PHOENIX GEOLOGICAL PAPERS

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George Addie, BSc., Geologist

THE GRANBY MINING COMPANY LIMITED

PHOENIX COPPER DIVISION

August 7, 1963

TO Mr. P. R. Matthew, Manager

FROM Mr. George Addie, Geologist

SUBJECT Phoenix Field Geology

Most of the month of July was spent mapping the area immediately North and East of the Ironsides Pit. Three interesting observations were made as follows:

1. The Argillite Contact
2. Auriferous Copper Skarn
3. Possible Porphyry Copper and Mineralization Source

1. The Argillite Contact:

The sequence of sharpstone, argillite with pebbles or concretions, aeolian sandstone, and skarn or limestone has been found to be very consistant. The argillite-sandstone together, make an excellent marker horizon. This sequence is present on the footwall of Ironsides and starting at a point approximately 1100' WNW of the Brooklyn Pit and going over 3000' on a bearing of N10°E passing approximately 400' to the West of Marshall Lake. This contact has a decreasing amount of skarn going Northward. It is proposed that this contact is identical to that in the Ironsides Pit. However, there is a separation of 2800' between the end of Ironsides Pit argillite and where it is seen again WNW of the Brooklyn Pit. Probably this is due to a number of faults which have not yet been located.

Conclusion:

Neither the Stemwinder nor Brooklyn-Idaho can be structurally related to the Ironsides (although the mineralization is the same) and that when the fault problem is solved, more of the Ironsides ore will be found.

2. Auriferous Copper Skarn:

L.W. Brock has pointed out in his report of 1902-3 (GSC Vol. 15) that the ores from the North side of the Phoenix ravine has a higher gold content.

At the two pits on the argillite contact to the WNW of the Brooklyn mine, the assays are:

Massive Pyrite	Cu Tr	Magnetic skarn	Cu 2.15%
	Ag 0.28 oz/T		Ag 1.72 oz/T
	Au 0.135 oz/T		Au 0.610 oz/T
			Zn 0.60%

(SYLV. - K)

August 7, 1963

TO Mr. P. R. Matthew, Manager

FROM Mr. George Addie, Geologist

SUBJECT Phoenix Field Geology (Cont'd)

2. Auriferous Copper Skarn: (Cont'd)

Approximately 700' E of Marshall Lake there is a pit in limestone with some magnetite which assays:

Cu	Tr
Ag	0.40 oz/T
Au	0.190 oz/T
Zn	8.60%

Conclusion:

The Argillite contact pits should be further investigated. As magnetic material is present in both pits, a ground magnetometer survey would probably give a sufficient indication of the size involved.

3. Possible Porphyry Copper and Mineralization Source:

At the Gilt Edge workings there is a fine grain, magnetic granodiorite which has been found to assay:

Granodiorite	Cu	0.52%	Skarn	Cu	0.52%
	Ag	0.12 oz/T		Ag	0.36 oz/T
	Au	0.05 oz/T		Au	0.04 oz/T
	Zn	Tr %			

While the granodiorite Ag/Au ratio indicates a higher temperature than the Ironsides Pit area, the skarn ratio fits the Ironsides Ag/Au curve very well.

It is interesting to note that the pits on the Argillite contact to the West of Marshall Lake and the pit 700' to the East have zinc values while the Gilt Edge and Ironsides do not. These pits are either a different period of mineralization (ie: Summit Camp) or they make a lower temperature zone around the thermal center.

Conclusion:

It is possible that the Gilt Edge granodiorite is the actual source of mineralization, and that a porphyry type copper ore exists in the unexplored granodiorite.

