CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

Copper Creek

Reproduce &

Return orig.

to Dell Rock

mailed original back Sept. 25, 1972

B.D.

PRELIMINARY FEASIBILITY STUDY
HASSAYAMPA DISSEMINATED COPPER DEPOSIT
YAVAPAI COUNTY, ARIZONA

THOMAS S. NYE
Consulting Economic Geologist

6921 E. Hawthorne
Tucson, Arizona 85710

Tel. (602) 296-4183

Mr. R. F. Hewlett, President
Sierra Mineral Management
4741 East Sunrise Drive
Skyline Bel Aire Plaza
Tucson, Arizona 85718

April 19, 1972

Dear Mr. Hewlett:

Enclosed is my report, Preliminary Feasibility Study, Hassayampa Disseminated Copper Deposit, Yavapai County, Arizona, together with my bill for services rendered. The feasibility study deals only with the economics of mining the near-surface ore by open pit methods and does not consider the deep ore potential, which appears to be substantial.

It was not possible, within the limits of time available and alloted for this study, to consider the economics of all of the different hydrochemical extraction methods which are possible with current technology. You might wish to investigate the following methods also, which are directed to the extraction of both primary and secondary sulfides:

1. Solution of sulfides at elevated pressure and temperature in an autoclave with dilute sulfuric acid and oxygen (98% Cu recovery reported by Sherritt Gordon). This process produces native sulfur, a marketable product, and copper sulfate solution, from which copper can be electrowon.

2. The Anatred (Anaconda-Treadwell) process employs 90% sulfuric acid, hydrogen cyanide, and hydrogen to produce both native copper and native sulfur. Anaconda's pilot plant on this process suffered from corrosion problems, which might be cured with further research.

3. Oxygenated pressure-leaching of sulfides. Sulfide ore is subjected to hot water and oxygen under pressure, to produce copper sulfate solutions from which copper can then be electrowon or precipitated on iron. The AEC has experimented with in-place leaching of ores using this technique, with some laboratory success. The method might be more effective on crushed or ground ore in a mill setup, since recovery would be greater due to greater surface exposure of the sulfide-bearing rock to the extracting solutions. A.E. Lewis and R.L. Braun of the Lawrence Livermore Laboratory, University of California, Livermore, presented papers on this method at the 1972 AIME meeting in San Francisco.

Should you have any questions regarding my report, please contact me. Thank you for your consideration.

Sincerely Yours,

Thomas S. Nye
Consulting Geologist

THOMAS S. NYE
Consulting Economic Geologist

6921 E. Hawthorne
Tucson, Arizona 85710

Tel. (602) 296-4183

Mr. R. F. Hewlett, President
Sierra Mineral Management
4741 East Sunrise Drive
Skyline Bel Aire Plaza
Tucson, Arizona 85718

April 19, 1972

FOR SERVICES RENDERED

Feasibility Estimate, Hassayampa Copper Project

Long Distance Telephone calls, for cost data:

3/3/72	San Francisco-Fluor Utah, mining costs	$4.57		
	St. Louis-Cerro-precip smelter costs	5.17		
	Bagdad, Ariz.-acid and iron costs	3.16		
4/14/72	Ariz. Dept. Property Valuation, Ad Valorem tax	4.22		
		$17.12		$ 17.12
2/23/72	Conf. with Cerro personnel re precip smelter, at San Francisco, 1/2 day @ $150.00		$ 75.00	
3/3-3/20/72	Research & Feasibility Calculations, 4 days @ $150.00		600.00	
3/28/72	Examination of Hassayampa property, 1 day @ $150.00		150.00	
3/29-4/19/72	Feasibility study, calculations, report preparation, 6 days @ $150.00		900.00	
			$1725.00	1725.00
			TOTAL DUE	$1742.12

Thomas S. Nye
Consulting Geologist

PRELIMINARY FEASIBILITY STUDY
HASSAYAMPA DISSEMINATED COPPER DEPOSIT
YAVAPAI COUNTY, ARIZONA

Summary and Conclusions

A preliminary study was made of the feasibility of mining the Hassayampa disseminated copper deposit near Prescott, Arizona. Data required to make a definitive analysis have not yet been developed, and the present study is based in part upon assumptions regarding the character of the deposit as well as operating and capital costs. The cost data are predicated upon the use of a "sharp pencil" by a versatile and capable operator, and there is little or no contingency factor in the calculations.

Various extraction methods were briefly considered. In-place leaching to produce precipitate copper concentrates might be done for a relatively low capital cost. The rate of, and overall, recovery of copper by this method would be low and the annual net cash flow might not be as high as for other methods. However, further studies of in-place leaching may be warranted after leachable copper reserves are better defined. A combination of agitation and heap leaching of rock mined by open pit methods, with solvent extraction and electrowinning of the copper, appeared to offer the highest annual cash flow and is the extraction method used in the cost analysis.

Mining was projected at 4000 tons of ore per day on the basis of 7.8 million tons of 0.5% copper ore having a stripping ratio of 1.72:1. 7.8 million tons of the stripped rock averaging 0.2% copper were to be heap leached, and the ore was to be treated in an agitation leach plant. 80% copper recovery was assumed for the agitation leach and 30% for the heap leach. Within the limits of the assumptions made the agitation /heap leach method might provide an annual net cash flow of about $1.6 million, a payback period of 3.75 operating years, and a discounted rate of return (equalizing rate of interest basis, or ERI) of 15%. A measure of profitability under favorable conditions is thus indicated. However, the need for additional exploration, development, and metallurgical analysis to provide the information for a more accurate feasibility estimate is self-evident.

A potential for additional reserves on the Hassayampa and adjacent property has been indicated which, if developed, would enhance the profitability of the projected operation. Projected increases in demand and the cost of pollution controls on smelters suggest that the price of copper may rise in the next few years. Electrowon copper can thus have a distinct economic advantage over smelter-produced copper. The Hassayampa deposit, depending on the results of further investigation, could be made into a viable mining operation and benefit by the projected increase in the price of copper.

April 19, 1972

REGISTERED GEOLOGIST
CERTIFICATE No.
THOMAS S. NYE
DEC. 31, 1972
ARIZONA U. S. A.

Thomas S. Nye
Consulting Geologist

Introduction

A preliminary feasibility study of the Hassayampa copper deposit was made at the request of R.F. Hewlett, President of Sierra Mineral Management, of Tucson, Arizona. This study is a trial run to determine the economic conditions under which the Hassayampa deposit might profitably be mined based upon estimates, furnished by Sierra Mineral Management, of grade, reserves, stripping ratio, and character of the ore. Reserves were stated (see attached table, from Sierra Mineral Management), from limited drilling, as 7.77 million tons of 0.5% Cu at a stripping ratio of 1.72:1. The ore has been described as consisting primarily of chalcocite coating and replacing pyrite and minor amounts of chalcopyrite. 7.35 million tons of rock averaging 0.2% Cu have also been estimated adjacent to or overlying the ore, in addition to several million tons of +0.2% rock underlying the ore. Cash flow calculations assume that 7.8 million tons of rock averaging 0.2% Cu will be stripped for access to ore and pit control, and sent to the leach dump.

A visit to the Hassayampa property was made on March 28, 1972 to examine the terrain and general geologic features.

The formulation of detailed mining and extraction plans was considered but deferred as the data upon which to base these estimates are not yet available.

Extraction Methods

Several methods of extracting the copper are technically possible, including the following:

a) Leaching in place and precipitation or LIX-electrowinning of the copper in solution.

b) Mining the ore, placing it on a leach dump, and extraction of the copper from solution by precipitation or LIX-electrowinning.

c) Mining the ore, sending +0.4% Cu ore to an agitation leach plant and +0.1-0.4% Cu rock to a leach dump, and extracting the dissolved copper by LIX-electrowinning.

HASSAYAMPA LEACH OPEN PIT

Bench	+ .40% Cu Tons	+ .40% Cu Grade	0.2 - 0.4% Cu Tons	0.2 - 0.4% Cu Grade	-0.2% Cu Tons	-0.2% Cu Grade
5400						
5375						
5350			85,000	.29		
5325	235,000	.53				
5300	365,000	.44				
5275	835,000	.45				
5250			535,000	.23	1,005,000	.11
5225	400,000	.46	850,000	.25	1,175,000	.10
5200	750,000	.46	1,010,000	.25	580,000	.05
5175	1,565,000	.59	445,000	.22	140,000	.05
5150	1,640,000	.55	505,000	.24	155,000	.13
5125	1,980,000	.44	1,560,000	.24		
5100			2,080,000	.29	530,000	.16
5075			1,330,000	.25		
5050			585,000	.33		
5025			430,000	.33		
5000			305,000	.34		
	7,770,000	.50	9,720,000	.27	3,640,000	.10

SUMMARY

Cut-Off	Tons	Grade	Sr
0.00	21,130,000	.325	-0-
0.20	17,490,000	.372	.208
0.30	9,090,000	.476	1.32
0.40	7,770,000	.500	1.72

Copper precipitate could be sent to a smelter, or could be smelted on the property using a small smelter designed by Cerro Corporation to treat precipitate copper. Precipitate copper has at times been considered undesirable by some smelters owing to dust problems but, being sulfur-free, can be smelted with little or no air pollution in contrast to standard sulfide ore concentrates. Recent smelting and refining charges have ranged from 7¢ to 9¢ per pound of copper on a toll basis, and the net smelter price per pound of copper in precipitate concentrates has been reported to be 8¢ to 14¢ less than the quoted market price for refined copper.

The capital and operating costs of pollution controls which have been or are being installed in the smelters may result in higher smelting charges. Recent industry estimates (Dr. W. C. Lacy, oral communication, 12/71) of the smelting cost increase due to pollution controls have ranged from 4¢ to 20¢ per pound of copper, depending upon the severity of the controls imposed.

Data provided by Cerro on the precip smelter indicate that a small smelter capable of treating one ton per hour of copper precipitates might be constructed for $100,000-$150,000. The resulting blister copper might be sold for between 5¢ and 12¢ under the price per pound for refined copper, depending on the buyer. Operating costs for this smelter, with 90% recovery, might be in the range of 5¢ to 10¢ per pound of recovered copper. There might be a small cost advantage, depending on specific conditions, in producing blister copper on the property over shipping concentrates to a smelter. The greater advantage of having a precipitate smelter is in not being dependent upon the ability or willingness of a given smelter to accept precip copper. Pollution control requirements have reduced the already-strained capacities of existing smelters in recent months, forcing the stockpiling of concentrates and, in one case, the shutdown of a major copper mine (Esperanza, south of Tucson) for lack of smelter capacity. In any case, the precip-smelter-refinery route reduces the profit margin substantially.

A LIX-electrowinning plant of sufficient size to treat the Hassayampa ore can be constructed for a capital cost of 2-4¢/pound of recovered copper (vs. 3.5-5¢ of iron/lb of recovered Cu in precipitate) depending on the grade of the ore and amount of copper produced. The production cost for this method is reported to range from 3¢ to 5¢ per pound of recovered copper, depending on the size of the facility. Recovery is reported to be close to 100% of the copper in solution. The resulting electrolytic copper can be marketed, at or slightly below the quoted price for refined copper, to a wide range of consumers. Thus the profit margin for the LIX-electrowinning route is greater than that for the precipitate/smelter/refinery route.

Leaching in place and heap leaching may not require as high a capital expenditure as that for an agitation leach plant. However, recoveries for these methods are in the range of 30% to 50% of the leachable copper in the rock and a period of months to years is required to effect recovery. The retention time for agitation leaching is a few hours at most, and recovery can be as high as 95%.

Solutions from in-place or heap leaching would have a lower copper concentration than solutions using the agitation leach method, thus requiring a larger LIX-electrowinning plant for the same rate of copper production. Hence there might not be a significant capital cost reduction for heap or in-place leaching unless precipitates were produced. However, the cost of iron per pound of copper is more or less equivalent to the capital cost of a LIX-electrowinning plant, and the precipitate concentrates have the additional burden of smelter plus refining charges.

General considerations suggest that a combination of agitation leaching of ore averaging 0.5% Cu and heap leaching of rock averaging 0.2% Cu (overburden) with LIX-electrowinning of the resulting solutions may provide the largest annual net cash flow of the different methods discussed. This combination extraction method is therefore used in the trial run of economic feasibility which follows. However, leaching in place with precipitate or electrolytic copper production could have merit depending on the results of leaching tests, and may warrant further investigation.

Economic Assumptions

Available data are insufficient to make a precise evaluation of the economic feasibility of mining the Hassayampa deposit. More drilling is required to prove up the reserves, grade and stripping ratio; acid consumption, minimum grinding required for effective copper extraction, and the amount of leachable copper as a percentage of total copper are not presently known. Consequently this study is based upon a series of assumptions, which are outlined below. One of the most critical assumptions is the potential operator's ability to hold capital and operating costs to a minimum. There is little or no contingency factor in the calculations which follow.

Sources of cost data used to estimate various individual costs in this report are:

Surface Mining, by E.P. Pfleider, AIME, 1968
R. Medhi, Bagdad Copper Corporation (acid and iron costs)
G. Roseveare, Ariz. Bur. Mines, Tucson (grinding costs and acid consumption)
Cerro Corporation (copper precipitate smelter)
Recent analysis of existing operations (agitation leach costs)
J. Dorlach, General Mills Corporation, Tucson (LIX-electrowinning capital and operating costs)
D. Rabb, Ariz. Bur. Mines, Tucson (acid & iron costs and availability)
G.W. Irvin, Ariz. Dept. Mineral Resources (Arizona Taxation)
V. Dale, Ariz. Dept. Property Valuation, Phoenix (Arizona Taxation)
Possible Effects of Tax Equalization on the Mining Industry of Arizona, by G.W. Irvin, unpublished M.S. thesis, 1968, University of Arizona
Mining Equipment Salesmen (equipment purchase, owning, and operating costs, and performance data)

Capital requirements have been estimated from existing agitation plant costs and from data provided by J. Dorlach of General Mills on LIX-electrowinning plant costs. Dorlach has stated that the cost of a LIX-electrowinning plant may be reduced to one-half or one-third of that of a turnkey installation by independent equipment purchase and contracting of the installation, or installation by the operator. The cost of an agitation leach plant can be much higher than that estimated here, if an elaborate turnkey installation is made with outside engineering services.

Below are the assumptions made for the cash flow calculations.

1. 7.8 million tons of 0.5%Cu, stripping ratio 1.72:1, including 7.8 million tons averaging 0.2% Cu of strip rock.

