A STUDY OF THE

HEDLEY MASCOT MILL TAILS

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By Alfred R. Allen. April 1940.

The University Of British Columbia.

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A. INTRODUCTION.

The problem which most concerned the writer when undertaking a study of the Hedley Mascot Mill Tails was the relative quantity of gold which occurs in the pyrrhotite and arsenopyrite. Previous workers had shown definitely that the non-metallic gangue minerals contain approximately 75% of the gold. Further, it was previously believed, but not proven, that the pyrrhotite held a smaller proportion of the remaining gold than the arsenopyrite. To prove the above hypothesis it was necessary to make a clean separation between the pyrrhotite and arsenopyrite and assay each. Dr. H.V. Warren pointed out that the pyrrhotite could be separated by a magnetic force. Dr. Smith of the University Physics Department supplied the writer with several types of electro- and permanent magnets, and after some experimenting, the small horseshoe Alnico permanent magnet was found to be the "gem" of the collection. Four such magnets were purchased by the Department of Geology, and the writer designed the apparatus to be described in this report.

A 2000 gram sample of the Hedley Mascot Mill Tail was screened, infra-sized, magnetically treated, and super-panned, The various products were assayed for gold.

B. SCREENING.

The 2000 gram sample was screened by the wet method through a Tyler 200 mesh screen. Gaudin (1) points out in his latest book that when dry-screened, electrostatic charges and small quantities of moisture tend to make the finely ground material adhere, and several small particles sticking together will not pass through a screen while the individual particles would pass through the screen. Compared with a previous dry-screen analysis made on this material, the dry-screening produced 75% -200 size, and the wet-screening produced 81% -200 size. Gaudin's information, therefore, is advantageous in this particular study. The +200 size was dried and screened with the mechanical Tyler screens. The weights of the screened products and percent of total weight are shown on Table I.

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(1) Gaudin, A.M., Principles of Mineral Dressing, First Edition, 1939. pp.61-62.

C. INFRASIZING.

The -200 mesh product was infra-sized into seven products. The average diameters of the particles for each product were as follows:

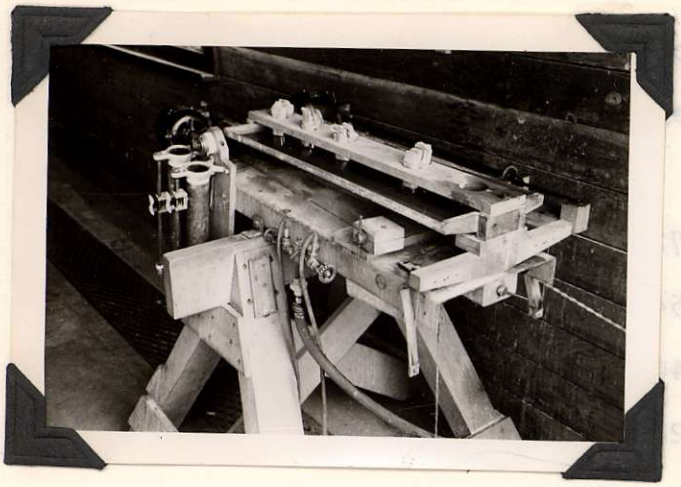
1. -72 microns
2. +54 microns.
3. +40 microns.
4. +28 microns.
5. +20 microns.
6. +14 microns
7. ±10 microns.

Each product was assayed for gold.

D. MAGNETIC SEPARATION.

(a) Introduction.

Pyrrhotite, being magnetic, may be separated from other non-magnetic or less magnetic material by magnetism. Simple experiments with dry and wet material were tried by the writer and the wet separation was found to be the simplest and best. It was found that more pyrrhotite could be removed when the wet mixture was agitated, hence the Haultain Super-Panner was used. The apparatus is shown in the accompanying photographs.



An Oblique End View Of
The Haultain Super-Panner
With Center Board Attatchment
Containing Magnets In 100cc. beakers.

A Side View Of The
Haultain Super-Panner
With The Center Board Attatchment.

Photographs By M.S.Lougheed Geol. '40 U.B.C.

