Flambeau Mine

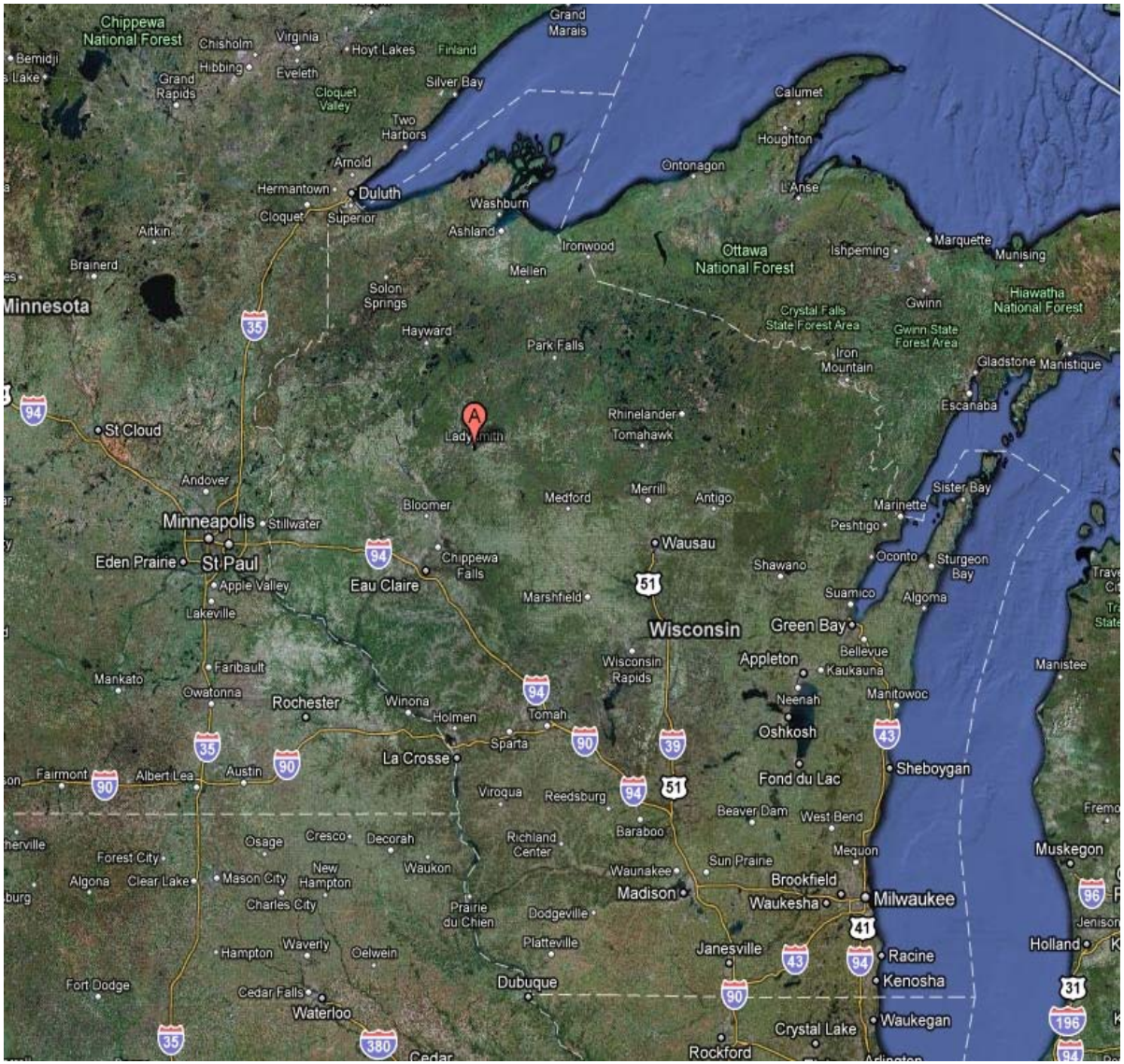
Ore Analysis

Overview

- Locality
- Flambeau Mine Data
- Flambeau Geologic Information
- SEM
- SEM Results
- Ternary Diagram