2. 0.5%Cu rock sent to agitation leach plant, 0.2% rock sent to heap leach, copper solutions processed by LIX-electrowinning to produce electrolytic copper.

3. Mining by open pit, using truck/wheel loader combination.

4. Plant within 1/4 mile downhill from the open pit.

5. Water is reasonably available. The water table is at or near the bottom of the valleys, and diversion dams should be constructed to avoid flooding in the mine area. These dams may also serve for water storage, and furnish part or all of the water required for the operation.

6. Mining 3 shifts/day, approx. 3600 tons of rock/shift, 4000 tpd ore, 350 days/year, 5.6 year operating life (60% operating rate first year).

7. Mobile equipment leased, drilling & blasting equipment purchased second-hand.

8. Mining costs:

Drilling & blasting	$0.06
Loading	0.06
Hauling	0.05
General	0.07
	0.24
+ 10% (inflation)	0.03
+ leasing cost	0.11
Total Mining, per ton	$0.38
Cost/ton of ore, 1.72 S.R.	$1.03

Mining cost is from "Surface Mining", pp.874-896, average of different operations, and includes operating and maintenance costs. "General" cost is average of 15 mines and includes labor overhead, development drilling, pumping, assays, office, supervision, etc. Leasing cost estimate is based on allowing lessor a reasonable profit under competitive conditions. Depending on specific negotiations and equipment this cost could be higher or lower. The utilization rate of the equipment is assumed to be 90% or better. A rough check of mining costs was made using manufacturer's ownership and operating cost estimates under specific operating conditions, + labor + leasing costs. This estimate resulted in a mining cost of $0.39/ton vs. the $0.38/ton cost used here.

Most of the mines from which cost data were obtained are much larger than the projected Hassayampa operation, and benefit from the economies of large-scale operation. However, the Hassayampa operation has generally a much shorter haul distance which is largely downhill, in contrast to the other mines. Furthermore, the equipment utilization rate was quite low for some of the mines whose costs were used in estimating the cost for the Hassayampa operation.

The plant site is assumed to be located topographically below most of the ore which is in the surrounding hills. The area is highly dissected, with steep slopes, and the low mining cost assumes that up to 25% of the waste overburden may be blasted, or blasted and dozed off, the tops of the ridges to roll down and fill the adjacent gullies with little further handling. Some of the partly-filled gullies could then be prepared as leach pads. Part of the leach rock and ore could similarly be blasted and allowed (or aided with a dozer) to roll off the ridges to the bottom, reducing the haul distance. Part of the waste would be used in diversion/storage and settling pond dam construction, and in constructing level sites for plant installation.

A small part of the near-surface rock may be rippable, which could reduce the mining cost somewhat. However, this was not considered in the present calculation.

The attached map from Sierra Mineral Management shows the area of the proposed pit, on a scale of one inch = 500 feet. Holes drilled in the pit area are shown as circles with crosses. In the present study the plant site is assumed to be located in the low area southwest of the pit; waste and leach material would be deposited in the gullies north and east of the pit, and the settling pond(s) would be located in the main draw south of the pit, below the plant site.

Depending on the equipment selected, the figures for loading and hauling may vary, but the overall rock moving cost should remain the same, approximately. Proper selection and scheduling of mobile equipment for minimum turnaround and haul time with maximum loads and utilization rates is critical to the mining cost. Inefficient equipment management can sharply increase the mining cost.

9. Acid cost $25.00/ton delivered from Bagdad, or $0.0125/lb; 2 lb acid/lb Cu recovered required.

10. Solvent extraction/electrowinning cost $0.03/lb recovered Cu (per J. Dorlach, General Mills).

11. Overall Cu recovery (90% recoverable, approx. 90% recovery) 80% from agitation leach, 30% from heap leach (ignoring for now the variation in recovery rates and overall recovery with time).

12. Agitation leach cost/ton of ore, based on scale-up from existing operations and assuming low crushing and screening costs, coarse grind:

Acid	$0.20
Crush & Screen	0.50
Slimes	0.25
Plant Maintenance	0.20
Water, Air, Power	0.10
Assays	0.06
Plant Administration	0.12
Total	$1.43

13. Leach Dump costs, per ton:

Preparation & Collection	$0.04
Acid	$0.03
Misc.	$0.02
Total	$0.09

14. LIX-electrowinning cost per ton, @ $0.03/lb Cu recovered:

Ore	$0.24
Leach Dump	$0.04

15. Overall cost and profit per ton of ore @ $0.52/lb of recovered copper:

Ore: 0.5% Cu, 80% recovery @ $0.52 = $4.16 Gross
Leach Dump: 0.2% Cu, 30% " " = $0.62 Gross

Operating Cost, Ore	
Mining (1.72 s.r.)	$1.03
Agitation Leach	1.43
Lix-Electrowinning	0.24
Overall administration & sales	0.20
	$2.90
Net per ton	$1.26

Operating Cost, Leach Dump	
Extraction	$0.09
Lix-Electrowinning	0.04
	$0.13
Net per ton	$0.49

Combined operating net, ore & leach dump, $1.75/ton of ore.

16. Development drilling and startup costs, expensed, $0.5 million.

17. Capital costs (independent purchase and contracting of construction, used equipment where feasible, assumed):

LIX-Electrowinning plant	$1.6 million
Agitation Leach Plant(incl. ponds)	2.4 "
Mining Equipment	0.5 "
Misc. Facilities & vehicles	0.4 "
Water Supply	0.25
Total	$5.15 "

18. Straight line depreciation of plant over 6 years.

19. Ad Valorem tax. This tax is based on 60% of the full cash value of the operation, at county/state tax rates. The tax rate has varied from year to year and the estimate of the full cash value has been the subject of some negotiation.

The average ad valorem tax in 1963-1965 was $4.87 per $100.00 of assessed value (60% of full cash value). The full cash value is the total net after tax earnings of the operation plus depletion and depreciation, discounted (Hoskold formula) over the life of the operation at a 6% safe and 10% risk rate. The full cash value varies from year to year as it is recomputed annually based upon previous and projected earnings. In years of no production the assessed value (25%, commercial rate) of plant and property is taxed. Formal ad valorem tax estimates can become quite complex (per V. Dale, Ariz. Dept. Property Valuation).

For simplicity, the full cash value in the present calculations was based on an average annual income of $1.66 million for 6 years ($1.606 million + contingency for income/tax changes) discounted to a total of $6.72 million. The assessed valuation (60% of FCV) was $4.032 million, which at a tax rate of $5.00 gave an ad valorem tax of $0.202 million which was, again for simplicity, assumed to be constant during years 1-5 of production. The rate for year 0 was assumed to be the assessed value of the capital expenditure. The ad valorem tax can vary substantially without drastically changing the cash flow estimate, and is not considered critical for present purposes.

20. Property payments were capitalized, on the assumption that the property might ultimately be purchased. Payments through 1972 were assumed to be $25,000.00. Minimum annual payments are $100,000 thereafter, with a 2.5% net smelter basis royalty on production. The royalty is calculated here on gross receipts minus LIX-electrowinning costs. A slightly higher cash flow can be obtained by expensing the property/royalty payments.

Cash Flow and Rate of Return

The projected cash flow is shown on the attached work sheet. Calculations for the discounted cash flow, equalizing rate of interest method, periodic basis, are shown below. The projected and discounted cash flows are in millions of dollars. The cash flows for years -1 and 0 below consist of the capital expenditures for those years plus or minus the net operating cash flow.

Year	Cash Flow	x	15% Factor	=	Discounted Cash Flow
-1	(3.225)		0.86957		(2.804)
0	(1.575)		0.75614		(1.191)
1	1.599		0.65752		1.051
2	1.625		0.57175		0.929
3	1.625		0.49718		0.808
4	1.625		0.43233		0.703
5	1.582		0.37594		0.595
					+ 0.091

Discounted Cash Flow, Periodic ERI Basis, slightly in excess of 15%.

[illegible]

7.[illegible] million tons @ 0.[illegible]% Cu, 80% recovery, 1.72 [illegible], of which
7.8 million tons is leach dump @ 0.28% Cu, 30% recovery

Year	-1 (1972)	0 (60% rate)	1	2	3	4	5
Gross		4.015	6.692	6.692	6.692	6.692	6.501
Devel/Oper cost	0.200	2.545	4.242	4.242	4.242	4.242	4.121
Operat. Profit	(0.200)	1.470	2.450	2.450	2.450	2.450	2.380
Startup cost	(0.150)	(0.150)					
Loss carry-forward		(0.350)	(0.035)				
	(0.350)	0.970	2.415	2.450	2.450	2.450	2.380
2% sales tax on gross		0.080	0.134	0.134	0.134	0.134	0.130
		0.890	2.281	2.316	2.316	2.316	2.250
Ad Valorem Tax		0.065	0.202	0.202	0.202	0.202	0.202
		0.825	2.079	2.114	2.114	2.114	2.048
Depreciation, S/L		0.860	0.860	0.860	0.860	0.860	0.860
		(0.035)	1.219	1.254	1.254	1.254	1.188
Ariz. Inc. Tax			0.038	0.039	0.039	0.039	0.037
			1.181	1.215	1.215	1.215	1.151
Depletion			0.590	0.607	0.607	0.607	0.575
			0.591	0.608	0.608	0.608	0.576
Fed. Inc. Tax, 48%			0.284	0.292	0.292	0.292	0.276
Net After Tax	(0.350)	(0.035)	0.307	0.316	0.316	0.316	0.300
+ Depreciation		0.860	0.860	0.860	0.860	0.860	0.860
+ Depletion			0.590	0.607	0.607	0.607	0.575
Cash Flow	(0.350)	0.825	1.757	1.783	1.783	1.783	1.735
Property Pay.	0.025	0.100	0.158	0.158	0.158	0.158	0.153
NET CASH FLOW	(0.375)	0.725	1.599	1.625	1.625	1.625	1.582
Capital Exp.	2.850	2.300					
Cap. Outstand.	2.875	5.175	4.450	2.851	1.226		
Cap. Payback		0.725	1.599	1.625	1.625		
Cap. Balance	2.875	4.450	2.851	1.226	0.000		

Payback Period: Approximately 3.75 production years.

Conclusions and Recommendations

Cash flow calculations indicate, within the limits of the assumptions made in this study, a discounted rate of return of slightly more than 15% and an annual net cash flow of about $1.6 million. Whether or not this can be achieved depends on factors yet to be determined, as indicated previously.

Additional reserves may exist on the property, which has not been fully explored, and on adjacent land which is reported to be favorable for ore. Reserves developed on the adjacent land may be available for exploitation under an agreement between Sierra Mineral Management and the adjacent land owners. Further exploration, and development of reserves, on both the Hassayampa and adjacent land is recommended.

Acid consumption, the percentage of leachable copper to total copper in the rock, grinding necessary to achieve 90% or better recovery in an agitation leach process, and the percentage of copper which can be extracted (and time required) by heap and in-place leaching should be determined.

The results of this work and development drilling will provide a more accurate basis for estimating the operating requirements and profitability of a mining operation on the Hassayampa copper deposit.

The economics of mining different ratios of grade and tonnage of ore to waste and leach rock should be studied, after the metallurgical studies recommended above are completed. A different ratio of ore/leach rock/waste might provide a better profit margin.

Industry predictions are that the demand for copper will increase relative to supply in the next few years, which may result in a higher price for copper. Smelter pollution control costs may also force the price of copper up, as long as the output of foreign copper producers is restricted by inefficiency and political turmoil. Should foreign competition become too severe it is likely that tariffs would be imposed to put domestic copper on a more equal footing. Price increases due to pollution control costs would work to the advantage of the projected Hassayampa operation, which would not be dependent upon the purchase of its copper production by smelters. The outlook, although not certain, is that future rising copper prices may enhance the profitability of the projected Hassayampa operation, particularly if additional reserves are developed.

THOMAS S. NYE

Thomas S. Nye
Consulting Geologist

April 19, 1972

J. DAVID LOWELL
CONSULTING GEOLOGIST

5211 N. ORACLE TUCSON, ARIZONA 85704 PHONE 887-5341

August 12, 1971

Richard F. Hewlett, President
Sierra Mineral Management
4747 East Sunrise
Tucson, Arizona 85718

Dear Mr. Hewlett:

On August 2 I visited your Hassayampa project near Prescott, Arizona, in company with Jim Briscoe and J. W. Still.

Since my last visit S.M.M. has corrected some of the geologic mapping and core logging which was done by Noranda and has also clarified the land status of the area. One hole has been completed by S.M.M. which, together with results of several Noranda holes, suggests the existence of a partly dissected chalcocite blanket which might constitute a medium-sized mineable ore deposit.

Drilling which is in progress to test the tonnage and grade of the chalcocite deposit has been systematically planned and will give a reasonably good picture of the deposit. If results are encouraging when these holes are completed you might consider a fence of relatively close-spaced holes across the principal block of chalcocite ore to provide a cross section showing the profile of the leached zone, the continuity of copper values, and the distribution of oxide copper, etc. I would also recommend that a 6" core hole be drilled through a representative cross section of the deposit to provide a sample of coarse ore for heap leaching testing.

I am less optimistic regarding the possibility of a deep, primary, ore-grade deposit after spot checking the core and reviewing the log of the 1500-foot deep Hole 70-1. This hole penetrates into a zone of relatively weak alteration and low total sulfide below 750 feet. This suggests that the strongly mineralized zone may have the overall configuration of an overturned bowl which has been cut by erosion to leave a crude ring of stronger hypogene copper mineralization and chalcocite enrichment. Unless geologic mapping suggests a structural reason such as flat faulting or tilting to explain Hole 70-1, I do not think the prospect justifies additional deep drilling. It would also be difficult or impossible to operate a deep block cave mine without acquiring additional property.

S.M.M.'s property situation is also a significant problem from the standpoint of a possible strip and heap leach operation on the chalcocite body, but I feel that this possibility is sufficiently encouraging to justify a good deal of work including metallurgical work and preliminary feasibility studies. Favorable factors are the apparent accessibility of the ore, the presence of chalcocite which is relatively easy to leach, and the presence of sufficient pyrite to possibly make the ore self-leaching.

Yours very truly,

J. David Lowell

J. David Lowell

JDL:h

JAMES A. BRISCOE
Vice-President &
Chief Geologist

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602 / 299-9736

Mr. R.F. Hewlett,
President
Sierra Mineral Management
4741 E. Sunrise Drive
Tucson, Arizona

SUBJECT: Letter of Transmittal of Preliminary Exploration Report, Hassayampa Project, Yavapai County, Arizona.