(b) Apparatus.

1. Haultain Super-Panner.
2. Center-board with five two-inch holes.
3. Four 100 cc. pyrex beakers.
4. Four small horseshoe Alnico magnets.

(c) Procedure.

The center-board was screwed firmly to the Super-Panner table, using the screws which ordinarily fasten the water feed and suction at the head and foot. The Alnico magnets fitted into the 100 cc. beakers and were wedged on each side with folded paper towels. The beakers were placed in the center-board holes. The table was set in a horizontal position, or a slight tilt to the foot, and water added to cover the bottoms of the beakers. The product was fed at the foot of the table in 100 gram lots or less. The table was set in motion with a moderate end bump and very slow side motion. The material moved to the head of the table, passing under each magnet, and the pyrrhotite collected on the bottom of each beaker. The material was removed from the head and re-fed at the foot periodically. At various intervals the beakers were removed from the center-board and the pyrrhotite collected. This was accomplished by immersing the bottom of the beaker in clean water in a 700 cc. beaker, lifting the magnet from the small

I.

I. The Pyrrhotite, Clinging To The Bottom Of The 100cc. Beakers, Is Removed From The Table.

2.

3.

2 - 5. The Pyrrhotite Is Released From The Magnetic Field And Deposited In A 700cc. Beaker Of Water.

4.

5.

beaker until the magnetic force was not strong enough to hold the pyrrhotite, allowing it to settle to the bottom. The water was then decanted, and the pyrrhotite dried, weighed, and assayed.

(d) Results.

A minimum recovery of 90% pyrrhotite from the Hedley Mascot Mill Tailings was quickly and easily accomplished by the magnetic method. As a check, a 500 gram batch was treated and 6.0 grams of pyrrhotite, or 1.2% by weight, removed. The total pyrrhotite separated from the sized products amounted to 1.08% by weight. The recovery was, therefore, 90%.

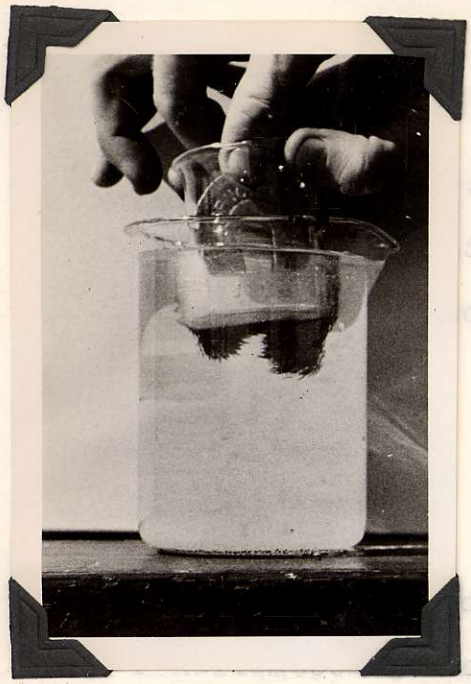
(e) Notes on the Magnetic Separation.

(i) The Time required for 90% Recovery.

About 80% of the pyrrhotite was removed in 20 minutes, using as a maximum a 200 gram charge on the table. The remaining 20% was recovered in an additional one hour.

(ii) Main Requirements for Pyrrhotite Recovery.

Freedom of movement in the magnetic field is essential. Using dry separation methods, foreign non-magnetic material was included in the loosely consolidated pyrrhotite mass. Some of this may have been carried by the general movement of the pyrrhotite particles through the powdered material; again,



Atthee moment of release the particles show the position of the magnetic lines of force.

Enlargement of view No 4.

The pyrrhotite, when released, settles quickly to the bottom of the 700cc. beaker.

Enlargement of view No5.

it may have been caused by particles of magnetic and non-magnetic ~~particles~~ material adhering because of static electric charges, as suggested by Gaudin (1); or it may have been caused by particles adhering because of some moisture on their surfaces. When agitated in a water solution, the static charges are discharged, the particles adhering by moisture are freed, and there is less obstruction to the migration of the magnetic particles towards the magnet.