Location

- Ladysmith, Wisconsin
- 2500x500 x220 feet in size



Flambeau Record

- Years of operation 1993-1997
- 181,000 tons copper
- 334,000 ounces gold
- 3.3 million ounces silver
- Old accumulation of ore possibly 1860-520MA

Jones et al., 1999

Flambeau Record

- Similar to at least 10 other 'prospects' in Wisconsin differing mainly in types of ore- chalcocite
- Flambeau- and in a higher grade of ore
- Cherty horizons indicating hot springs within ore
- Distinctive mine in that the Chalcocite has an brassy yellow bronze, purple or blue patina on the crystals determined to be Bornite Cu_5FeS_4 coating by microprobe studies

Jones et al., 1999

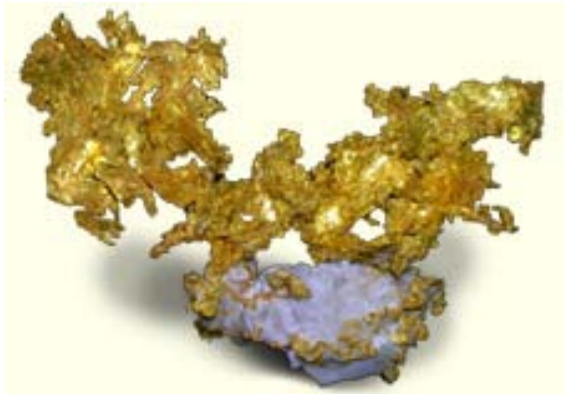
Flambeau Geologic Setting

- Mine in a broad belt of Precambrian volcanic and associated sedimentary rocks called the Wisconsin Magmatic Terranes on the South margin of the Canadian Shield
- Area was once tectonically active and beds were tilted up 90 degrees
- Rocks are remnants of a volcanic island arc that collided with ancient continent about 1860ma

Jones et al., 1999

Flambeau Primary Ore

- Pyrite- FeS_2
- Chalcopyrite-Cu FeS_2
- Chalcocite
- Sphalerite-Zn S
- Galena-Pb S
- Gold-Au
- Silver-Ag



Flambeau Ore Body

- Orebody is a volcanogenic massive sulfide (VMS) deposit
- One of the most concentrated ever mined
- Sulfides deposited on flanks of rhyolitic volcanic islands from hydrothermal brines containing Iron, Copper, Zinc, Lead, Silver and Gold
- At the Flambeau location these metal rich brines produced a layer of 50 foot layer thick sulfide mud with admixed volcanics

Jones et al., 1999

Flambeau Ore Body

- Flambeau is result of orebody extensively altered and enriched by chemical weathering
- Sulfide minerals were unstable in O rich ground waters
- Above water table sulfur went to sulfates by oxidation
- Fe in original pyrite,pyrrhotite and chalcopyrite oxidized into goethite or hematite
- These irons were insoluble and remained at surface and formed an iron rich cap with gold present

