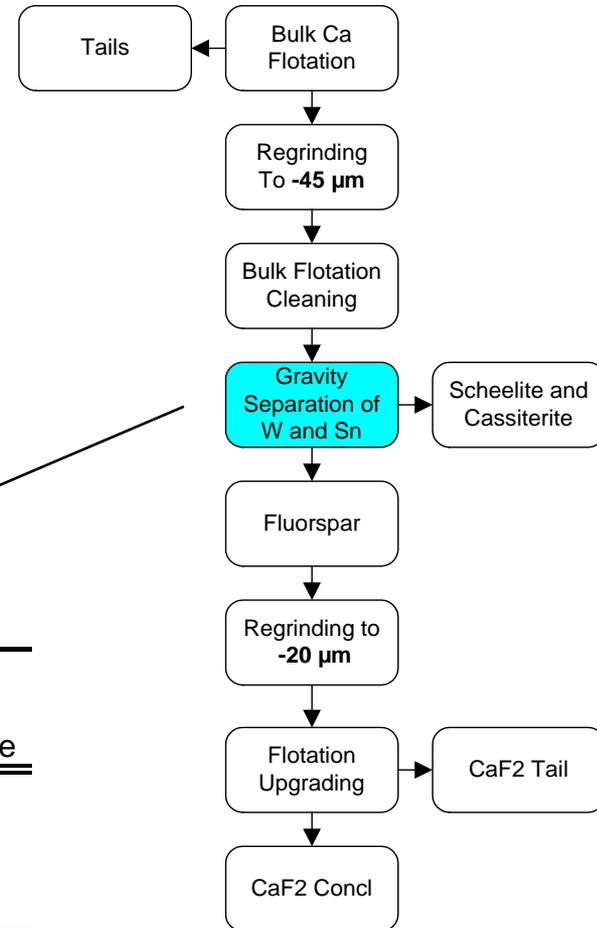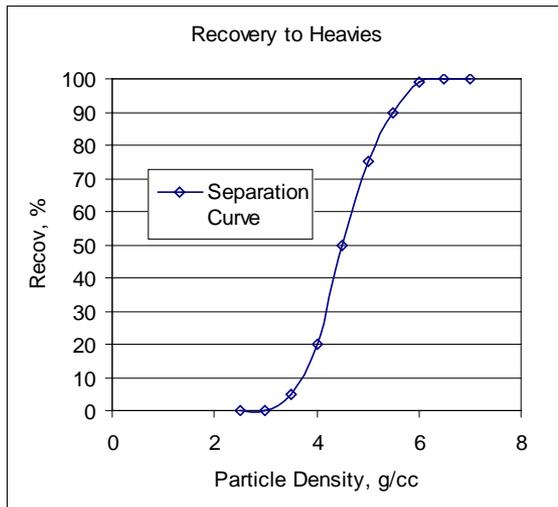
Grind	Recovery, %		
	Lights	Heavies	
	Fluorspar	Scheelite	Cassiterite
K80 = 75 µm	99.8	76.5	78.5
-63 µm	99.8	82.4	79.8
-45 µm	99.9	84.3	84.8
-20 µm	99.9	85.6	86.0

Gravity Separation: Coarser is EASIER/Cheaper

Bulk Ca Flotation → Tails

Bulk Ca Flotation → Regrinding To **-45 µm**

Regrinding To **-45 µm** → Bulk Flotation Cleaning

Bulk Flotation Cleaning → Gravity Separation of W and Sn → Scheelite and Cassiterite

Gravity Separation of W and Sn → Fluorspar

Fluorspar → Regrinding to **-20 µm**

Regrinding to **-20 µm** → Flotation Upgrading → CaF2 Tail

Flotation Upgrading → CaF2 Concl

MOINA QEMSCAN INTERPRETATION
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- Head and Available Metal
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- Flowsheet Simulation
- Magnetic Separation

Magnetic Separation

Assumptions:

All Fe-Oxide Minerals = Magnetite

Sn-Fe-Oxides Minerals = Cassiterite + Magnetite

	Recovery in Magnetic Concentrate				
Grind	Mass	Fluorspar	Fe	Scheelite	Cassiterite
K80 = 75 µm	25.3	6.77	72.1	4.70	45.4
-64 µm	24.9	3.91	73.7	1.77	42.3
-45 µm	23.6	2.79	72.6	0.91	34.5
-20 µm	19.7	1.66	68.2	0.17	25.7
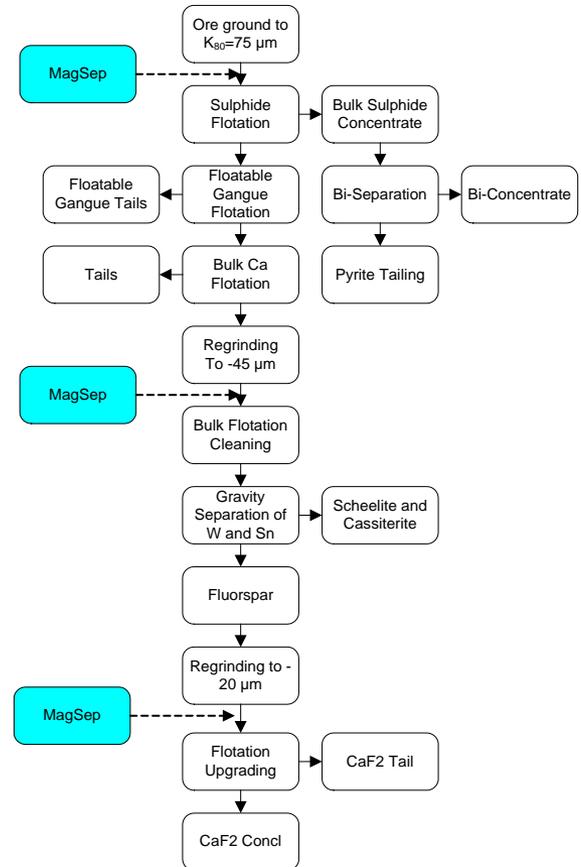
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- Simulated Recoveries

Overall Recoveries

Fluorspar:

The fluorspar concentrate will need to be reground and will be too fine to market without agglomeration. The concentrate grade will be limited by the 1% limit of CaCO3.

The maximum <u>fluorspar</u> recovery will be 83% (@ -20 µm). This equates to the <u>F-recovery</u> of 76.4%.

The recovery of fluorspar from the sample will be dictated by the concentrate quality.

Scheelite:

At target grade of 60% WO3, the <u>scheelite</u> recovery would be 87% without regrinding and 97% for a fine regrind of -20 µm.

The <u>WO3</u> recoveries will be 82.5% and 92% for no regrinding or -10 µm regrinding, respectively.

Overall Recoveries

Cassiterite:

Target grade = 70% Sn. The <u>cassiterite</u> recovery would be 45% without regrinding and 75% for a fine regrind of -20 μm.

Since only 48.3% of the Sn is in cassiterite, the <u>Sn-recoveries</u> will be 22% and 36% for no regrinding or -20 μm regrinding, respectively.

Bismuth:

Assuming the processing of the Bi-concentrate will likely be a leaching process. May be able to accept low-grade concentrate, below 20% Bi, or even 10%Bi. Recoveries (based on grade-recovery) can be over 90%.

Coarse flotation at start: maximum 73% Bi Recovery.