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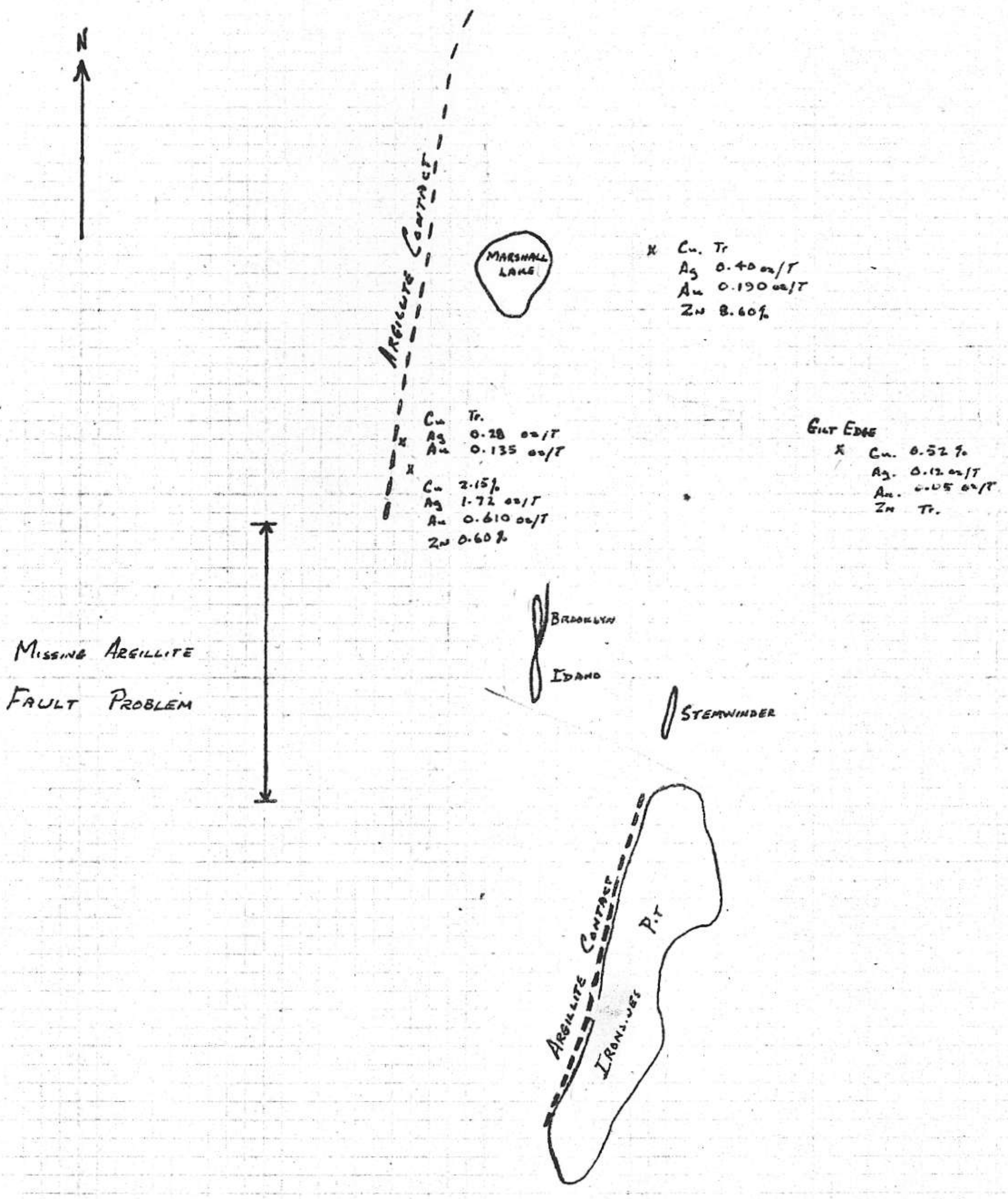


Location Sketch for July, 1963

Scale 1" = 1320'

PHOENIX GEOLOGICAL PAPERS

1 9 6 3

1. THE RELATIVE ISOMIN
2. THE RELATIVE ISOMAG
3. PHOENIX - MIRROR IMAGE MINE THEORY
4. COPPER-EXCESS SULPHUR HYPOCYCLOID

THE RELATIVE ISOMIN

DEFINITION:

The relative isomin is a measure of equal mineralization expressed as a percentage of the foot assay values for the area under consideration.

PROCEDURE:

In the Rawhide case all the intersections of vertical drill holes have been used. The foot assay value for each drillhole is expressed as a percentage of all the foot assay values of the drill holes in this area. The same technique has been used with the values obtained from the Rawhide percussion drillholes.

THEORY:

It is possible that hypothermal solutions may have followed some channel in the skarn zone. If so, then one would expect the mineralization to be strongest in this channel. Thus, even though the concentrations may change the relative values would indicate the channel. In this case it is assumed that the assays represent one continuous ore zone with a consistent dip.

APPLICATION:

When the Isomin map is compared with the isochlore map it is seen that in most cases the anomalies co-incide. When the isomin map from the percussion drill holes is related to the diamond drill hole isomin map, one gets the impression of a mature river channel with an ox-bow lake.

CONCLUSION:

The concept of the relative isomin is useful in locating ore zones. Contouring of foot assay values give erratic and confusing contours. When these are converted to a relative value the results become more meaningful. This is a useful economic concept in that once the relative mineralization is known, the ore grade can be picked out and followed.

THE GRANBY MINING COMPANY LIMITED
PHOENIX COPPER DIVISION
GRAND FORKS, B.C.

SCALE: 1 INCH 100 FEET

TITLE Monarch Isomin Map (from Percussion Holes)

NO.

G. Addie

D A T A

Hole	Width	Cu.	Ratio	Isomin	Ft. Assay
328	14.5	2.40	4.1	2.4	34.7
277	13'	2.60	15	2.3	33.8
267	4	5.60	15	1.5	22.4
247	12	1.90	20	1.6	22.7
314	20	0.7	10	1.0	14.0
315	40	2.19	16.5	6.0	87.5
293	24	1.2	10	2.0	28.9
502	18	1.63	26	2.0	29.4
501	38'	1.68	6.89	4.4	64.1
	8'	2.5	16.6		
508	7'	0.9	10	1.8	26.3
			9.4		
510	36	1.74	3.3	4.3	62.6
482	6	1.10	10	0.4	6.6
479	6	2.30	30	0.9	13.8
518	6	1.60	5	0.6	9.6
516	18	0.92	13.9	1.1	16.2
321	9	3.2	3.3	1.6	23.8
324	11	1.1	10	0.8	12.1
322	9	1.3	6	0.8	11.7
397	6	1.0	10	0.4	6.0
400	15	5.3		5.5	79.5
401	11	2.7		2.7	39.7
402	16	1.7		1.9	27.2
403	13	0.7		0.6	9.1
462	7	3.4		1.6	23.8
463	6	1.8		0.7	10.8
464	6	3.7		1.5	22.2
274	11	1.91		1.4	21.0
272	16	0.8		0.9	12.8
276	26	1.1		2.0	28.6
266	8	1.4		0.8	11.2
271	5	0.7		0.2	3.5
295	10	0.9		0.6	9.0
279	9	0.8		0.5	7.2
278	19	1.8		2.3	34.2
246	14	1.5		1.4	21.0
421	14	1.2		1.1	15.7
422	5	2.1		0.7	10.5
296	12	2.9		2.3	34.9
285	34	1.3		3.0	44.1
290	17	1.6		1.9	27.2
288	14	1.7	5	1.6	23.7
310	29	0.7		1.4	20.2
282	21	2.7		3.9	56.9
317	18	1.2		1.5	21.6
504	16	1.5		1.4	20.8
503	19	1.86		2.4	35.
394	13	0.9		0.8	11.7
505	13	1.8		1.7	24.6
395	4	1.8		0.5	7.2
506	12	1.2		1.0	14.4
430	10	3.2		2.2	32.
613	14	3.1		2.9	42.6