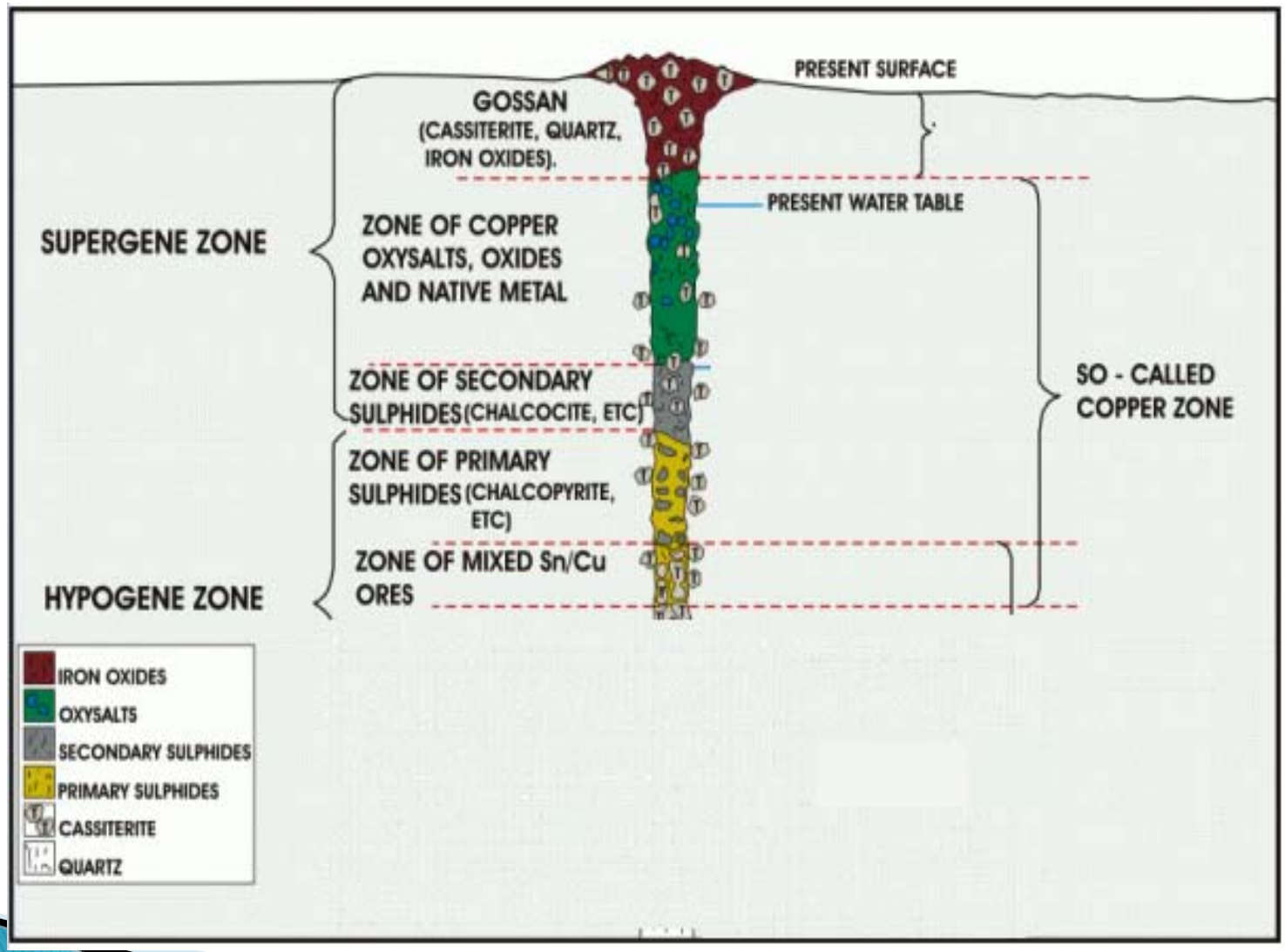
Jones et al., 1999

Flambeau Ore Body

- Near surface the acid rich ground water dissolved nearly all the Copper, Zinc and Silver and carried them deeper into the water table
- Below the water table oxygen was less available; Copper replaced iron in the sulfide minerals
  - Pyrite and pyrrhotite went to chalcopyrite, then bornite with iron going into the solution
  - Zoning of chalcocite, bornite, and chalcopyrite

DeMatties,T., 1996

Diagram of Mineralized Zones



www.poldark-mine.co.uk/images/geol_17

Methods

- Scanning Electron Microscope
- Used to obtain morphology and surface features of materials
- Electron Beams focused on a specific area of specimen
- Radiation signals are recorded by detectors
- Returned signals include secondary electrons, backscatter electrons, X Rays, emissions of ultraviolet, visible or infrared wavelengths during electron bombardment