Dear Mr. Hewlett,

With this letter I transmit to you the geologic and preliminary drilling report on the Hassayampa Project, Yavapai County, Arizona, prepared by Mr. Nicholas R. Nuttycombe. Mr. Nuttycombe, a summer employee, supervised the project from mid-June until the end of September. His rather detailed report represents conclusions based on his geologic mapping, assisted by Mr. W.E. Speer, and geochemical rock chip and soil sampling done by Messrs. Mike Jensen and Tom Johnson.

Mr. Nuttycombe's geologic and alteration maps are well done and are as accurate as the base topographic map permitted. Moderate soil cover over the alteration zone results in most contacts and fault locations being approximated. Intrusive relationships, except where drill hole information was available, were hard to establish.

Geochemical rock chip and soil sampling proved to be the most useful ore guide. Unfortunately because of slow sample return, much of our rotary drilling during the summer was based on preliminary sampling and hence some of the anomalies which are plotted on the maps accompaning this report should receive further drilling effort.

Some of the drill hole assays were returned after Mr. Nuttycombe finished his report and the geologic and assay crossections (Appendix A) were compiled after he had terminated. Thus, he was unaware of some of the data which is indicative of the small chalcocite ore body in the vicinity of RDH-6. This factor lead him to be more pessimistic than might have otherwise been the case.

During the coarse of the summer, we followed our usual policy and had our consultants examine the property. Examinations were made by Messrs. Dave Lowell, Jack Still, and Dr. Willard Lacy.

Mr. Still examined the engineering aspects of the property and was generally optimistic on the preliminary indicators of a low grade leach operation on the property. A copy of his letter report on the examination is enclosed in this report.

Mr. Lowell thought the preliminary indications of a leachable chalcocite blanket were of interest. He felt the lack of definite increase in copper grade of DDH 70-1 with depth was a negative factor in assessing the possibilities of ore at depth on the property. The presence of a zone of secondary orthoclase exposed at the surface with a surrounding halo of increased but still sub-economic copper values, he also felt was a negative factor. Using the Kalamazoo deposit as a type example, the presence of the orthoclase zone at the surface at Hassayampa might indicate that nothing different would be found at depth. A copy of his letter report is included in this report.

Dr. Lacy visited the project in late August, when the drilling was a little further along. He felt that the project was worth continuing considering the dollar value of copper mineralization which had been indicated at that time. He did feel that considering the low tenor of the mineralization, the contract with the property owners should be re-negotiated to a more realistic level. This has, as you know, been accomplished recently. In examining the area in the vicinity of RDH-6 (Plate B-2), Dr. Lacy felt the shattered nature of the rock was indicative of the area being a zone of mega-breccia. This area contains the strongest molybdenum geochemical anomalies and drill holes indicate the strongest chalcopyrite prot re intersected to date. For this combination of reasons the area of possible mega-breccia appears to be the best spot for a drill hole to probe for a deep ore body (P-1, Plate B-1).

In conclusion, at the time of this letter we have strong indications that a leachable chalcocite ore body exists. Further test drilling, metallurgical, and engineering studies will be necessary to determine its economics. The possibility for economic copper mineralization at depth exists and this potential has yet to be tested. Data unfavorable to this hypothesis include: 1) the presence of a zone of secondary orthoclase at the surface without attendant ore grade chalcopyrite; and 2) lack of increasing copper values in DDH 70-1 which bottomed at 1,500 feet. Data favorable to this hypotheses include: 1) apparently increasing alteration and mineralization with depth in drill holes P.D.-6, 70-3, and 71-3(?), 2. the coincidence of high molybdenum geochem anomalies and a possible zone of mega-breccia.

I feel that we should proceed with the drilling of one deep test hole within the moly anomaly-mega-breccia zone at location P-1(Plate B-1). This hole should be drilled with rotary equipment because of the speed of drilling, the cost saving and because the rotary cuttings will give us the required information, ie. whether copper values are getting higher with depth. The rotary cutting information can be supplemented by spot cores taken at 200 foot intervals or when considered necessary by the project geologist. If and when the cuttings assay over 0.2% copper consistently, the hole should be cased and deepened with NX size wire-line diamond tools. For a meaningful test of the properties depth potential the hole should be drilled to a minimum depth of 3,000 feet. Whether additional holes should be drilled will have to be determined from the results of P-1. Unless significant favorable results are obtained, the one hole should test the potential and no further deep drilling need be done.

A bid from Boyles Brothers Drilling Company has been received which indicates a rotary hole to a depth of 3,000 feet should cost approximately $28,000.

Very truly yours,

James A. Briscoe,
Vice President

JAB/vlc

R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602 / 299-9736

HASSAYAMPA PROJECT

Prescott Area, Yavapai
County, Arizona

A PRELIMINARY GEOLOGIC AND EXPLORATORY DRILLING REPORT ON THE PROJECT

Submitted To: James A. Briscoe
Chief Geologist

Submitted By: Nicholas R. Nuttycombe
Project Geologist

TABLE OF CONTENTS

SUMMARY

Within the Hassayampa area, Precambrian granodiorite, "aplite" and meta-andesite (greenstone) have been intruded by a sequence of Laramide rocks of slightly varying texture and composition. Though the age relationships have not been definitely established, the sequence from oldest to youngest is presently considered to be - biotite quartz monzonite #1, porcelain aplite, biotite quartz monzonite #2, quartz latite porphyry, dacite (?), and andesite. If this sequence is correct it is the reverse of what is considered to be the normal differentiation sequence.

Hydrothermal alteration and mineralization activity proceeded throughout most of the period of intrusive activity. This is reflected by decreasing intensities of alteration in successively younger (?) rock types which characteristically have less quartz veining and copper mineralization, but which may locally be strongly bleached and contain barren pyrite.

Disregarding the effects of the younger (?) rock types on the alteration pattern, the area as a whole does exhibit the classical porphyry copper alteration zoning. Secondary orthoclase flooding occurs centrally followed by an extensive area of clay-sericite-quartz alteration. The clay-sericite-quartz alteration is then encompassed by propylitic alteration.

The total sulfide content is definitely lowest within the "core" area of younger (?) rocks and the area of strongest secondary orthoclase flooding. The highest sulfide areas are some distance from the low sulfide "core"

and their distribution forms a highly discontinuous ring pattern, (Plate B-3). No distribution patterns of chalcopyrite volumes or pyrite to chalcopyrite ratios have been established. Molybdenite occurs throughout the clay-sericite-quartz zone, but no well defined associative relationships have been established for it either.

The alteration and mineralization is fracture controlled to a large extent, but no dominate fracture directions were recognized. Major faults and fault intersections have controlled alteration to some extent, but generally no important increase in sulfide mineralization has occurred along them. Other notable structures within the area are breccia pipes and a series of concentric ring structures which encompass most of the alteration area. The transition from clay-sericite-quartz alteration to propylitic alteration and the largest area of brecciation are spatially associated with the innermost of the ring structures. The breccia pipes locally contain strong pyrite mineralization, but they are considered to be rather late features and do not appear to offer significant potential for important copper-molybdenum mineralization.

Chalcocite has been encountered in most of the drill holes, but it generally is not present below a depth of 200'. The shallow thickness, sparse development, and presence of fresh sulfides at or near surface in most areas suggest that the area has been subjected to rapid erosion. If this is the case, a chalcocite blanket of economic grade and tonnage could have existed at one time, but was largely destroyed by recent rapid down cutting along the Hassayampa drainage.

The limonites which are present are reflective of the rock types in which they occur and the degree of mineralization. Due to the generally low copper content, and the probable rapid erosion rate, no areal distribution of "live" limonite indicating the presence of significant chalcocite exists.

The results of preliminary wide spread surface sampling indicate that both copper and molybdenum also have a ring shaped distribution pattern. The larger areas of high molybdenum concentrations occur outside the "core" area and are spatially associated with the strongest secondary orthoclase development. The areas of highest copper values are generally displaced from, but spatially associated with the areas of highest molybdenum concentrations. This displacement probably reflects the greater mobility of copper in an arid supergene environment, but one can reasonably expect that the two metals are more closely related in the hypogene environment. Some exceptions to this generalization are of course to be expected.

CONCLUSIONS

The age and nature of the Laramide intrusive rock types, and the alteration and mineralization present in the Cumming's Copper Creek area (Hassayampa Project) are all characteristic of porphyry copper deposits. With the proper erosional history an economic chalcocite ore body probably would have existed in the area today. Rapid erosion has either destroyed any rich pre-existing chalcocite blanket or precluded its development. The existence of fresh sulfides at or near surface in most places and the shallow water table suggest any chalcocite blanket in the area would be thin. The incision of the drainages to a depth close to the water table appears to have segmented the blanket that does exist, further reducing the economic potential. This active erosional environment has resulted in the deposition of only a thin chalcocite blanket of marginal grade under present economic and technologic conditions.

The possibility of hypogene mineralization of economic grade and tonnage existing at depth is questionable in light of what is presently understood about the area. Surface mapping indicates that a good cross-section of the alteration and mineralization zones is exposed. Assuming the mapping and interpretations are correct, it is the writers opinion that the same protore grades which occur "near" surface will continue downward maintaining the same zonal relationships.

Several other bits of information should be considered, however, before the possibility of increasing grades with depth is ruled out. These are: (1) The fact that Phelps Dodge's drill hole #6, which was drilled to a depth of 1,236 feet maintained its copper grade with depth and even showed a slight increase in grade toward the botton, (Plate A-6). (2) The suggestion of a mega-breccia existing in the vicinity of the hammer drill hole HA #6 and (3) The definite increase in alteration and mineralization in drill hole #71-3, which collared in essentially unaltered andesite, but encountered increasing clay-sericite alteration, pyrite and chalcopyrite mineralization and even some secondary orthoclase toward its bottom at 452'.

RECOMMENDATIONS

The best continuous molybdenum geochemical highs should be drilled on

100' centers to determine if the grade and thickness of chalcocite below them is sufficient for a small scale heap leach operation. Depending upon what is encountered in the best areas other areas of lessor geochemical concentrations should or should not be drilled.

A deep test should be made somewhere within the broad molybdenum geochemical high. Ideally the test hole should be located on a strong anomaly somewhat centrally located within the broad high. It should be collared elevationally low, but not in the bottom of possibly fault controlled drainages and an attempt should be made to avoid drilling the hole in aplite. The depth to which the hole is taken should be largely determined by what it encounters, but 2,500 to 3,000 feet would be the minimum necessary to give new third dimension information.

LOCATION AND ACCESS

The Hassayampa (Cummings-Copper Creek) project area is located in Yavapai County, Arizona, approximately 9 1/2 highway miles southwest of Prescott. Most of the area of interest falls within sections 23, 24, 25 and 26 of Township 12 1/2 N. Range 3 W. It is reached by travelling southwest of Prescott on U.S. Highway 89 (White Spar Highway). Further entrance into the property, which lies immediately south of the highway, is made along either Little Copper Creek or Copper Creek road.

PROPERTY STATUS

Within the Hassayampa area Sierra Mineral Management and Norandex control the following claim groups: (1) The Cummings group of 15 patented claims, (2) The Dean Rose group of 16 patented claims, (3) The Peacock group of 5 unpatented claims, and (4) The S.M.M. group of 12 (?) unpatented claims. Our competitors, Perry, Knox and Koffman, control the pattented Little Coppers #2 and #3 claims and the unpatented Oak group comprised of approximately 50 claims. A third individual, Douglas Stanford, holds 9 unpatented claims comprising the Silver King group. Five of the Oak claims are apparently in conflict with the Silver King claims which were staked earlier.

The Cummings and Dean Rose claim groups held by Sierra Mineral Management and Norandex are separated from one another by unpatented Oak claims and the patented Little Coppers #2 and #3. The Peacock and S.M.M. groups of unpatented claims join and extend south from the patented Cummings group.

Claim maps prepared by Norandex and subsequently at the request of Sierra Mineral Management, by Jack Splane, indicated that a number of fractions existed within the Oak claim group. Subsequent field checking, however, has indicated that these fractions do not exist. The land status as recognized at the time of this writing is shown on the enclosed land status map, (Plate B-1).

PROCEDURES

The surface mapping was carried out using a 1"=500' enlargement of the U.S.G.S. 15 minute Kirkland Quadrangle sheet. (Original scale 1:62,500, contour interval 50'). Notes describing the rock types and alteration were made at approximately 500 points throughout the area and hand specimens were collected at approximately 200 of those locations.

The density of scrub vegetation and fairly extensive soil cover hindered and often precluded the accurate mapping of contacts or other continuous features in the field. Therefore, aerial photographs with a scale of 1"=1,000' were used in conjunction with the field work to establish many of the contact locations shown on the map.

The preliminary geochemical sampling was carried out using the existing road ways for control. Samples were collected 100' on each side of the roads at 400' intervals. Additional samples were then collected in intermediate areas of particular interest. The sample locations were plotted on a 1"=500' topographic base map with the new drill roads on it surveyed by compass and pace by Mr. Carson of Norandex.

Rock chip samples were collected where outcrops were available. Where they were not, soil samples were collected from below the organic surface horizon. In addition soil samples were also collected adjacent to rock chip samples for about 10% of the locations. These dual samples were used to establish conversion factors for the soil samples. No conversion factor was found necessary for molybdenum. The conversion factor arrived at for copper was: Rock equivalent = 1/3 concentration in soil. This conversion factor was not used in situations where it resulted in one soil sample having a copper concentration extremely anomalous with respect to those of surrounding rock chip samples.

Subsequent to the preliminary sampling all the indicated anomalous areas were sampled on approximately 100' centers. A portion of this sampling was controlled by brunton and range finder surveying. Most, however, was carried out by pacing along contour lines.

GENERAL GEOLOGY

The Hassayampa project (Cummings-Copper Creek) area is a center of Laramide intrusive activity with associated hydrothermal alteration and mineralization. Older Precambrian meta-andesites and granodiorite have been intruded by a slightly varying textural and compositional sequence of rocks of Laramide (?) age. The sequence includes monzonites, latites, dacites, and andesites which occur together forming a composite stock with a moderate N55°-S55°W elongation. The sequence as listed is the assumed sequence of intrusion. If this is correct, each of the successive intrusions was displaced slightly northwestward and smaller than the preceeding one.