Hole	Width	Cu.	Ratio	Isomin	Ft. Assay
(633	99'	1.7)			
616	10	2.4		1.6	24.
547	12	1.7		1.4	20.4
514	19	1.64		2.1	31.2
399	5	1.1		0.4	5.5
398	3	4.0		0.8	12.0
323	28	1.0		1.9	28.
327	8	0.6		0.3	4.8
			TOTAL	99.3%	145.6

THE RELATIVE ISOMAG

DEFINITION:

The relative isomag is a measure of equal magnetic values expressed as a percentage of the sum of the magnetic values for the area under consideration.

PROCEDURE:

The gamma values for the area under consideration are added and each value is expressed as a percent of the total. These percentages are then contoured.

THEORY:

If an area is blanketed by a magnetic bed, or flow, the sub-surface anomalies may be masked. However, by finding the relative value of the magnetic readings this masking effect can be eliminated.

APPLICATION: (See Moe Ground Magnetometer Map and Moe Relative Isomag Map)

In an examination of the Moe anomaly it is found that the major magnet features are reproduced in the Relative Isomag Map. The difference appears in the lower, or background readings. On the center east side of the map area the 4500 gamma anomaly becomes more pronounced in the relative isomag map. Also the area of the 3000 gamma readings is much larger than the corresponding isomag area. This allows for further interpretation of the area.

OBSERVATIONS: See Appendix I

MAP DATA: See Appendix II

CONCLUSION: The relative magnetic values may be more discriminating than the gamma reading alone, especially if an area is masked by magnetic beds or flows.