Klein and Dutrow, 2008

SEM Ore Photos

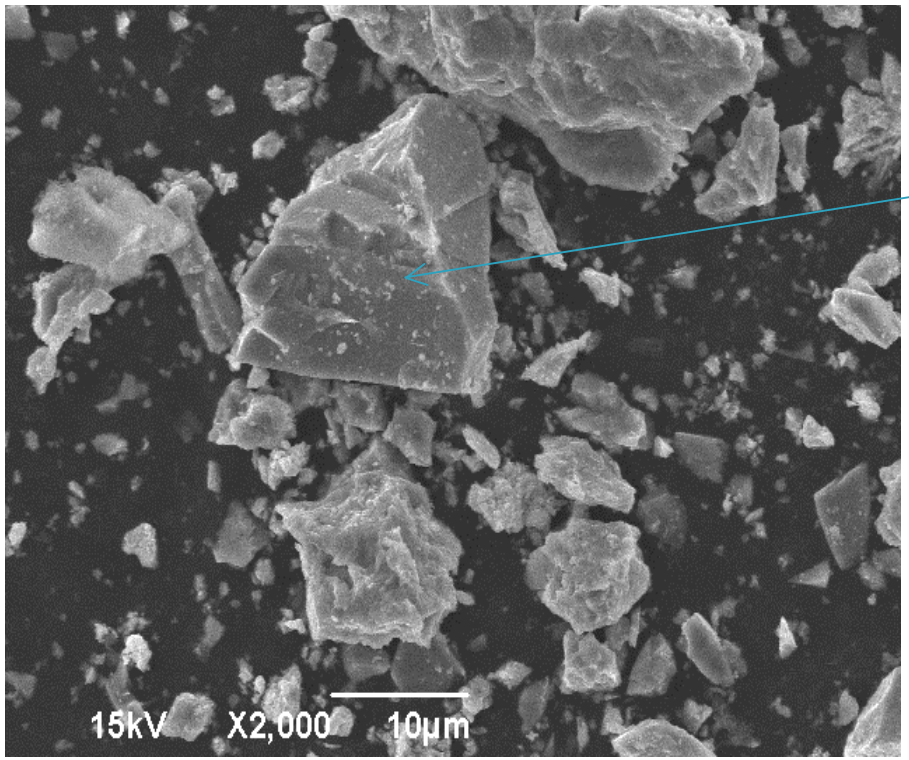
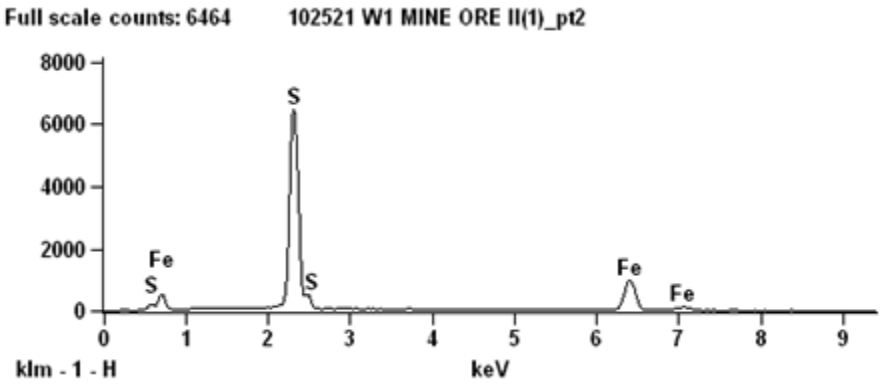