Compositionally the sequence is the reverse of what would be expected from a normally differentiating magma. This may be evidence that the assumed sequence is incorrect. Other apparently contradictory relationships exist on the geologic map which could be resolved if the sequence of intrusion was reversed.

Rock Descriptions

Older Precambrian Meta-Andesite: This is the oldest rock type present in the area mapped. It has been subjected to low-grade regional metamorphism and can now be classed as a greenstone. It weathers readily to soil and consequently outcrops are not abundant. Its presence, however, is indicated by the nature of the soil, a characteristic soft topography, and extremely dense scrub vegetation.

Texturally the rock is fine to medium grained. Small lathlike feldspars are intergrown with an olive green matrix composed of chloritized mafics and very fine grained feldspar. Locally the matrix content is so high that the feldspars present are obscured.

The meta-andesite is in contact with the altered and mineralized biotite quartz monzonite, but it is locally altered only to the extent of being bleached. The mafics are always chloritized elsewhere, but this is primarily due to the effects of regional metamorphism. The rock has undoubtedly also experienced the propylitic alteration induced by the Laramide intrusive system, but the effects are difficult to distinguish from those of the regional metamorphism.

In core from drill hole 71-4 the meta-andesite contains approximately 3% fracture controlled pyrite. Many of the mineralized fractures exhibit secondary biotite and magnetite halos. Where the meta-andesite is exposed in road cuts the limonites in fractures are medium to dark brown.

Older Precambrian Granodiorite: The granodiorite is a medium to coarse grained equigranular rock with approximately 55% plagioclase, 10% orthoclase, 15% anhedral quartz, 15% biotite, and 5% hornblend.

It is by far the most abundant rock type in the Hassayampa Project area. Meta-andesite bounds it on the east and it has been intruded by the composite Laramide stock.

Within the propylitic alteration zone the mafics are altered to chlorite; epidote occurs as thin fracture fillings; there is a small percentage of fracture controlled pyrite, completely altered to hydromica and clay; feldspars are less bleached and fine grained biotite aggregates with associated pyrite are commonly present. The biotite is possibly secondary and the pyrite probably derived its iron from the original biotite. The granodiorite also has abundant fracture controlled pyrite which required the introduction of both iron and sulfur. The total volume of pyrite is normally higher in the granodiorite than in the other rock types, probably because of the two modes of development.

Jarosite is the common limonite product developed in the granodiorite.

<u>Aplite-Fine Grained Granodiorite(?)</u>: Possibly two distinct ages of rocks have been grouped in this classification. The largest masses of rock mapped as aplite are believed to be closely related to the granodiorite and are probably Precambrian in age. These rocks are texturally similar to the granodiorite but are finer grained, have considerably less biotite, and are much more dense. The other type is normally found in smaller dikes, is even more fine grained, and the quartz and feldspar occur in graphic intergrowths. This second variety may be younger than Precambrian.

The aplites commonly have a bleached appearance both within the proplitic zone and in the clay-sericite-quartz zone. In the oxidation zone the feldspars are commonly stained red by hematite. The density of the aplites render them rather unfavorably as host rocks unless they have been strongly fractured.

B.Q.M.P. #1: This is assumed to be the oldest of the Laramide intrusive rocks. It is a biotite quartz monzonite porphyry with a fine grained ground mass. Mineralogically it contains 35% feldspar phenocrysts to 1/4" diameter, 10-15% biotite in books to 1/4" thick, and 3% quartz "eyes" to 1/4" diameter. The groundmass in which these phenocrysts are set is very fine grained and is apparently predominately quartz and orthoclase. It may reflect chilling but appears more like a flooding alteration. The phenocrysts are commonly vague and ghostly. This rock also commonly contains approximately 3% fine grained pyrite well disseminated throughout the groundmass.

Within supergene environments the biotite of the rock alter to hydromica and the feldspars to clay and sericite except where protected by strong silification. Fresh biotite is not uncommon below the supergene zone and the feldspars are less strongly altered.

Jarosite and light to medium orange brown limonites are the common limonites developed in this rock.

Porcelain Aplite: This rock type is not abundant and occurs only in dikes. The dikes are distinctive in that they commonly trend more or less east-west. Normally they are, as the name implies, porcelain-like in appearance. In some however, a small percentage of vague quartz eyes and feldspar phenocrysts can be found. For that reason they are believed to be closely related to the B.Q.M.P. #1.

A small percentage of well disseminated pyrite is common in the groundmass. Later sulfides occur in fractures which have very pronounced alteration halos of quartz and sericite. In surface exposures the porcelain aplite is stained both by hematite and jarosite.

B.Q.M.P. #2: This rock is similar to B.Q.M.P. #1, but lacks the fine grained chilled or flooded groundmass. The feldspar phenocrysts, biotite books and quartz eyes are set in a finer grained feldspar and quartz matrix.

Within the supergene zone the feldspar of this rock type are generally strongly bleached and the biotites are altered to hydromica. Jarosite and various shades of brown limonite develop after sulfides. Below the effects of the supergene environment the biotites are generally fresh, but do not show evidence of being secondary.

Quartz Latite Porphyry: Much of what is considered to be the barren core of the composite stock is composed of this rock type. It is generally light pink to grey in color and has a fine grained to aphanitic groundmass of quartz and feldspar.

The sulfide content in this rock averages less than 2%. This low volume may result from its central position within the altered area or its dense nature. Whatever the explanation the rock is only weakly mineralized and bleached. Due to its paucity of sulfides limonites are sparse to absent.

This rock type has been assumed to be younger than the monzonites on the basis of its weak alteration and mineralization.

Dacite (?) Porphyry: The dacite porphyry is composed of 60% feldspar phenocrysts to 3/16" diameter and 15% thin biotite books and flakes of the same diameter uniformly distributed throughout a finer grained feldspar matrix. Free quartz is generally not visible to the naked eye.

The dacite(?) is in contact with the quartz latite porphyry and actually engulfs breccia fragments of the quartz latite porphyry, as seen in diamond drill hole 71-6. This establishes the age of the dacite (?) as younger than the quartz latite porphyry. Some of the quartz latite porphyry breccia fragments also contain quartz-sulfide veinlets which indicates that the dacite is younger than some of the alteration-mineralization. The dacite itself however, does contain some fracture controlled pyrite. In surface exposures the rock is strongly bleached and softened and has a light orangish-tan color due to the presence of a soft orange limonite. The limonite may be derived to a large extent from the alteration of biotite.

Andesite Porphyry: The andesite is a fine to medium grained porphyry composed of 70% feldspar, 10% hornblend, 15% biotite and 2% magnetite. It is slightly porphyritic with approximately 20% of the feldspars obtaining a maximum diameter of 1/8".

There is very little evidence of alteration of the matrix and feldspar phenocrysts at the surface and evidence of only trace amounts of sulfides. However in drill hole 71-3, which is 452' deep, the alteration gradually increases in intensity with depth. Most is clay-sericite alteration of feldspars, but some secondary (?) orthoclase is present. The sulfide content also increases from 0.5% to plus 1% and some chacopyrite is present at depth.

Latite-Andesite Dikes: This group of dikes range in texture and mineralogy. They are grouped together because they are all considered to be late or post mineral in age. Most of them trend north-northeast. They can be found cutting all other rock types and they lack fracture controlled alteration and mineralization. Some do contain disseminated pyrite, but this is considered to be syngenetic.

<u>Basalt</u>: The basalt is the youngest rock type within the area mapped. It is medium grey in color and moderately vesicular. Well preserved surface features have been found locally which indicate that the material is a surface flow. It is undoubtedly related to similar basaltic flow rocks of Quaternary-Tertiary age which are found capping older rocks throughout the Bradshaw mountains.

STRUCTURE

<u>Ring Structures:</u> The largest scale structural features recognized to be directly related to the intrusive center are a series of discontinuous concentric rings which are centered about the stock. The longest dimension of the stock is approximately 4,000' and the approximate ring diameters are 5,000', 9,000', and 12,000'.

The rings are expressed topographically and the innermost one has an extensive area of brecciation, the rapid transition from clay-sericite-quartz to propylitic alteration, and the basalt flow spatially associated with it. The rings are undoubtedly related to the intrusion of the stock and probably developed either as a result of doming and/or collapse.

<u>Stock Emplacement:</u> The composite stock is elongated in a N55°E-S55°W direction and some of the wide monzonite dikes to the south have the same general trend. If the monzonites represent the first phases of the Laramide intrusive activity the trend of the stock and dikes could reflect the original controlling structural system.

<u>Faults and Dikes:</u> There are two well defined structural trends of faulting and dikes within the area. The most pronounced of the two trends is N10°E. It is emphasized by the numerous dikes in the northeast corner of the area, but can be seen throughout the area. Offsetting of the east-west trending

porcelain aplite dikes in the northeast corner of the area indicates that the N10°E system is one of right lateral displacement. Relationships between dikes and mineralization indicate that the zone was active over a long time span.

The second of the well defined structural trends is N20°W. It is evidenced by the pronounced fault zone containing the composite dikes in the center of the area and the brecciation in the vicinity of diamond drill hole 71-6 and east of hammer drill hole HA #2. This trend was active subsequent to the intrusions of the monzonites and the quartz latite porphyry, but is old enough to have controlled early diking and significant amounts of alteration and mineralization. No sense of displacement has been determined for this set. In addition to these two dominate sets there are many other directions of diking and faulting, but no other definite sets have been recognized.

Breccias: A number of areas of wide spread brecciation occur within the area mapped. The largest occurs in the west central portion of the area. In this breccia the size of fragments ranges from inches to tens of feet. Most are angular and reflect only shattering, but others are rounded and have obviously been transported. This breccia is just inside the innermost of the encircling ring features and may have been generated by gas discharge along the structure. The fragments are all strong to intensely altered, but the breccia apparently only locally contains strong sulfides. Some of the fragments contain mineralized veinlets of pre-breccia age.

This general description holds for the breccias in the vicinity of and to the north of diamond drill hole 71-6 and to those east of 71-1. In drill hole 71-6 breccia fragments of quartz latite porphyry containing quartz-sulfide veinlets are engulfed by the younger dacite (?).

The breccia north of 71-6 and those southeast along the composite dike structure have apparently formed at structural intersections. The northern most one does have intrusive characteristics, but the other two may be entirely structural. The breccia zone east of HA #2 and its extension (?) to the southeast are probably dominantly structural.

The area around hammer drill hole HA #6 is intensely broken with few through going structures. This may reflect another area of mega-brecciation.

For the most part the breccias which appear to have an intrusive origin seem to be late features with respect to the mineralization. Strong pyrite is locally developed in some of them, but they are apparently low in hypogene copper. Drill hole P.D. #1 was drilled near a breccia dike containing abundant brochantite (?), but this mineralization probably reflects exotic mineralization localized by permeability.

Alteration and Mineralization

The alteration and mineralization within the area is typical of porphyry copper deposits. Secondary orthoclase occurs centrally and is enclosed by an area of clay-sericite-quartz alteration. Propylitic alteration then extends beyond the clay-sericite-quartz alteration. The sulfide content is highest in the clay-sericite-quartz zone and lowest in the central area of strong secondary orhtoclase. The alteration is apparently controlled to some extent by host rock or age, however. The core of the composite stock, composed of quartz latite porphyry, dactie(?) porphyry, and andesite porphyry, is less strongly altered and mineralized than the surrounding monzonites and granodiorite.

Secondary Orthoclase: Two extensive areas of orthoclase flooding and veining have been mapped and are shown on the alteration - mineralization overlay. Diamond drill hole 70-1 is located within an area of pervasive orthoclase flooding in which the mineral has replaced up to 60% of the rock locally. Hammer drill hole HA #3 is located in the second main area of this alteration. Within that area the alteration is less pervasive, but it is locally as strong. Secondary orthoclase veining and flooding also occurs locally at many other points on the property. Some of the occurrences are indicated on the alteration - mineralization overlay. In addition to drill hole 70-1 secondary orthoclase was encountered in holes 71-1, 71-2, 71-3 and 71-8.

Barren quartz veins are abundant within the main orthoclase zones and are obviously related to its introduction. The total sulfide contents are exceptionally low and no increase in the chalcopyrite to pyrite ratio was noted in the main areas of secondary orthoclase.

Clay-Sericite-Quartz: The clay-sericite-quartz alteration is widespread, but its intensity is variable. On the surface most of the rocks are strongly bleached, but below the supergene zone much of the feldspar alteration is to a pale green product which is believed to be montmorillonite. Within this zone some of the biotites have been altered to hydromica, but a large percentage are fresh.

Quartz Veining: Quartz veining is abundant throughout most of the area averaging 5% by volume and locally approaching 30%. A variety of types of veins are present which probably reflects different ages of development. The types recognized are an early barren stage with gradational boundaries, sharp walled quartz-MoS_2 veins, and sulfide veins with quartz-sericite halos. These types have not been distinguished on the alteration overlay.

There are two main areas shown on the mineralization-alteration overlay in which quartz veins are rare. These areas are associated with a decrease in total sulfides and are considered unfavorable for exploration.

Secondary Biotite: Secondary biotite is present, but its extent is unknown. It is common in the granodiorite where it occurs as fine grained aggregate bunches with associated pyrite. Both minerals are apparently replacing the original biotite. Some also occurs with magnitite along pyrite filled fractures in the meta-andesite. The monzonites often contain fresh books of biotite but this appears to be primary.

Propylitic: The transition from clay-sericite-quartz alteration to propylitic alteration is abrupt in most places. On the west and north sides it is spatially associated with the innermost ring feature.

Within the granodiorite the alteration is characteristized by chloritization of the mafics and the development of epidote along fractures. Some fracture controlled pyrite occurs in this zone also. The propylitic alteration is difficult to distinguish from the effects of regional metamorphism in the meta-andesite.

Sulfide Distribution: Surface mapping and induced polarization surveying indicate that the distribution of sulfide mineralization is also of halo form. Throughout the clay-sericite-quartz zone the total sulfide content averages approximately 4%. Several areas of + 7% total sulfide contents have been mapped, however, and they also reflect a discontinuous halo distribution. The sulfide content is lowest in the core area of the stock and in the area of pervasive orthoclase veining and flooding. The sulfide content of the core area as shown on the alteration - mineralization overlay averages less than 2%.

The areas of strongest pyrite development occur in the granodiorite and in structurally prepared areas. Within the granodiorite the pyrite associated with the fine grained biotite probably formed during a period of introduction of excess sulfur.