APPENDIX I

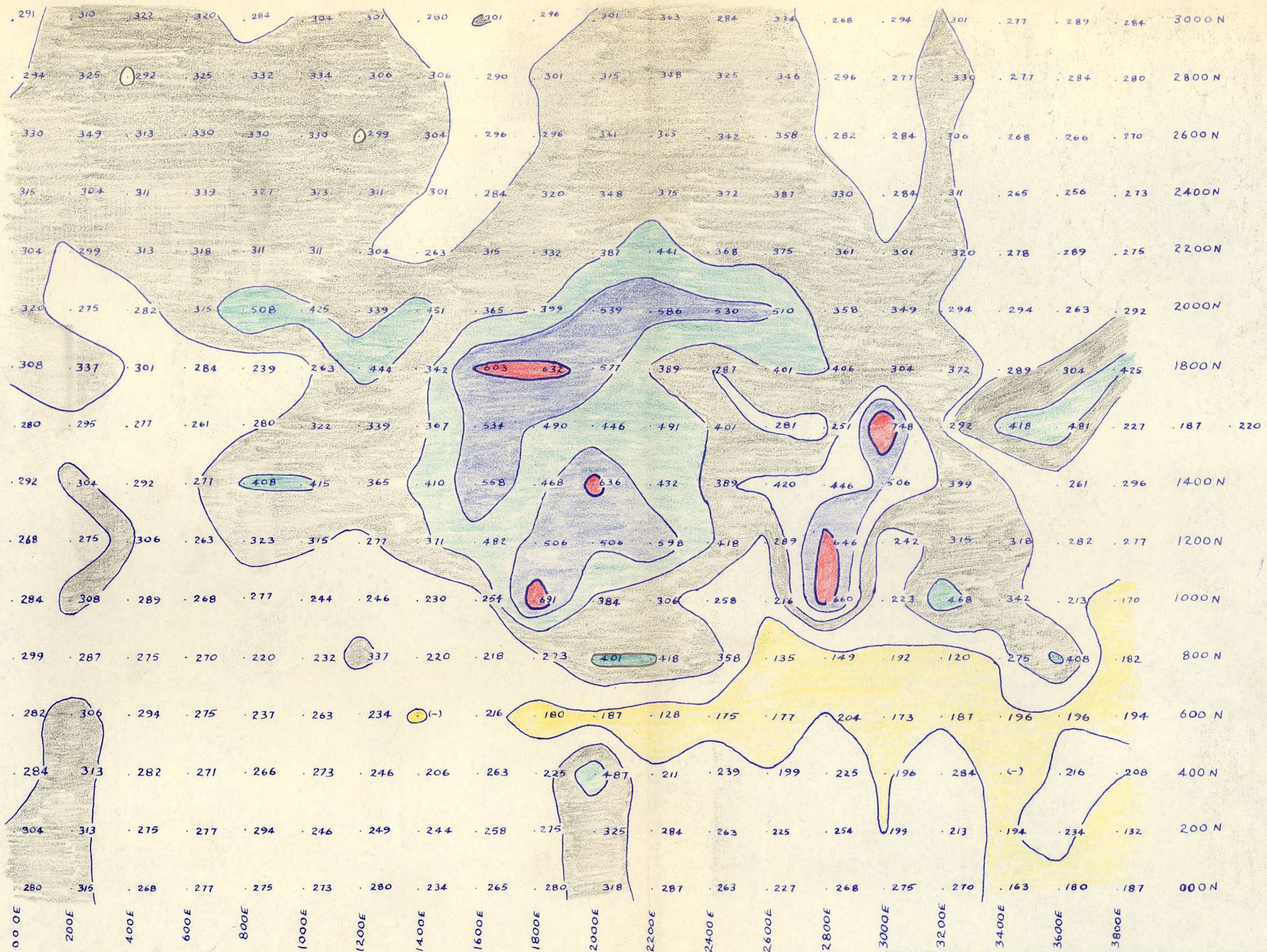
Gamma	%	Gamma	%	Gamma	%	Gamma	%	Gamma	%
3127	.291	3535	.330	3255	.304	3306	.308	3127	.292
3331	.310	3739	.349	3205	.299	3612	.337	3255	.304
3458	.322	3356	.313	3356	.313	3229	.301	3127	.292
3433	.320	3535	.330	3407	.318	3050	.284	2974	.277
3051	.284	3535	.330	3331	.311	2566	.239	4377	.408
3255	.304	3535	.330	3331	.311	2821	.263	4453	.415
3229	.301	3203	.299	3254	.304	4759	.444	3917	.365
2999	.280	3254	.304	2821	.263	3662	.342	4402	.410
3299	.301	3178	.296	3382	.315	6467	.603	5983	.558
3178	.296	3178	.296	3560	.332	6773	.632	5014	.468
3227	.301	3661	.341	4145	.387	6186	.577	6825	.636
3890	.363	3916	.365	4732	.441	4171	.389	4632	.432
3050	.284	3662	.342	3943	.368	3076	.287	4172	.389
3586	.334	3841	.358	4019	.375	4300	.401	4504	.420
2872	.268	3025	.282	3867	.361	4351	.406	4785	.446
3153	.294	3051	.284	3229	.301	3255	.304	5422	.506
3229	.301	3280	.306	3433	.320	3994	.372	4274	.399
2974	.277	2872	.268	2985	.278	3101	.289		
3102	.289	2847	.266	3102	.289	3255	.304	2796	.261
3051	.284	2898	.270	2949	.275	4555	.425	3174	.296
3153	.294	3382	.315	3433	.320	3000	.280	2872	.268
3484	.325	3255	.304	2949	.275	3165	.295	2949	.275
3127	.292	3331	.311	3025	.282	2974	.277	3280	.306
3484	.325	3637	.339	3382	.315	2795	.261	2821	.263
3561	.332	3510	.327	5448	.508	3000	.280	3459	.323
3586	.334	3357	.313	4555	.425	3450	.322	3382	.315
3280	.306	3331	.311	3637	.339	3637	.339	2974	.277
3280	.306	3229	.301	4835	.451	3934	.367	3977	.371
3101	.290	3050	.284	3917	.365	5728	.534	5167	.482
3229	.301	3433	.320	4274	.399	5256	.490	5429	.506
3380	.315	3737	.348	5777	.539	4785	.446	5422	.506
3737	.348	4018	.375	6287	.586	5268	.491	6417	.598
3484	.325	3994	.372	5677	.530	4300	.401	4478	.418
3713	.346	4147	.387	5473	.510	3016	.281	3101	.289
3178	.296	3535	.330	3841	.358	2694	.251	6927	.646
2974	.277	3051	.284	3739	.349	8025	.748	2592	.242
3535	.330	3331	.311	3152	.294	3127	.292	3382	.315
2974	.277	2846	.265	3152	.294	4478	.418	3407	.318
3051	.284	2745	.256	2821	.263	5153	.481	3025	.282
2999	.280	2923	.273	3127	.292	2430	.227	2974	.277
						2005	.187		
						2362	.220		