Photo of Pyrite determined by Mineral Recalculation using weight percent

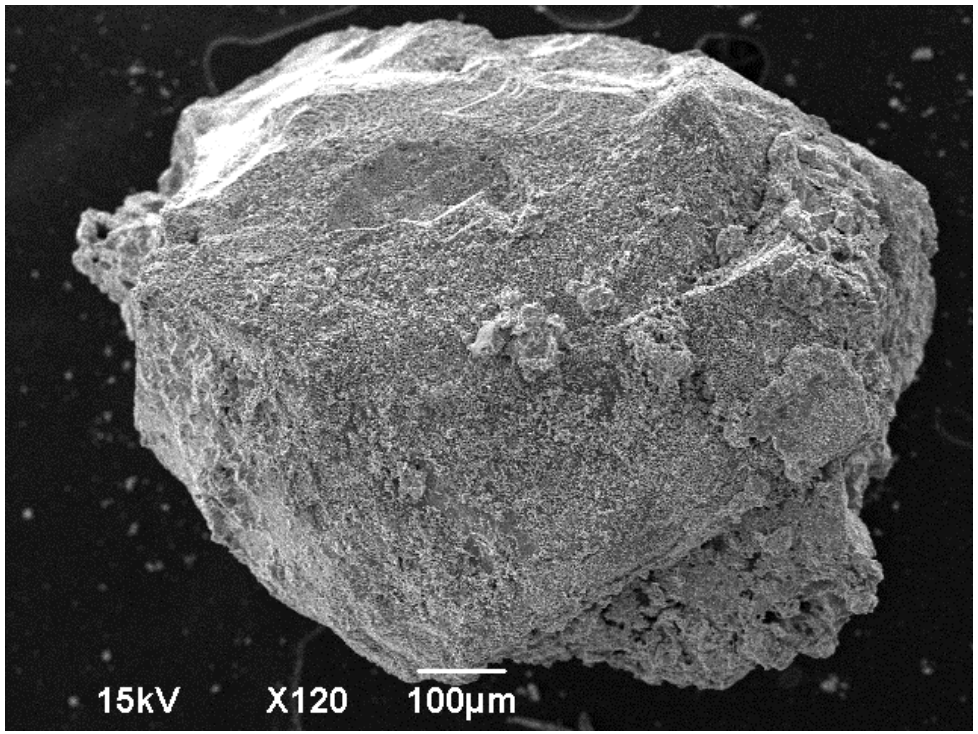
10521 Mine ore 2

Final Mineral Formula FeS_2



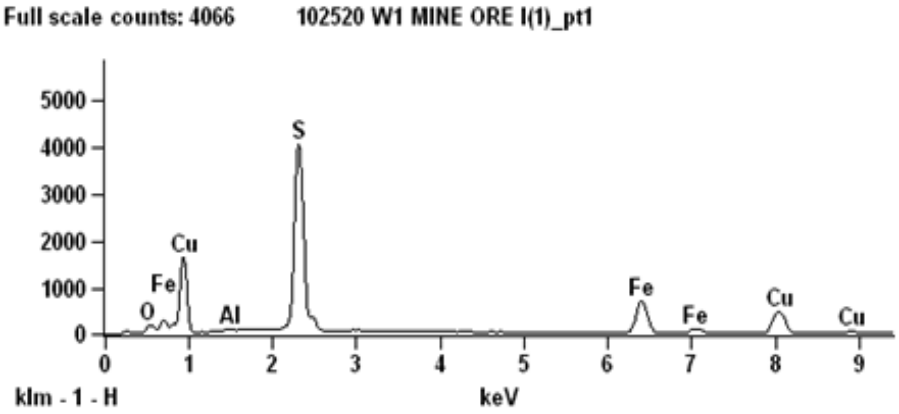
	Element	Wt% Sem	Atomic Weight	Atomic Proportion	Ratios
	S	53.34	32.06	1.663755459	2
	Fe	46.66	55.85	0.835452104	1
	Cu				
Total		100			

SEM Ore Photos



Mineral photo of **Chalcopyrite** by Recalculation of Mineral Weight Percent

Cu Fe S_2



	Element	Wt% SEM	Recalculate	Atomic Weight	Atomic Proportion	Ratios
	S	31.04	31.12403489	32.06	0.97080583	2
	Fe	25.18	25.24817006	55.85	0.452071084	1
	Cu	43.51	43.62779505	63.55	0.68651133	1
Total		99.73				