Chalcopyrite: Chalcopyrite is generally fracture controlled and associated with pyrite. Most of the fractures that contain chalcopyrite do have quartz-sericite halos, but it also occurs in unhaloed fractures. Not enough information is available to determine distribution of chalcopyrite to pyrite ratios or any definite relationship between molybdenite and chalcopyrite. In the areas that have been drilled to date the highest average primary grade encountered has been 0.19%, the average for the bottom 25 feet of hole HA #6 which is 265' deep.

Chalcocite: Chalcocite has been present in most of the drill holes, but it is generally present only as a very thin film on other sulfides. Its paucity in most of the holes can be attributed to the low primary grade in the areas of the holes, a shallow water table and the existence of only a thin oxidized zone within which the oxidation has not been complete. It is conceivable that a chalcocite blanket of economic grade and tonnage existed in the area at sometime in the past, but was stripped by rapid erosion.

Covellite: Covellite can be found in small amounts in surface rocks in many areas. It has probably formed from the alteration of chalcocite, but it is not necessarily a good guide to it. It is apparently present mainly in the near surface rocks and at times has chalcocite free pyrite immediately below it.

Turquoise(?): Turquoise (?) or what is more probably allophane occurs in small amounts throughout much of the altered area and is locally abundant. Most of the occurrences are in granodiorite, but some are in monzonite. It is by far most abundant on the hill that holes 70-2 and P.D. #3 were drilled on. On the south and east slopes of that hill turquoise (?) occurs as numerous fracture fillings and veinlets to 3/4" thick. On the basis of the drill results it is obvious that its presence cannot be considered to indicate the grade of copper below the surface.

Brochantite: Brochantite is present only in the strongly broken area in the vicinity of drill holes P.D. #1 and HA #6. It is by far most strongly developed in a breccia dike in the vicinity of P.D. #1. The porous breccia probably provided a favorable area for its deposition.

Molybdenum Minerals: Molybdenite associated with quartz veins is quite widespread and easily found on the surface. Its distribution has not been accurately mapped however due to the time that would be involved, and the fact that geochemical surface sampling does show its distribution. In addition to molybdenite some ferrimolybdenite and akaganeite are present. Some of the molybdenum geochemical highs are apparently related to the occurrence of akaganeite and there is some evidence that it might be concentrating the molybdenum.

Limonites: Careful attention was paid to limonites while mapping, but no areas of significant size containing favorable limonites were recognized. The only relationships which can be established are general ones between rock types and limonite products. The most common limonite in the granodiorite is jarosite. The feldspars of the aplite become stained red from hematite, but the fracture controlled limonite is commonly jarosite. The porcelain aplite also becomes stained red by hematite. B.Q.M.P. #1 developed light to dark orange browns and medium to dark red brown limonites. B.Q.M.P. #2 and the quartz latite porphyry are characterized by very light orange-brown limonites or the absence of limonites. Soft gold-orange limonite developes in the dacite (?). The latite-andesite dikes and the andesite plug develop medium to dark brown limonites.

SURFACE GEOCHEMISTRY

The distribution of geochemical quantities of molybdenum and copper in outcrop and soil offers the best guide to better grade copper mineralization. The maps prepared from the preliminary wide spaced sampling show the same general circular distribution of copper and molybdenum as the surface mapping indicated for alteration and the induced polarization indicated for the sulfide concentrations. Within the general patterns there are highs which, hopefully, indicate better grade mineralization. Most of the holes drilled to date are peripheral to those highs and therefore neither prove nor disprove their validity.

Detailed sampling on approximate 100' centers has been carried out in the areas of indicated anomalies to further define them. Preliminary results of this sampling indicates sizeable areas with irratic distribution of molybdenum values within the range of 100 to 300 parts per million.

The copper anomalies correspond fairly well with the molybdenum, but are somewhat displaced from them. This is as should be expected on the basis of the difference in their mobilities in an acid environment.

A total of 28 holes have been drilled on the property to date. The first 6 were diamond drill holes put down by Phelps Dodge Corporation in the early sixties. Of those holes only one, PD #1, encountered potentially ore grade mineralization, assaying 0.43% copper over 150 feet. It contains 150' of 0.43% copper mineralization. This hole was spotted near or possibly on a porous breccia dike which containes abundant exotic copper. All of the better grade mineralization is at the top of the hole and from 153' to the bottom at 607' the assays are less than or equal to 0.1% copper.

Except for PD #6 the remainder of their holes are approximately 600' deep and none encountered potentially ore grade mineralization. Hole PD #6 was drilled to the depth of 1236'. It did not encounter potentially ore grade mineralization, but did show a slight apparent increase in grade from 734' to the bottom. This increase is actually relative to the interval 234' to 734' which averaged less than 0.1% copper. No geologic log is available for the hole, but the change in grade may reflect a change from aplite to granodiorite.

Norandex diamond drilled eleven holes. Most of them are between 400 and 600 feet deep, but the shallowest is 138' and the deepest 1,500'. The deep hole, number 70-1, is drilled in an area of very strong secondary orthoclase. This strong alteration continues to approximately 700' and then decreases abruptly and significantly, but then gradually increases somewhat toward the bottom of the hole. From 22' to 100' the copper content averages 0.27%. Below 100' there is only a couple of plus 0.2% copper intervals and the average grade decreases with depth until it is approximately 0.05% at the bottom.

With respect to copper grade the best holes that Norandex drilled are 70-2, which averages 0.30% over the interval 59' through 130'; and 71-5 which averages 0.29% over the interval 22' to 91'. Both of these holes are peripheral to the best moly geochemical anomaly subsequently defined.

Sierra Mineral Management has hammer drilled 10 and are drilling an eleventh hole at the time of this writting. The deepest, HA #1, went to 430'. The others are in the 200'-250' depth range.

The best holes drilled by Sierra are: HA #1, which averages 0.42% copper in the interval from 30' to 195'; and HA #6 which averages 0.35% copper in the interval 70' to 265'. Hole number HA #11 is being drilled at this time and averages 0.58% copper between 50' and 80', the present bottom.

Of the 28 holes drilled six contained potentially ore grade and thickness of copper mineralization. All but one of these, HA #1, were drilled either within or peripheral to the largest well defined molybdenum anomaly. Of these five only HA #6 and HA #1 were drilled subsequently to defining the anomaly and with the purpose of testing it.

PETROGRAPHIC ANALYSIS
by
Dr. Sidney Williams
Phelps Dodge Corp.

HASSAYAMPA

C70-1 247'

The specimen is a quartz monzonite porphyry with scattered plagioclase phenocrysts (which may be clustered together) set in a fine grained matrix of quartz and interstitial orthoclase. Mafites originally were scarce. The rock has experienced mild epizonal alteration.

Pyrite and chalcopyrite occur along fractures with little or no gangue. The walls of the fractures are replaced by coarse, anhedral orthoclase which may be slightly perthitic. Siderite is sparingly present in the fractures and also replaces mafites. Coarse and euhedral sphene crystals have been replaced by leucoxene and the plagioclase throughout the rock is mildly sericitized.

Minerals are present in the following estimated amounts: quartz 18%, orthoclase 30%, plagioclase 44%, sericite 4%, siderite 1%, leucoxene 1%, sulfides 1%, and traces of apatite.

C70-1 358.5'

The specimen is a quartz monzonite porphyry like above but the fabric shows evidence of mild shearing. The plagioclase phenocrysts are somewhat distorted and rounded in a xenomorphic-granular quartz/orthoclase matrix. The mafite probably was biotite. Epizonal hydrothermal alteration has been notably stronger than above.

The plagioclase is flecked with ankerite and coarse sericite. These minerals, along with accessory rutile, also replace mafites. Sulfides (chalcopyrite, molybdenite, and pyrite) occur in quartz veinlets which carry ankerite and orthoclase. More orthoclase occurs in the vein walls, however, where it has replaced the matrix of the rock.

Mineral percentages are estimated as follows: quartz 13%, orthoclase 30%, plagioclase 40%, sericite 10%, leucoxene 0.5%, sulfides 0.5%, ankerite 6%, and traces of apatite and zircon.

C70-1 626.5'

The specimen is a quartz monzonite with phenocrysts of quartz, plagioclase, and biotite set in a chilled, microcrystalline matrix of quartz and orthoclase. The rock has been mildly brecciated by late magmatic movement as at 358.5'. Hydrothermal alteration has been mesozonal.

The fabric is cut by veins of quartz, orthoclase, and ankerite. These have altered their walls more strongly than the bulk of the rock. The plagioclase in the rock is flecked with sericite. Near the veins it has been strongly replaced by sericite with secondary biotite and minor ankerite. Orthoclase throughout the matrix is clean and recrystallized but shows an increase in grain size only near the veins. Here it also may replace the margins of plagioclase phenocrysts. Sulfides (molybdenite, chalcopyrite, and pyrite), although clearly related to the veining, seem to prefer to be disseminated in the alteration envelopes.

Minerals are present in the following estimated amounts: quartz 15%, orthoclase 38%, plagioclase 43%, sericite 6%, biotite 4%, leucoxene 1%, sulfides 1%, ankerite 1%, and traces of apatite.

C70-1 828'

The specimen is a quartz monzonite porphyry with a very fine grained and chilled matrix of quartz and orthoclase. More abundant in this sample are quartz phenocrysts which also tend to be embayed. Other phenocrysts are biotite and plagioclase. Hydrothermal alteration has been weak and epizonal.

The rock is cut by quartz veins which carry pods of subhedral siderite and some sulfides, particularly molybdenite. Replacement of the vein walls by orthoclase occurs rarely and does not appreciably penetrate the walls. A few veinlets carry only orthoclase but seem to be devoid of sulfides. Within the rock the orthoclase shows no sign of recrystallization. Plagioclase is speckled with sericite and biotite wholly replaced by montmorillonite with accessory leucoxene. Rarely is siderite disseminated in the rock; when it is it tends to be in altered biotite.

Minerals are present in the following estimated amounts: quartz 21%, orthoclase 34%, plagioclase 36%, sericite and hydromicas 5%, leucoxene 0.5%, sulfides 0.5%, and siderite 2%, and traces of apatite.

C70-1 1482'

The specimen is a quartz monzonite porphyry. Phneocrysts are randomly oriented and are biotite, plagioclase, and slightly embayed quartz. All may be broken but evidence of late magmatic movement is lacking. The groundmass is microcrystalline quartz and orthoclase. In a few cases plagioclase phenocrysts have been pertially replaced by orthoclase but this is a late magmatic effect. Hydrothermal alteration has been virtually nil.

Pyrite is sparingly disseminated throughout the rock, and near these grains the biotite may be partly or wholly replaced by montmorillonite, sericite, ankerite, and leucoxene. Elsewhere it is quite fresh. Plagioclase is almost free of sericite. Sphene is all replaced by rutile and ankerite except in rare cases where sphene remnants occur in these pseudomorphs. Magnetite has been replaced by hematite.

Mineral percentages are estimated as follows: quartz 24%, plagioclase 38%, orthoclase 29%, sericite 2%, leucoxene 0.5%, sphene 0.5%, sulfides 0.5%, biotite 4%, and traces of apatite and magnetite.

C70-2 218'

The specimen originally was a sheared quartz monzonite porphyry with broken or granulated phenocrysts of plagioclase, quartz, and biotite in a microcrystalline quartz-orthoclase matrix. Hydrothermal alteration has been mesozonal and intense.

Plagioclase is almost totally replaced (as is orthoclase) by fine grained sericite ans secondary biotite embedded in clays. The biotite has been replaced by mats of secondary biotite also. Sphene has been replaced by rutile. The alteration is uniform and not stronger along quartz-sulfide veins which cut the fabric. These carry both pyrite and chalcopyrite (slightly filmed with chalcocite and covellite). Allophane tends to be scattered in the fabric near these veins; elsewhere the clays are kaolin.

Mineral percentages are estimated as follows: quartz 24%, orthoclase 2%, plagioclase 8%, sericite 16%, clays 40%, biotite 6%, sulfides 2%, rutile 1%, and traces of zircon.

C70-2 328'

The specimen is a dacite originally composed of phenocrysts of hornblende, plagioclase, and quartz in a microcrystalline matrix showing flowage alignment. It has been subsequently intensely altered in the mesozone.

The plagioclase is mostly replaced by a mush of sericite and various other hydromicas (inclusive of allophane). The hornblende is completely replaced by fine grained secondary biotite and sericite. Pyrite is disseminated throughout the fabric but concentrated in quartz veins which carry traces of apatite. Alteration along these veins is no different than elsewhere.

Minerals are present in the following estimated amounts: quartz 22%, plagioclase 18%, sericite, clays, etc. 45%, biotite 12%, sulfides 2%, rutile 0.5%, and traces of apatite.

C70-2 346.5'

The specimen is a tonalite originally consisting of anhedral plagioclase laths set in equally coarse, interstitial quartz. The rock was mildly crushed prior to mild epizonal K-metasomatism.

Portions of the rock are replaced by orthoclase which has attacked the margins of plagioclase, then replaced it in toto, and enters into a sort of graphic intergrowth with the remaining quartz. Plagioclase is flecked with sericite and ankerite. Mafites present have been obliterated except for traces of rutile which suggest their former shape. Pyrite occurs along sinuous fractures with no gangue; they are merely filmed with sericite. Sericite adjacent to the pyrite tends to be of coarser size.

Minerals are present in the following estimated amounts: quartz 32%, orthoclase 14%, plagioclase 45%, sericite 5%, pyrite 1%, ankerite 2%, and traces of apatite and rutile.

C70-2 522'

The specimen is a tonalite composed of large equant and subhedral plagioclase with coarse granular interstitial quartz and hornblende and biotite. Accessory apatite and magnetite were concentrated in the mafites. Mesozonal hydrothermal alteration has been moderate.

The plagioclase is slightly sericitized and only rarely replaced along the edges by orthoclase. The mafites are totally replaced by matted secondary biotite and sericite studded with the original apatite grains. Pyrite grains are disseminated, especially in the altered mafites and do not occur in veinlets which carry gangue, but do occur along healed fractures. The quartz in the rock shows no signs of recrystallization.

Minerals are present in the following estimated amounts: quartz 12%, orthoclase 1%, plagioclase 64%, sericite 4%, biotite 14%, sulfides 3%, rutile 0.5%, apatite 0.5%, and traces of zircon.