APPENDIX I- Cont'd

Gamma	%	Gamma	%	Gamma	%
3051	.284	3025	.282	3255	.304
3305	.303	3280	.306	3357	.313
3102	.289	3152	.294	2948	.275
2872	.268	2948	.275	2974	.277
2974	.277	2541	.237	3153	.294
2617	.244	2821	.263	2643	.246
2642	.246	2515	.234	2668	.249
2464	.230			2617	.244
2719	.254	2311	.216	2770	.258
7411	.691	1928	.180	2948	.275
4122	.384	2005	.187	3484	.325
3280	.306	1368	.128	3051	.284
2770	.258	1877	.175	2821	.263
2311	.216	1903	.177	2413	.225
7080	.660	2184	.204	2719	.254
2388	.223	1852	.173	2133	.199
5014	.468	2005	.187	2285	.213
3662	.342	2102	.196	2081	.194
2286	.213	2107	.196	2515	.234
1827	.170	2082	.194	1419	.132
3204	.299	3051	.284	3000	.280
3076	.287	3357	.313	3382	.315
2948	.275	3025	.282	2872	.268
2897	.270	2897	.271	2974	.277
2362	.220	2847	.266	2949	.275
2490	.232	2923	.273	2923	.273
3611	.337	2642	.246	2999	.280
2362	.220	2209	.206	2515	.234
2336	.218	2821	.263	2846	.265
2923	.273	2413	.225	2999	.280
4300	.401	5218	.487	3408	.318
4479	.418	2260	.211	3076	.287
3841	.358	2566	.239	2821	.263
1444	.135	2132	.199	2438	.227
1597	.149	2413	.225	2872	.268
2056	.192	2107	.196	2949	.275
1291	.120	3050	.284	2897	.270
2948	.275			1750	.163
4377	.408	2311	.216	1929	.180
1954	.182	2235	.208	2005	.187
			Totals	1,072,119	99,955%

DATA

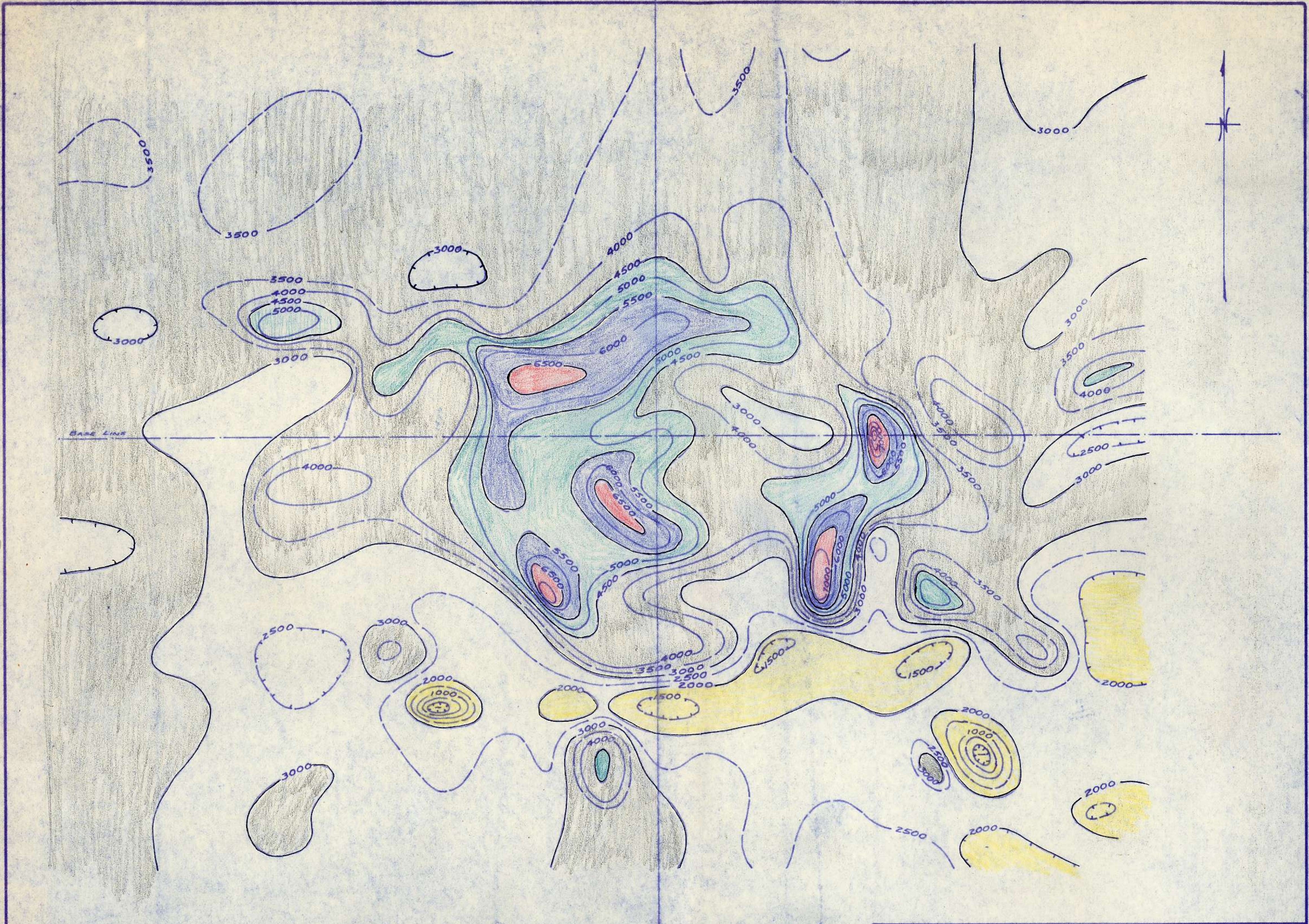
Gamma Values	Rel. Isomag Values (%)
2000	.187
3000	.280
4500	.420
5500	.513
6500	.609



MOE ISOMAG MAP

Scale: 1" = 400'

G. Addie



GAMMA CONTOURS

MOE GROUP OF MINERAL CLAIMS

GREENWOOD AREA, B.C.