A strong magnetic field is necessary, because pyrrhotite is usually not strongly magnetic. The small, horseshoe Alnico magnet is powerful enough for this requirement. Tested roughly on a balance it was found to lift approximately thirty-five times its own weight.

A simple means for the quick and complete removal of the pyrrhotite from the permanent magnetic field is best accomplished by having a non-magnetic covering over the metal. If not covered, the magnetic material adheres firmly to the surface of the magnet and must be scraped off. Such a process is slow and losses are likely to be high. The glass beakers were simple and practical for this purpose, and the material was freed from the magnetic field with a minimum of time and effort.

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(1) See footnote on page 2.

E. SUPER-PANNING.

Panning was slow and separation none too good because of the small arsenopyrite gangue ratio. The arsenopyrite tips were not clean, but were observed under the ultropack microscope and the amount of impurity estimated. In some tips the impurity amounted to 50%.

F. ASSAYING.

The head-assays and the gangue-assays were ordinary enough and the nail charge was used. The pyrrhotite and the arsenopyrite assays, on the contrary, were more difficult because of the small amounts of materials. The argols charge was used for each of these. The gold beads from the pyrrhotite assays were all very small. The two largest were weighed as closely as possible. All were then weighed, their sizes were compared with the two known ones, and their weights estimated, so that the sum of them all amounted to the total weight. The weights were all very low, and this method is believed by the writer to come within the limits of accuracy of this work. Only two gold beads from the arsenopyrite assays were large enough to weigh. These were from products 3 and 4. The remaining assays are estimated, and probably somewhat high.

G. DISCUSSION OF RESULTS.

The mill tailings assayed 0.04 ounces of gold per ton. For a 2000 gram batch this amounts to 2.741 milligrams of gold. The total amount of gold from the head assays of the sized products amounted to 3.442 milligrams, 25% higher than the single assayed amount. Similarly the total (partly estimated) gold content from the panned products amounted to 3.334 milligrams, 21% higher than the single assayed amount.

The gold total distribution ~~is~~ was calculated on the assumption that the largest amount, 3.442 milligrams, ~~is~~ was the ~~closest to~~ more correct ~~amount~~. Such a calculation left a discrepancy of 3.2% in the total of gold percentages, and this was spread between the arsenopyrite and pyrrhotite in proportion to their weights.

The final corrected percent weights and gold percentages are shown in the table below.

Product.	Weight as % of total	Gold ~~or~~ as % of total gold.
Gangue	98.87	78.62
Arsenopyrite	0.05	20.04
Pyrrhotite	1.08	1.33
	100.00	100.00

T A B L E I

Size	Cor. Wt. (grams)	% Wt.	Oz Au/ ton	Mg. Au Content.	% Au. Dist.
+ 65	13.5	0.67	0.08	0.037	1.07
+ 100	7.5	0.37	0.11	0.028	0.82
+ 150	69.0	3.45	0.12	0.284	8.25
+ 200	294.0	14.70	0.08	0.807	23.44
1	128.0	6.40	0.06	0.264	7.67
2	270.5	13.52	0.06	0.558	16.19
3.	238.0	11.92	0.04(5)	0.366	10.64
4	203.0	10.15	0.05	0.348	10.12
5	165.0	8.25	0.04	0.226	6.58
6	151.5	7.57	0.04	0.208	6.04
7	460.0	23.00	0.02	0.316	9.18
	2000.0	100.00		3.442	100.00

TABLE II

Size	Product.	Weight.	Cor.Wt. Grams.	Oz.Au/ton	Content Mg.gAu.	Distribution of Products. Wt. %	Distribution of Products. Au %	Total Distribution Wt.%	Total Distribution Au %
+65	~~Pyrite~~ Pyrrhotite	-			-				
	Ar'te	-			-				
	Gangue	-			-				
		13.5	13.5	0.08	0.037			0.675	1.075
+100	~~Pyrite~~ Pyrrhotite	-			-				
	Ar'te	-			-				
	Gangue	-			-				
		7.5	7.5	0.11	0.028			0.375	0.813
+150	~~Pyrite~~ Pyrrhotite	1.50	1.50	0.04	0.002	2.170	0.70	0.075	0.058
	Ar'te	-	-	-	-			-	
	Gangue	49.50	67.50	0.08	0.185	97.830	65.30	3.375	5.375
		51.00	69.00		0.187	100.000	66.0		5.433
+200	~~Pyrite~~ Pyrrhotite	5.72	5.72	0.03	0.006	1.950	0.75	0.286	0.174
	Ar'te	0.07	0.07	-	-	0.002		0.004	
	Gangue	211.00	288.21	0.06	0.594	98.048	73.65	14.410	17.240
		216.79	294.00		0.600	100.000	74.40		17.414