C70-3 107'

The specimen is a quartz monzonite composed of ragged phenocrysts of plagioclase set in a chilled, microcrystalline matrix of quartz and orthoclase. All vestiges of the original mafites are destroyed. Alteration has been mild and epizonal.

Pyrite associated with the alteration is disseminated in the fabric rather than in the barren, granular quartz veins which cut the fabric. No wallrock alteration along the veins can be demonstrated. The orthoclase in the matrix looks fresh and, although it was undoubtedly stable during alteration, little has been added. There are a few small orthoclase crystalloblasts, however. Plagioclase is feebly sericitized.

Minerals are present in the following estimated amounts: quartz 19%, orthoclase 44%, plagioclase 26%, sericite 9%, pyrite 1%, and traces of apatite, rutile, and zircon.

C70-3 319'

The specimen is a quartz monzonite porphyry identical in texture and general appearance to that at 107'. In addition to the plagioclase phenocrysts, outlines of thin biotite crystals have been preserved despite the later K-metasomatism.

Pyrite and chalcopyrite tend to occur in veins which cut the fabric but they may also be disseminated. The veins consist of quartz, orthoclase, and minor ankerite which have replaced the rock along fractures. Orthoclase in the matrix is fresh and shows patchy incipient crystalloblastic growth and replacement of plagioclase. Biotite has been replaces by wispy sericite with accessory leucoxene. The plagioclase is but slightly sericitized.

Mineral percentages are estimated as: quartz 18%, orthoclase 48%, plagioclase 27%, sericite 2%, sulfides 3%; apatite 1%, ankerite 1%, and traces of rutile.

C70-3 469'

The specimen is a quartz monzonite porphyry with a texture like those above. It too has suffered K-metasomatism but in this sample it is more pornounced.

Orthoclase has replaced the matrix to a slight degree and the newly crystallized orthoclase is somewhat enlarged and quite fresh. Along older fractures it has developed into larger crystals with the exclusion of quartz and plagioclase. These replaced fractures may merge into orthoclase or quartz-orthoclase veinlets. Pyrite and chalcopyrite tend to occur along slightly later fractures with no gangue. Biotite has been replaced by wispy sericite with accessory leucoxene. Where orthoclase has been coarsened, there may be interstitial allophane.

Minerals are present in the following estimated amounts: quartz 22%, orthoclase 55%, plagioclase 18%, sericite 2%, sulfides 2%, allophane 0.5%, and traces of apatite, rutile, and zircon.

C70-3 578'

The specimen is a quartz monzonite porphyry like those above. Phenocrysts of plagioclase are equant and scattered among thick biotite books and quartz in a microcrystalline quartz-orthoclase matrix. K-metasomatism, as in the sample immediately above, is more advanced than higher in the hole.

The matrix orthoclase shows some enlargement of grains, and it is very fresh. Along old fractures and at the margins of plagioclase grains it may be recrystallized as coarse anhedra with all of the former interstitial quartz excluded. Some of these replaced fractures are really veinlets with introduced quartz and sulfides as well. Sulfides also may occur where the vein gangue dies out and the vein becomes a string of aligned pyrite beads. Plagioclase is but slightly sericitized. Biotite has been replaced by sericite and smectite with accessory leucoxene. Ankerite is most abundant in mafites.

Minerals are present in the following estimated amounts: quartz 20%, plagioclase 20%, orthoclase 50%, sericite 4%, sulfides 1%, ankerite 4%, apatite 0.5%, and traces of rutile.

KENYON RICHARD
Mining Geologist
1501 MIRACLE MILE
TUCSON, ARIZONA 85705

602-622-0953

February 1, 1971

Mr. Richard Hewlett
Sierra Mineral Management
4741 East Sunrise Drive
Skyline Bel Aire Plaza
Tucson, Arizona 85718

Hassayampa-Copper Creek
Near Prescott Arizona

Dear Sir:

This letter consists of my preliminary impressions gained during the brief reconnaissance with you, Ron Karvinen and Dave Carson on January 20.

Carson had just arrived and intends to map the subject area. I believe he will do a very good job because he seems already experienced in dealing with those rock types and alteration types which characterize porphyry copper deposits. My present opinions about exploration possibilities are hedged a bit because I think Carson will come up with definitive facts rather quickly. I would like to keep in touch with Carson's work, and can later express more positive opinions.

The subject prospect is a good porphyry copper/moly "deposit", in contrast to the many deposits in the world which consist only of disseminated pyrite without all of the following geologic criteria which I consider important:

(1) The deposit, or the area of hydrothermal alteration with accompanying hydrothermal sulphides, is substantial in lateral dimensions.

(2) The altered rocks appear mostly to be Laramide intrusives.

(3) A small quartz porphyry intrusive with aphanitic ground mass and pre-mineral age is seen within the zone of alteration. This type of rock is found within all porphyry copper/moly deposits, and therefore it is an important feature. Usually, though, hypogene ore is found in the rocks <u>surrounding</u> that kind of porphyry, not within it.

(4) The leached outcrops and float show evidence of the original existance of some copper sulphides along with disseminated pyrite. But nowhere did I see in my brief traverse any "capping" material suggesting a "hot spot" of original copper sulphides of certain, good ore grade. Most of the outcrops and float seemed to me to be in that range where the amounts of original copper sulphides between, say, .10 and .70% Cu cannot be differentiated with much assurance.

(5) Within the mineralized zone the alteration is generally strong. Except in the case of the quartz porphyry, original textures have been mostly destroyed.

(6) A couple of small breccia pipes were seen. There may be more of them. Sometimes, though not always, these pipes contain better-than-average copper/moly values. Breccia pipes are almost always present in a good porphyry copper/moly prospect; and their mere presence in this deposit enhances its value as a prospect, whether the pipes carry better-than-average values or not.

Even though all of these favorable geologic features are present, this prospect does not represent a cinch, as you know. Although one should not quote race track odds, I would suggest that the chance is something like 1 in 4 that a viable ore body can be found within this deposit at a reasonable financial risk. These are pretty good odds.

To date the location of drillholes has been a matter of quickest first access--that is, along existent roads or new ones easily constructed along canyon bottoms. This procedure was entirely appropriate because it was partly guided by IP and geochem data and because, to begin with, a few drillholes were needed almost anywhere within the deposit. From now on, however, drillholes should be positioned without regard to any difficulty or extra expense of building access roads.

The locations of new drillholes should be governed by the early results of Carson's reconnaissance and mapping. Roads should immediately be cut into any areas which Carson finds interesting--for whatever geological reason. The more road cuts (which expose bedrock) the better. In fact, at this stage road cuts within zones of apparent better alteration-mineralization, but which are largely soil covered, should be considered as prospecting trenches having, possibly, as much value as drillholes. Such road cuts will certainly facilitate the matter of placing early drillholes in the best locations.

The results of IP surveys should of course be compared with geologic features as they are mapped, but I doubt that the IP will contribute much of value. Copper geochem results (either soil or rock chips) have to be evaluated with care because copper is so mobile. Moly geochem surface samples, however, sometimes provide better indication of the distribution of copper values in the sulphide zone than the copper geochem samples do themselves.

Drilling on this prospect should be conducted actively. The present program of drilling shallow, wide-spaced drillholes is OK; but I would anticipate, based on my inspection of a few segments of core and the thin section reports, that a possible vertical zoning of copper/moly values will become evident soon. If so, deep drillholes might become desirable rather early in the project.

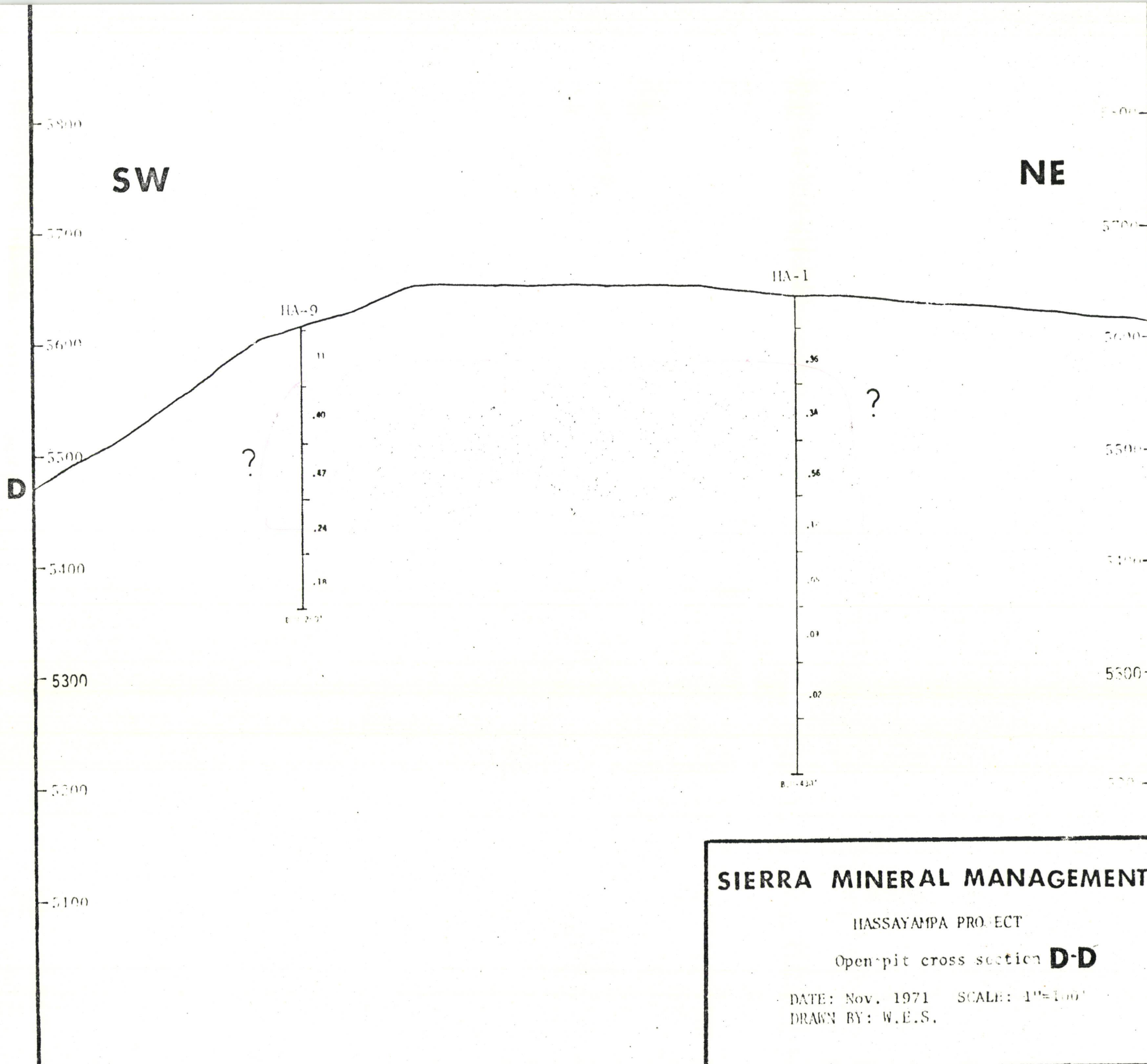
Yours very truly,

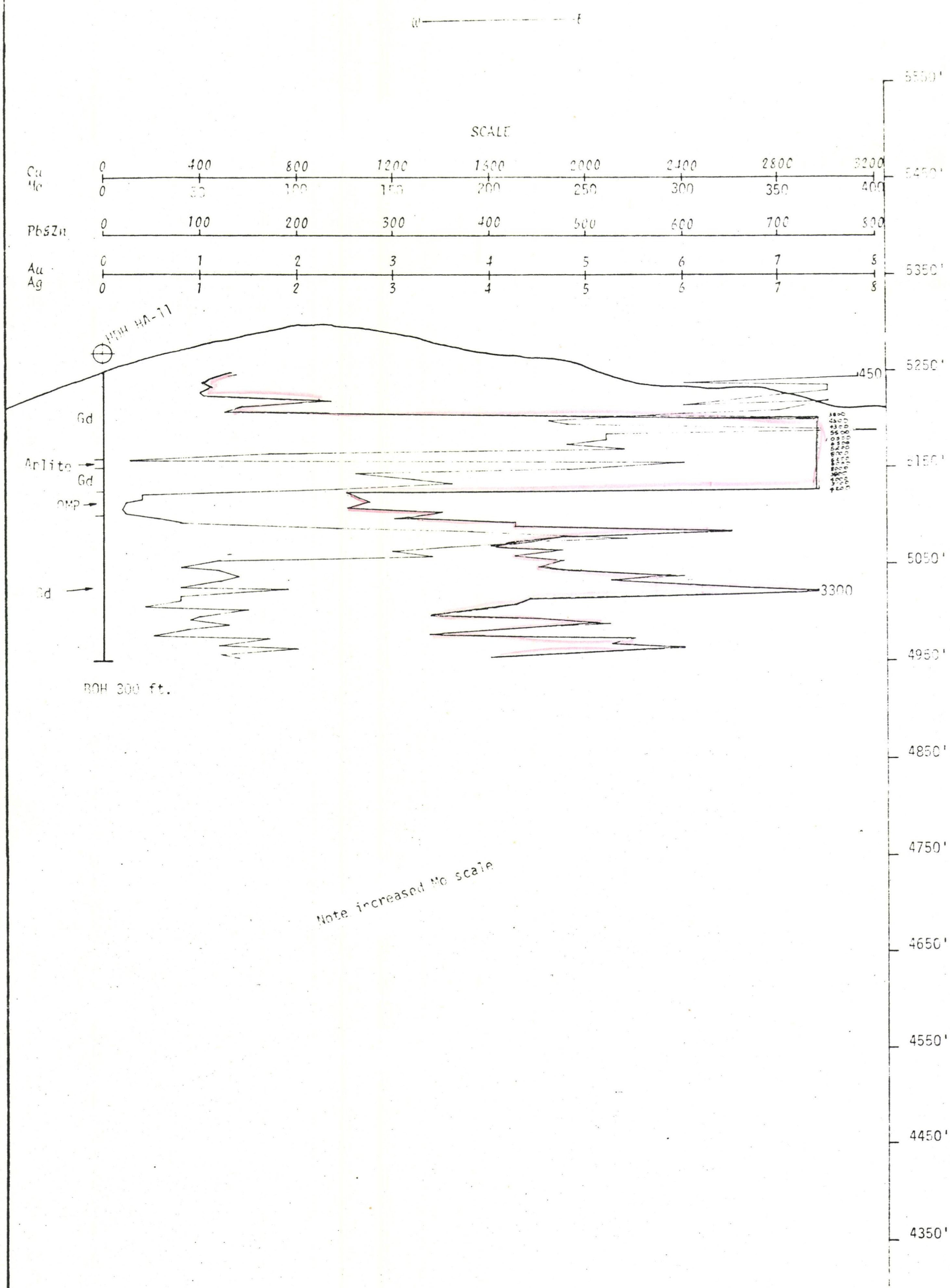
KR

Kenyon Richard

cc: Hewlett - 3 extra

KR:fw


SW
NE
5800
5700
5600
5500
5400
5300
5200
5100
D
D´
HA-9
HA-1
.40
.47
.24
.18
.36
.34
.56
.02
?
?
SIERRA MINERAL MANAGEMENT
HASSAYAMPA PROJECT
Open-pit cross section D-D´
DATE: Nov. 1971
DRAWN BY: W.E.S.