CONTOUR INTERVAL = 500 GAMMAS

1 INCH = 400 FEET

PHOENIX - MIRROR IMAGE MINE THEORY

THEORY:

The area covered by the Granby, Air Magnetometer map of the Eholt area, March 1956, is cut by a major E-W tongue of the Boundary Creek batholith, and on each side of this tongue (indicated by the main 2400 gamma anomaly), similar deposits will be found.

OBSERVATIONS:

1. Silver/Gold Ratio - From previous silver/gold ratio studies it has been found that major mines (Motherlode, Phoenix, Summit) have similar thermal characteristics and that their copper values all are related to these ratios by an equation similar to Newton's Law of Cooling. These similarities suggest a similar source for all the copper mineralization.

SHAPE OF INTRUSIVE:

The igneous tongue is widest in the west suggesting that this area would be the hottest. The silver/gold ratios do suggest the same temperature relationship.

ELEVATION:

Emma	3500')	All in the area above 2400 gammas and on the south edge of the tongue
Ora Denora	3500'(	
Motherlode	3450')	
B. C. Mine	3600')	
Phoenix		--Inbetween areas of 2400 gammas probably within tongue area of 2400 gammas.
Big Copper Mine		

It seems strange that these mines should have such a close similarity of elevations. This would suggest that the ore solutions emanated from the same source and at these particular elevations reached a critical point when deposition took place.

GOLD MINES:- Two known gold mines, the Gold Bug and Jewel Mine occupy relatively similar positions on each side of the intrusive tongue.

CONCLUSION:

Ironsides - Mirror Mine: If the above theory is correct the Morning Star area, although lacking in limestones is in a mirror position to Ironsides.


N
Motherlode
Sunset
Gold Bug Au.
× Jewel Au.
Morning Star
Emma
Oro Denoro
Ironsides
Snowshoe
BC Mine
Mirror Image Theory
Area above 2400 gammas
Scale 1" = ½ m.
inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

COPPER - EXCESS SULPHUR HYPOCYCLOID

PROCEDURE:

The excess sulphur was found by subtracting the copper assay from the sulphur assay. It is assumed that this excess sulphur has gone into pyrite.

OBSERVATION:

In the field there is a suggestion of:-

1. An inverse relation of pyrite and chalcopyrite.
2. Two periods of pyritization may be present.
3. Iron is considered to be in excess at all times.

Theory 1. - All the pyrite and chalcopyrite came at the same time.

The Copper to Excess Sulphur Hypocycloid suggests that up to 0.85% Cu. the grade may be dependent on the amount of sulphur available. Thus, up to this point, a sulphur rich environment is important. This is probably co-existent with a pyrite facies of mineralization. However, after this point there is a rapid decrease in sulphur. It may be that after 0.85% Cu. the temperatures involved are such that the pyrite is mobilized out of this zone but the sulphur is free to react with the copper to form the chalcopyrite.

Theory 2. - Two stages of pyritization are present.

Pre-ore pyrite could form a base of approximately 1% S. The cusp of the hypocycloid would then indicate a facies or channel of pyritization. (Thinking in terms of hypothermal solutions) From this one would expect the copper values to also increase with the amount of pyritization.

Theory 2 cont'd

Again at the peak of the cusp a mobilization of pyrite may take place giving a decrease in excess sulphur as the copper increases, that is, higher temperatures are involved. Or, the 0.85% Cu. values may mark a channel through which pyrite solutions were able to move.

Theory 3 - One period of copper mineralization after a period of pyritization

As the copper hypothermal solutions were introduced they replaced and filled some of the pyrite. Thus, the grade would be directly related to the amount of pyrite available for replacement. However, at the top of the cusp 0.85% Cu. the thermal gradient would be strong enough for the mobilization of pyrite. The copper solutions would then replace the skarn minerals or fill open spaces. This would mean that the pyrite in grades up to 0.85% can be expected to be relatively highly contaminated by chalcopyrite while the pyrite in the 0.85% and up range will be re-mobilized pyrite and relatively free of contamination.

Relation of Mill Recovery to Excess Sulphur

Again a hypocycloid curve is found but not of the same order as the above curve. This indicates that other factors are involved. However, these curves do indicate that the recovery is related to the grade and excess sulphur. Considering the normal range of recovery to be 80-90%, if the pyrite can be removed, the recovery will increase.

REPORTS:

Dr. G. Aletan (Jan. 1963) reports that over 95% of all Hematite, Magnetite and Pyrite are free of any contamination of chalcopyrite. (Author's note: This is from an examination of a concentrate.)

RECOMMENDATIONS:

1. Over 100 specimens should be assayed for Cu. and S. to see if the hypocycloid curve is true. The grade should have an even spread from 0.5-1.5% Cu.
2. Examine high grade and low grade (Cu. ore) for contaminated pyrite.