SEM Ore Photos

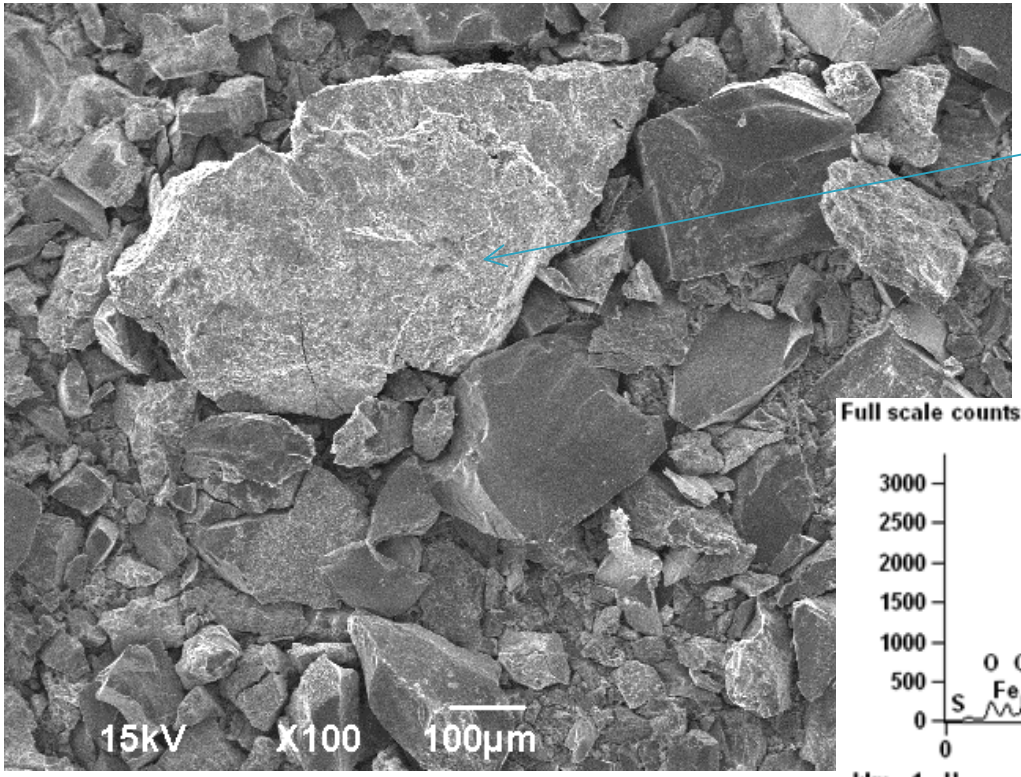
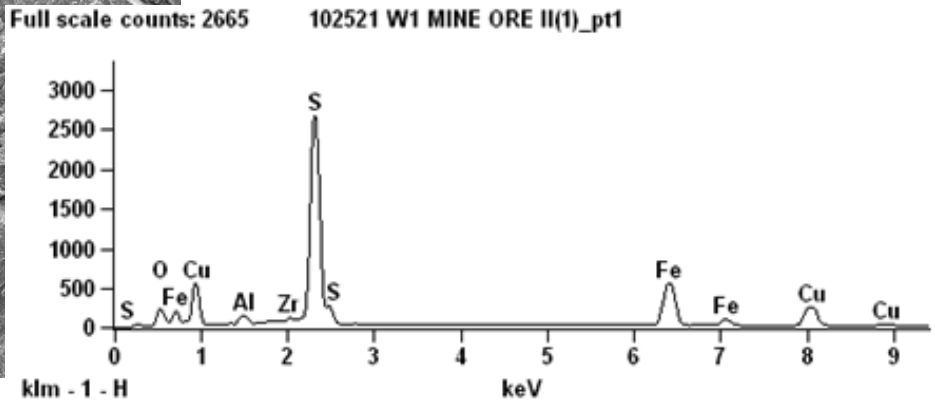