Cu 1"=400ppm
Mo 1"=50ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

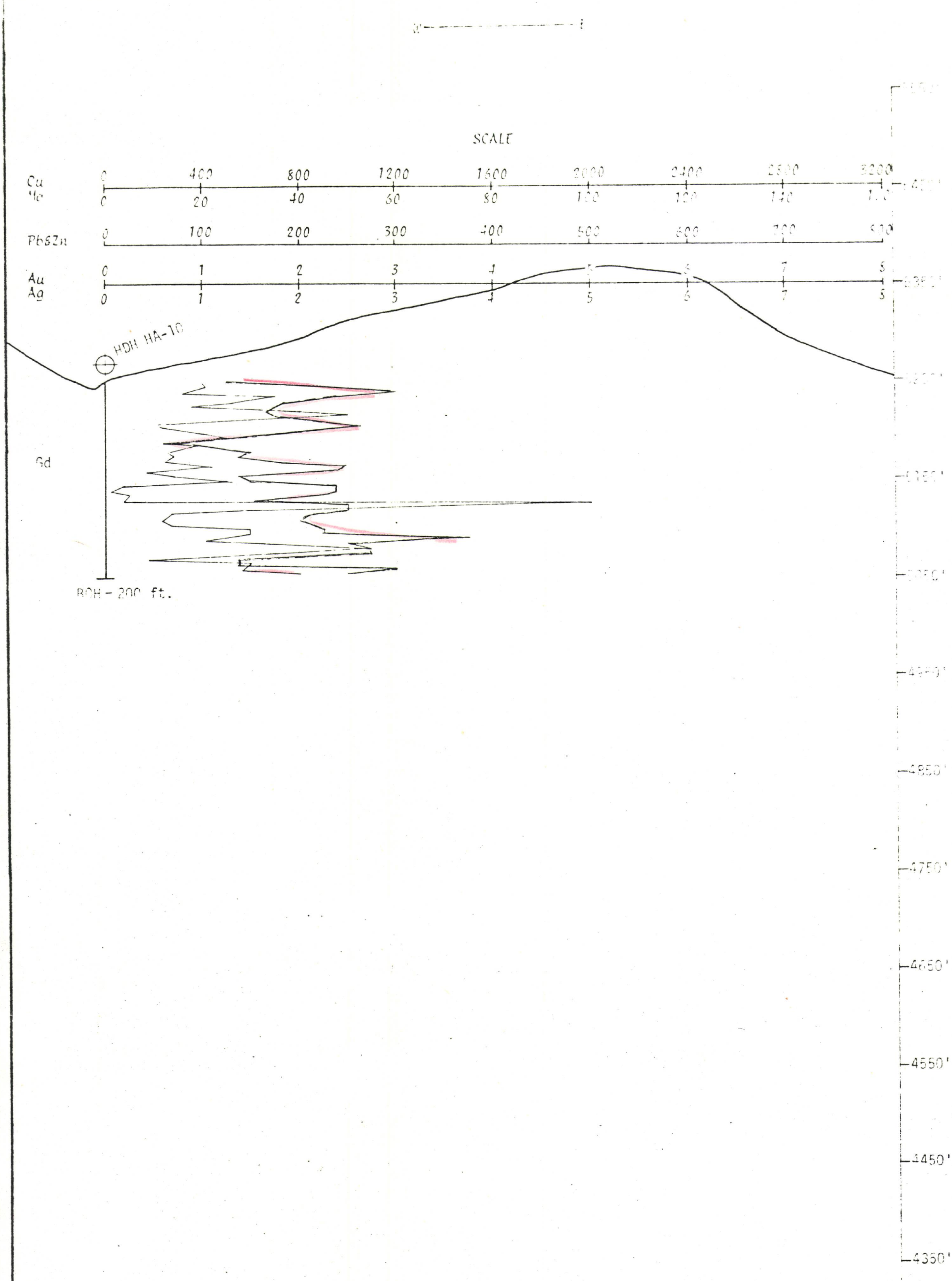
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA-11

DATE: 11/2/71 **SCALE:** 1" = 100'

GEOLOGY BY: W.E. Speer **DRAWN BY:** W.E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

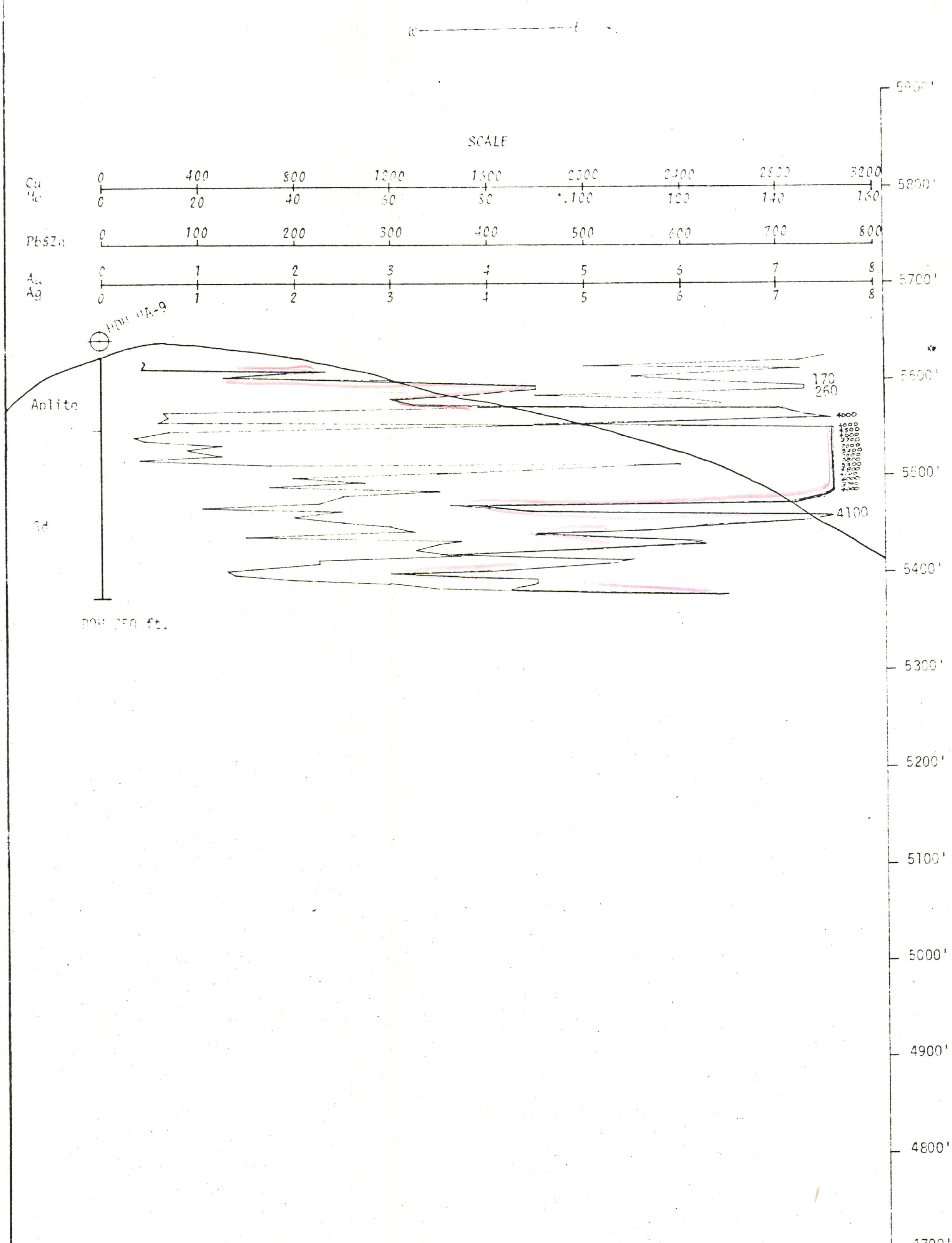
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA-10

DATE: 11/4/71 **SCALE:** 1"= 100'

GEOLOGY BY: F. Speer **DRAWN BY:** L.E.S



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

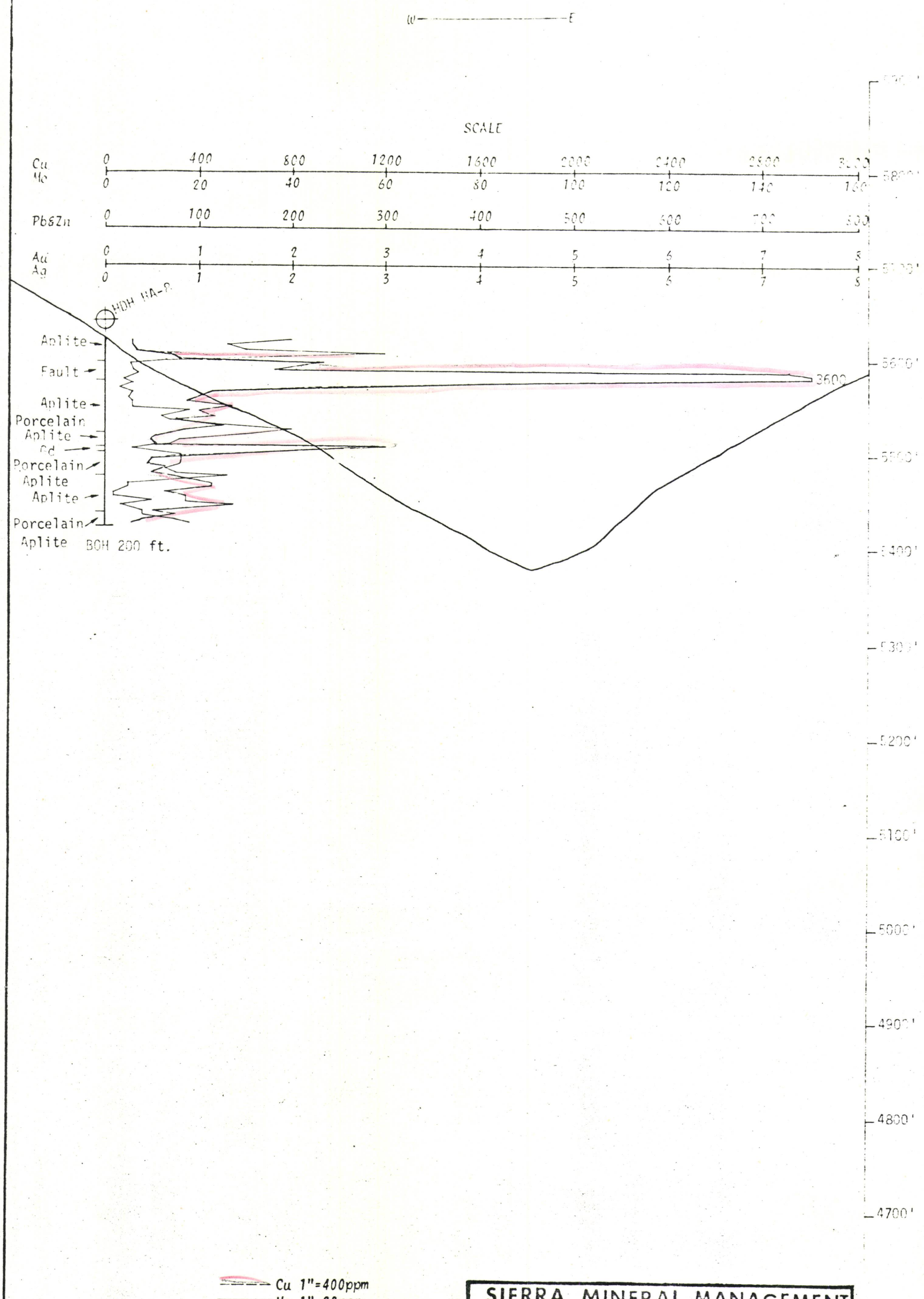
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA 9

DATE: 11/3/71 **SCALE:** 1"= 100'