CONCLUSION:

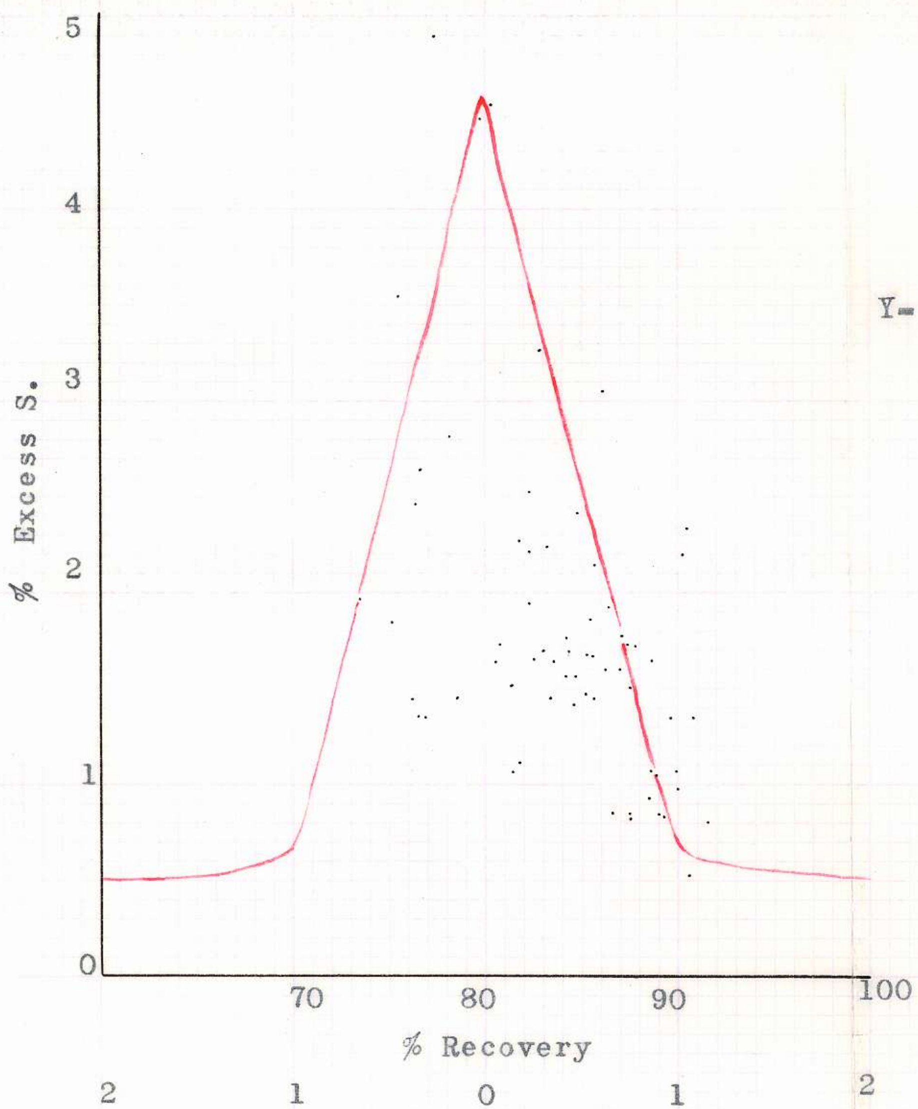
In unmixed ores in the recovery range of 80-90% (Grades above 0.85% Cu.) expulsion of the relatively barren pyrite will rapidly increase the recovery. In the lower grades (below 0.85% Cu.) the pyrite aids or has copper values.