(Cont'd. overleaf)

TABLE II (Cont'd.)

Size	Product	Weight	Cor. Wt. Grams	Oz. Au/ton	Content Mg. Au.	Distribution of Products. Wt. %	Au %	Total Distribution Wt.%	Au %
1	Pyrrhotite ~~Pyrite~~	1.95	7.95	0.06	0.004	1.530	1.51	0.098	0.116
	Ar'te	-	-		-	-		-	-
	Gangue	95.50	126.05	0.04	0.173	98.470	65.59	6.302	5.020
		96.45	128.00		0.177	100.000	67.10		5.136
2	Pyrrhotite ~~Pyrite~~	2.80	2.80	0.05	0.005	1.035	0.90	0.140	0.145
	Ar'te	0.16	0.17	16.50	0.096	0.063	17.20	0.008	2.785
	Gangue	221.30	267.53	0.05	0.457	98.902	81.90	13.377	13.270
		224.26	270.50		0.558	100.000	100.00		16.200
3.	Pyrrhotite ~~Pyrite~~	2.55	2.55	0.06	0.005	1.065	1.37	0.127	0.145
	Ar'te	0.20	0.21	8.75	0.063	0.088	17.20	0.010	1.830
	Gangue	167.00	235.24	0.047	0.381	98.847	104.00	11.762	11.070
		169.75	238.00		0.449	100.000	122.57		13.045
4	Pyrrhotite ~~Pyrite~~	1.85	1.85	0.08	0.005	0.911	1.43	0.093	0.145
	Ar'te	0.10	0.23	15.00	0.118	0.113	33.90	0.012	3.415
	Gangue	85.00	200.92	0.047	0.324	98.976	93.10	10.046	9.405
		86.95	203.00		0.447	100.000	128.43		12.965
5.	Pyrrhotite ~~Pyrite~~	1.49	1.49	0.09	0.005	0.903	2.20	0.074	0.145
	Ar'te	0.13	0.16	23.50	0.109	0.097	48.20	0.008	3.165
	Gangue	137.00	163.35	0.02	0.112	99.000	49.60	8.168	3.280
		137.62	165.00		0.226	100.000	100.00		6.590

(Cont'd. overleaf)

T A B L E II (Cont'd.)

Size	Product	Weight	Cor.Wt. Grams	Ox.Au/ton	Content Mg. Au	Distribution of Products. Wt.%	Au %	Total Distribution Wt.%	Au. %
6	Pyrrhotite ~~Pyrite~~	1.22	1.22	0.06	0.002	0.806	1.20	0.061	0.058
	Ar'te	0.08	0.13	23.10	0.103	0.086	49.40	0.006	2.990
	Gangue	92.00	150.15	0.02	0.103	99.108	49.40	7.508	2.990
		93.30	151.50		0.208	100.000	100.00		6.038
7	Pyrrhotite ~~Pyrite~~	2.50	2.50	0.08	0.007	0.544	2.29	0.125	0.203
	Ar'te	0.05	0.06	48.20	0.097	0.013	30.70	0.003	2.818
	Gangue	400.00	457.44	0.02	0.313	99.443	99.01	22.872	9.090
		402.55	460.00		0.417	100.000	132.00		12.111
		1499.67	2000.00		3.334				96.820