Photo of Chalcopyrite by Recalculation of Mineral Weight Percent

Cu Fe S_2



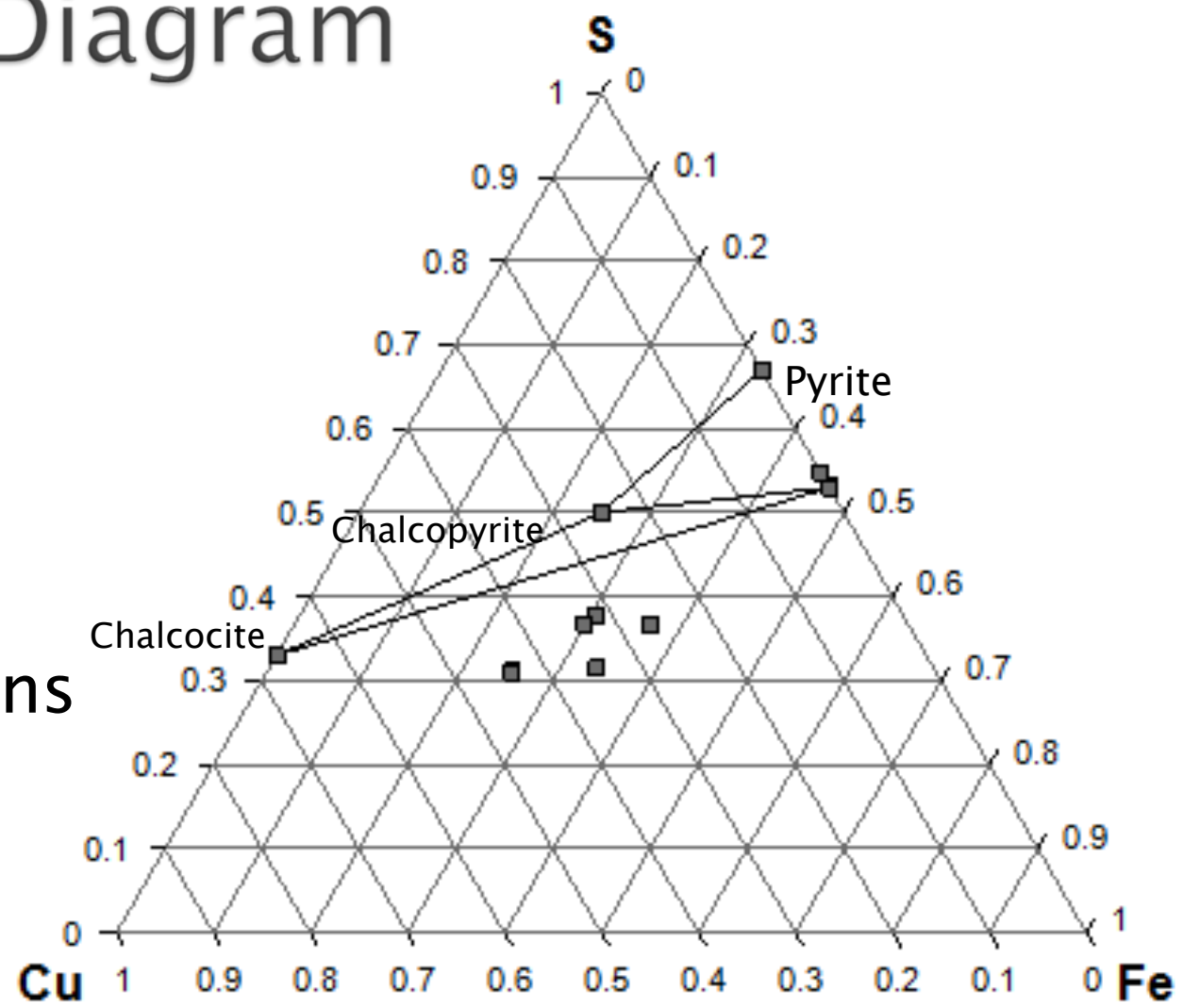
	Element	Wt% SEM	Recalculate	Atomic Weight	Atomic Proportion	Ratios
	S	36.79	37.70626217	32.06	1.176115476	2
	Fe	29.88	30.62416726	55.85	0.548328868	1
	Cu	30.9	31.66957056	63.55	0.498341	1
Total		97.57				

SEM Summary

- 8 points with numerous counts on each
  2500-7000 counts
- Both dark and light ore have similar composition
- Found 6 chalcopyrite $CuFeS_2$ and 2 Pyrite FeS_2
- 4 chalcopyrite points were almost exactly the correct formula
- 2 chalcopyrite points slightly different
- Pyrite points were nearly exact formulas

Ternary Diagram

- Corners consist of native elements
- Recalcs fell near actual compositions



References

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- DeMatties, T., 1996, A geologic framework for early Proterzoic volcanogenic massive sulfide deposits in Wisconsin: An exploration model. In Volcanogenic massive sulfide deposits of northern Wisconsin: A commemorative volume, Institute on Lake Superior Geology,42nd meeting, part 2, p. 31-65
- Jones, C., Koepp, J., and LaBerge, G., 1999, The Mineralogical Record, V.30, I.2, p. 107-116
- Department of Natural Resources- Wisconsin; http://dnr.wi.gov/org/aw/wm/mining/metallic/flambeau/ accessed 5/1/10
- www.poldark-mine.co.uk/images/geol_17

Questions?

Before

During

After