DATA

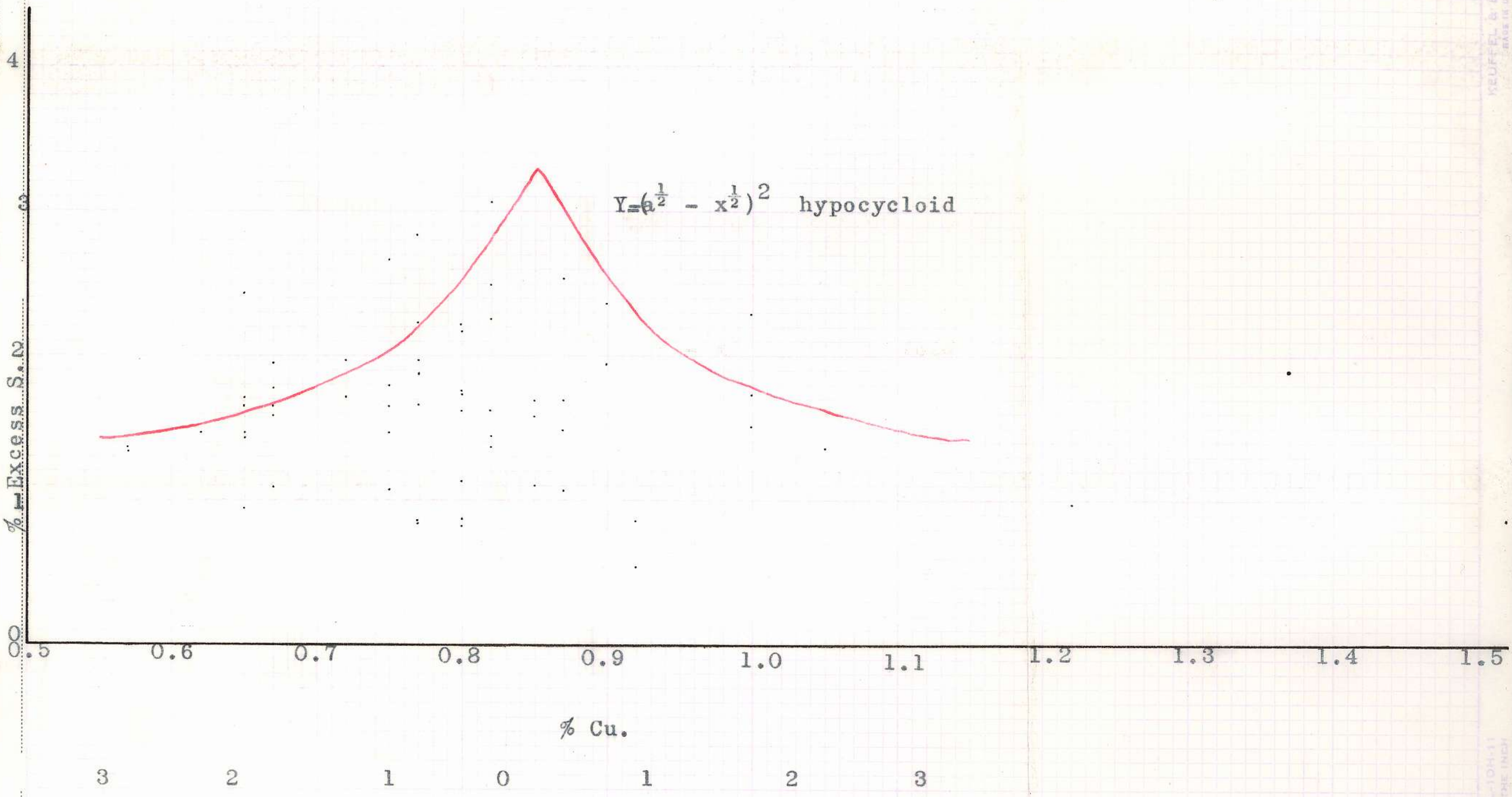
Date	Head Assay	Sulphur Assay	Excess Sulphur	Recovery
May 11 '59	0.77	2.41	1.64	88.67
12	0.87	1.92	1.05	88.90
13	0.80	1.66	0.86	86.67
14	0.85	1.94	1.09	88.62
15	0.65	1.58	0.93	88.53
16	0.77	1.51	0.84	90.01
17	0.80	1.65	0.85	89.09
18	0.75	1.81	1.06	87.09
19	0.92	1.86	0.84	87.42
20	1.22	2.20	0.98	90.64
21	1.05	2.40	1.35	90.88
22	0.80	1.60	0.80	91.54
23	0.92	1.44	0.52	90.58
24	0.77	1.60	0.83	89.93
June 3	0.80	1.91	1.11	81.77
10	1.37	3.25	1.88	85.45
24	0.57	1.90	1.33	89.73
July 1	0.37	1.81	1.44	76.11
11	0.75	2.54	1.79	87.19
28	1.52	2.36	0.84	87.50
Aug 24	1.52	6.10	4.58	80.68
25	1.10	6.00	4.90	77.24
26	1.32	5.80	4.48	79.84
27	0.82	3.86	3.04	86.03
28	0.90	3.25	2.35	90.51
29	0.82	2.24	1.42	84.67
30	0.77	2.74	1.97	73.46
31	0.32	3.87	3.55	75.31
Sept 1	0.65	2.28	1.63	80.57
2	1.10	2.60	1.50	87.75
3	0.82	2.18	1.36	76.41
4	1.00	3.28	2.28	81.71
5	0.82	3.30	2.48	76.27
6	0.87	3.38	2.51	82.14
7	0.80	3.00	2.20	90.41

D A T A

Date	Head Assay	Sulphur Assay	Excess Sulphur	Recovery
Feb '60	0.87	2.36	1.49	85.13
Mar	0.67	2.24	1.57	84.13
Apr	0.65	2.35	1.70	84.07
May	0.67	2.44	1.77	84.21
July	0.82	3.06	2.24	83.22
Aug	0.75	2.20	1.45	85.86
Sept	0.80	2.54	1.74	81.78
Oct	0.77	3.58	2.81	78.08
Nov	0.75	3.40	2.65	76.58
Dec	0.77	2.62	1.85	75.11
Jan '61	0.67	1.76	1.08	81.36
Feb	0.57	1.92	1.35	76.91
Mar	0.75	3.38	1.63	82.47
Apr	0.65	2.11	1.46	78.69
May	0.90	2.82	1.92	86.42
July	0.80	2.96	2.16	85.77
Aug	0.62	2.08	1.46	83.23
Sept	0.67	2.30	1.63	83.64
Oct	0.72	2.42	1.70	84.30
Nov	0.80	2.52	1.72	87.42
Dec	1.00	2.72	1.72	87.86
Jan '62	0.87	2.56	1.69	85.15
Feb	0.85	2.53	1.68	85.42
Mar	0.72	2.67	1.95	
Apr	0.85	4.12	3.27	82.99
May	0.65	3.06	2.41	84.89
June	0.77	2.98	2.21	82.18
July	0.67	2.61	1.94	82.35
Aug	0.85	2.42	1.57	84.76
Sept	0.82	2.42	1.60	86.16
Nov	0.65	2.06	1.41	81.39



$Y = (a^{\frac{1}{4}} - x^{\frac{1}{4}})^4$ (hypocycloid)



$Y=(a^{\frac{1}{2}} - x^{\frac{1}{2}})^2$ hypocycloid
% Excess S.
0
1
2
3
4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
% Cu.
3
2
1
0
1
2
3