HEDLEY MASCOT

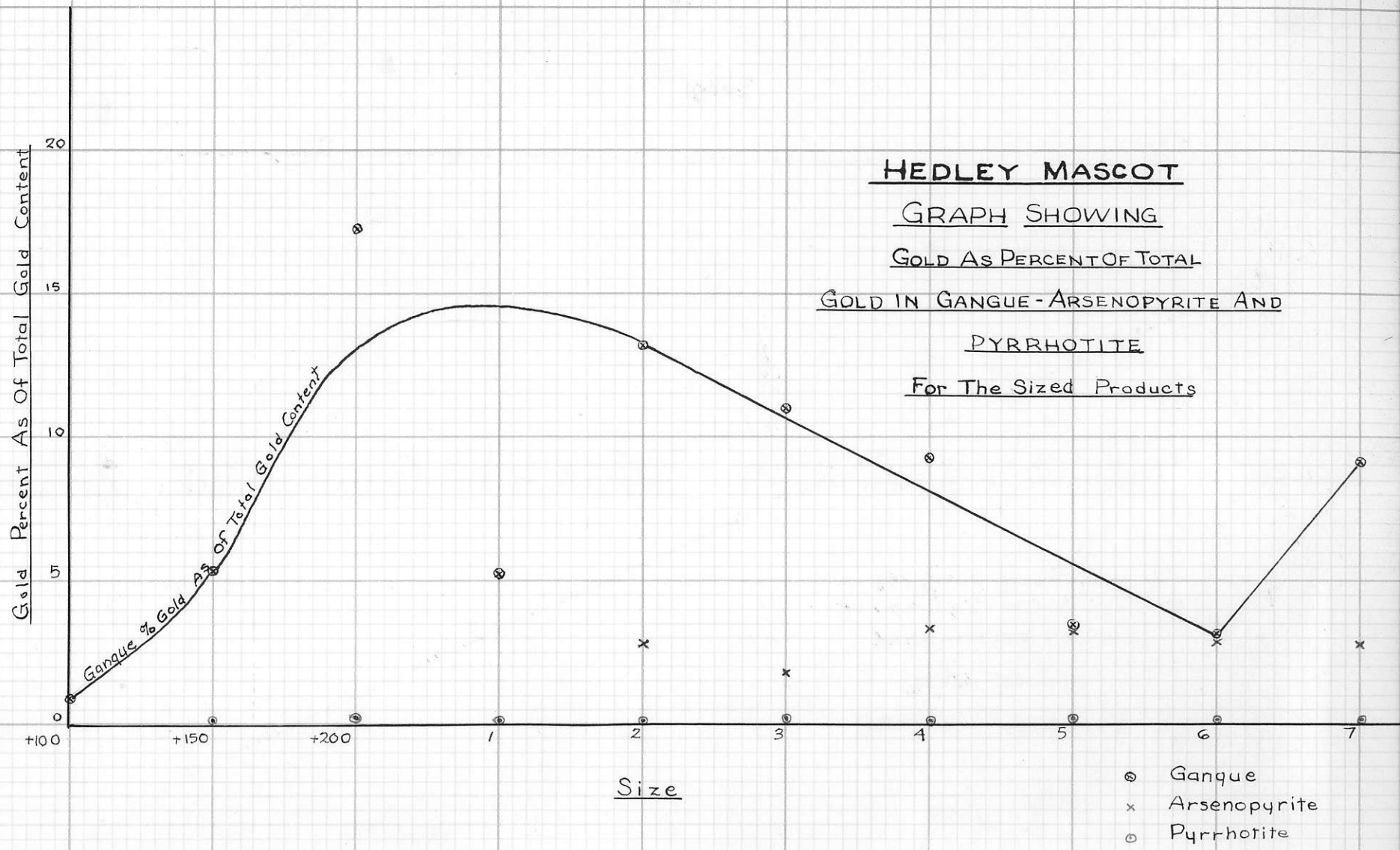
GRAPH SHOWING

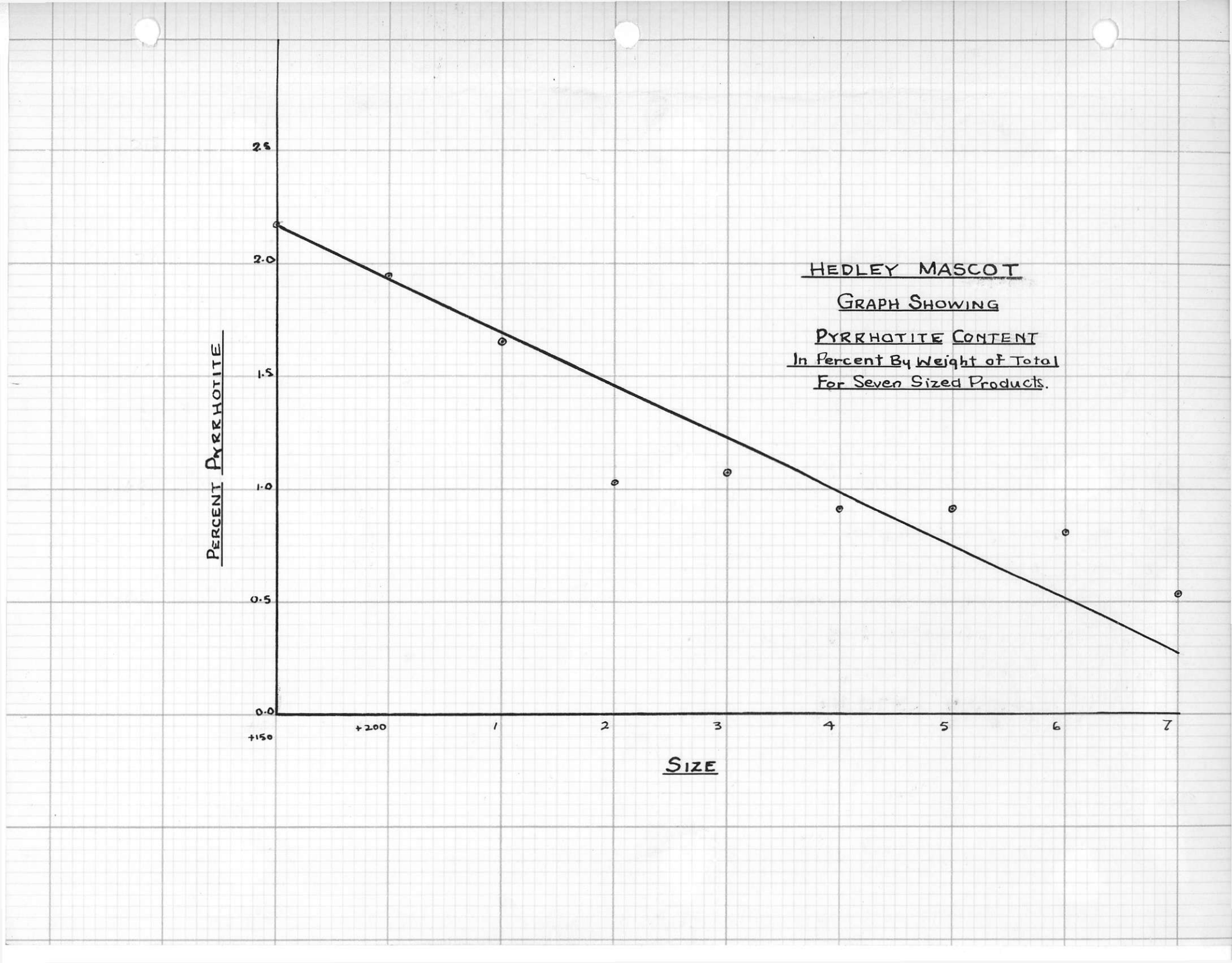
GOLD AS PERCENT OF TOTAL

GOLD IN GANGUE - ARSENOPYRITE AND

PYRRHOTITE

For The Sized Products




HEDLEY MASCOT
GRAPH SHOWING
PYRRHOTITE CONTENT
In Percent By Weight of Total
For Seven Sized Products.
PERCENT PYRRHOTITE
2.5
2.0
1.5
1.0
0.5
0.0
+150
+200
1
2
3
4
5
6
7
SIZE