GEOLOGY BY: **DRAWN BY:** E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

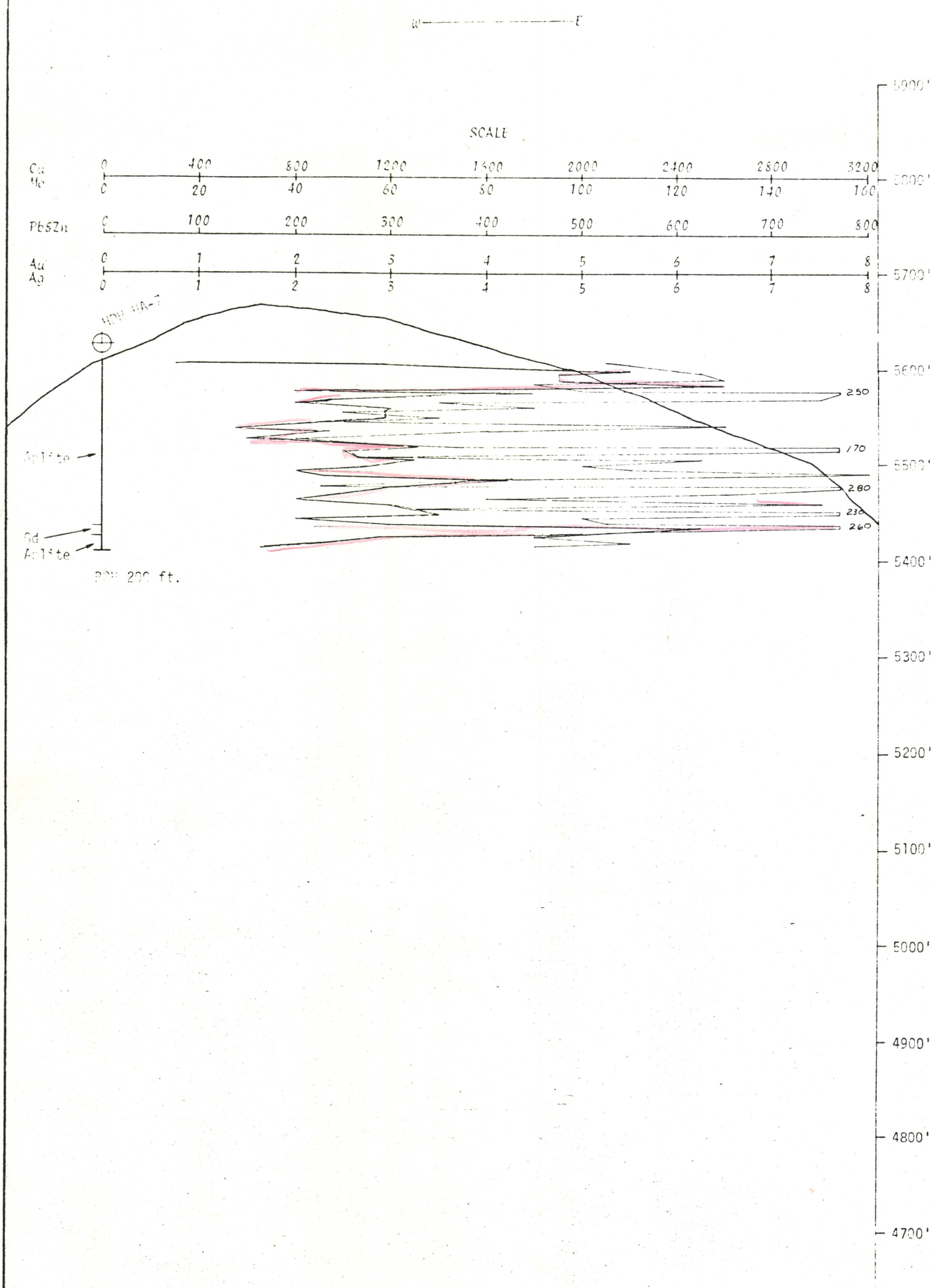
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA-8

DATE: SCALE: 1" = 100'

GEOLOGY BY: Speer DRAWN BY: E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

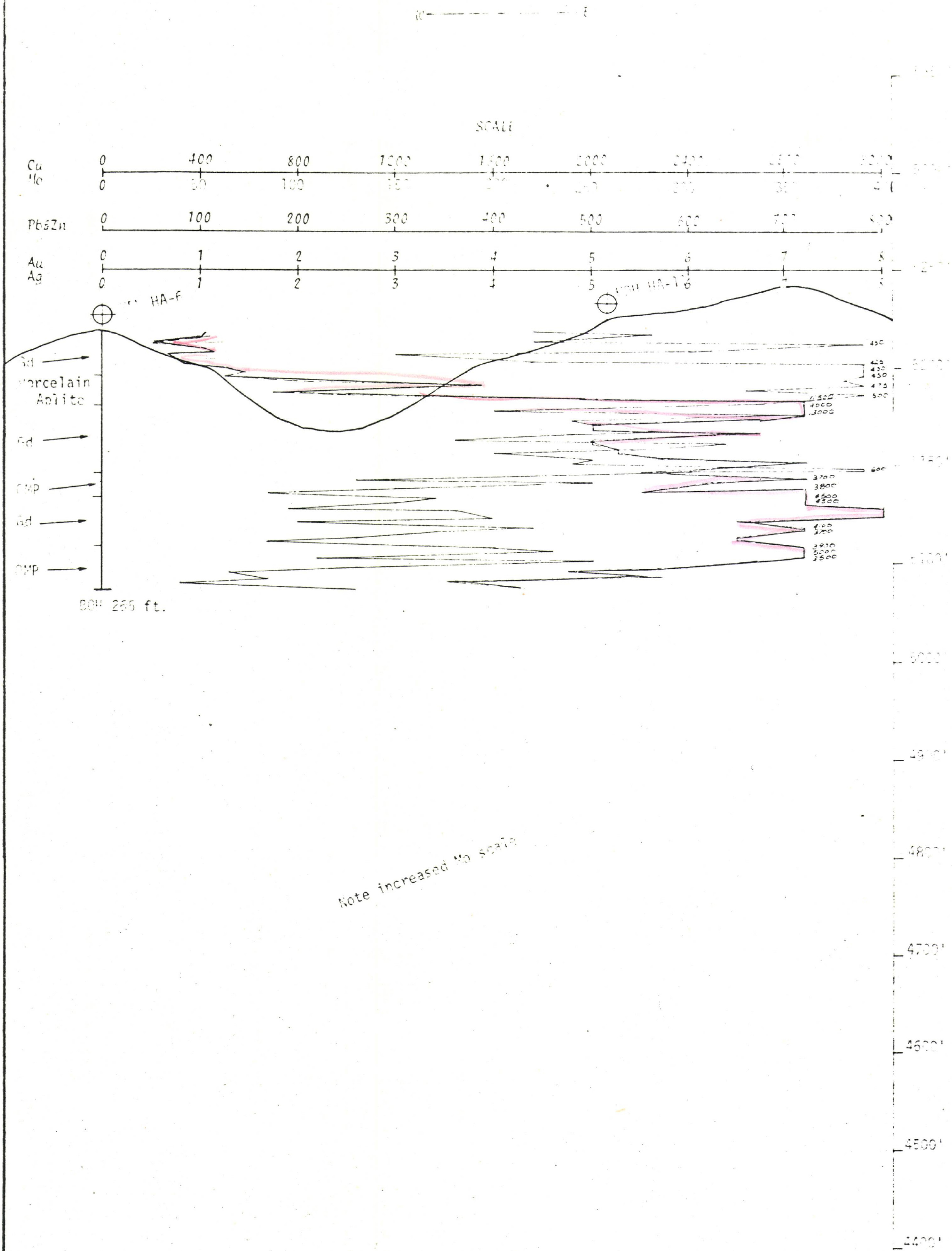
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA 7

DATE: 11/2/71 **SCALE:** 1" = 100'

GEOLOGY BY: W.E. Speer **DRAWN BY:** W.E.S.



Cu 1"=400ppm
Mo 1"=50ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

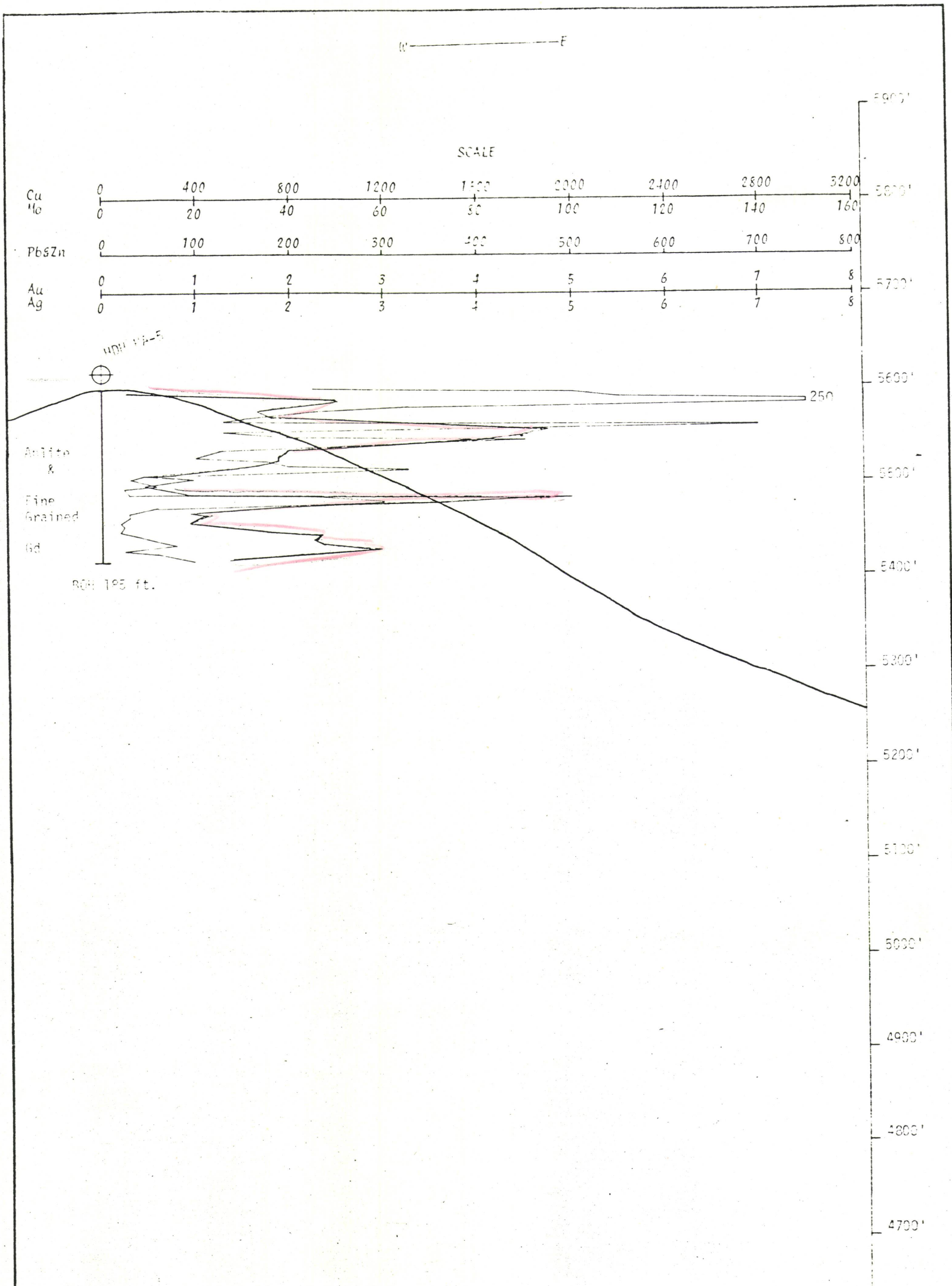
SIERRA MINERAL MANAGEMENT

PROJECT — [illegible]

DRILL HOLE PROJECTION NO. [illegible]

DATE: [illegible] SCALE: 1"= 100'

GEOLOGY BY: [illegible] DRAWN BY: [illegible]



- - - Cu 1"=400ppm
—— Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

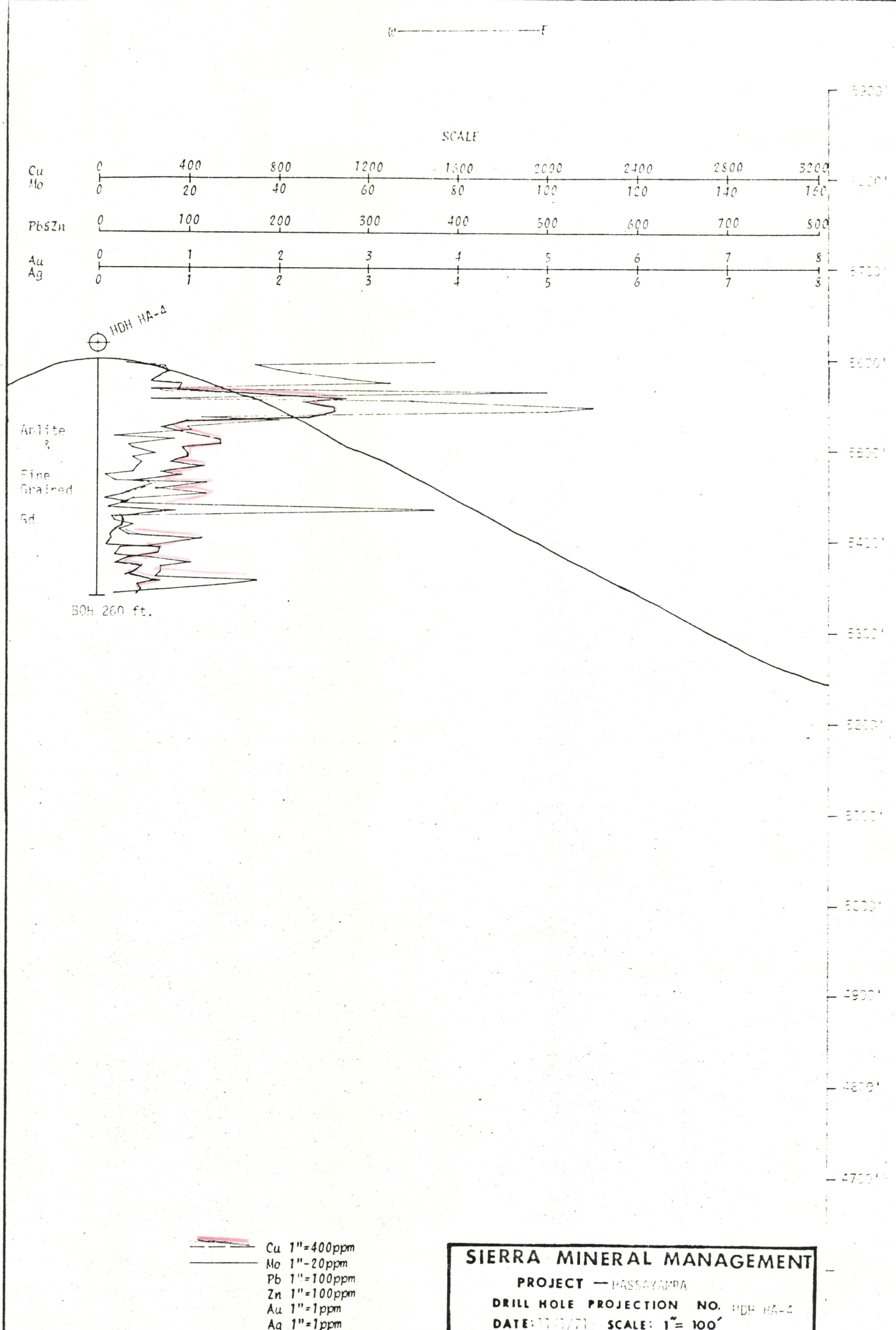
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. HA-5

DATE: SCALE: 1" = 100'

GEOLOGY BY: DRAWN BY: W.E.S.



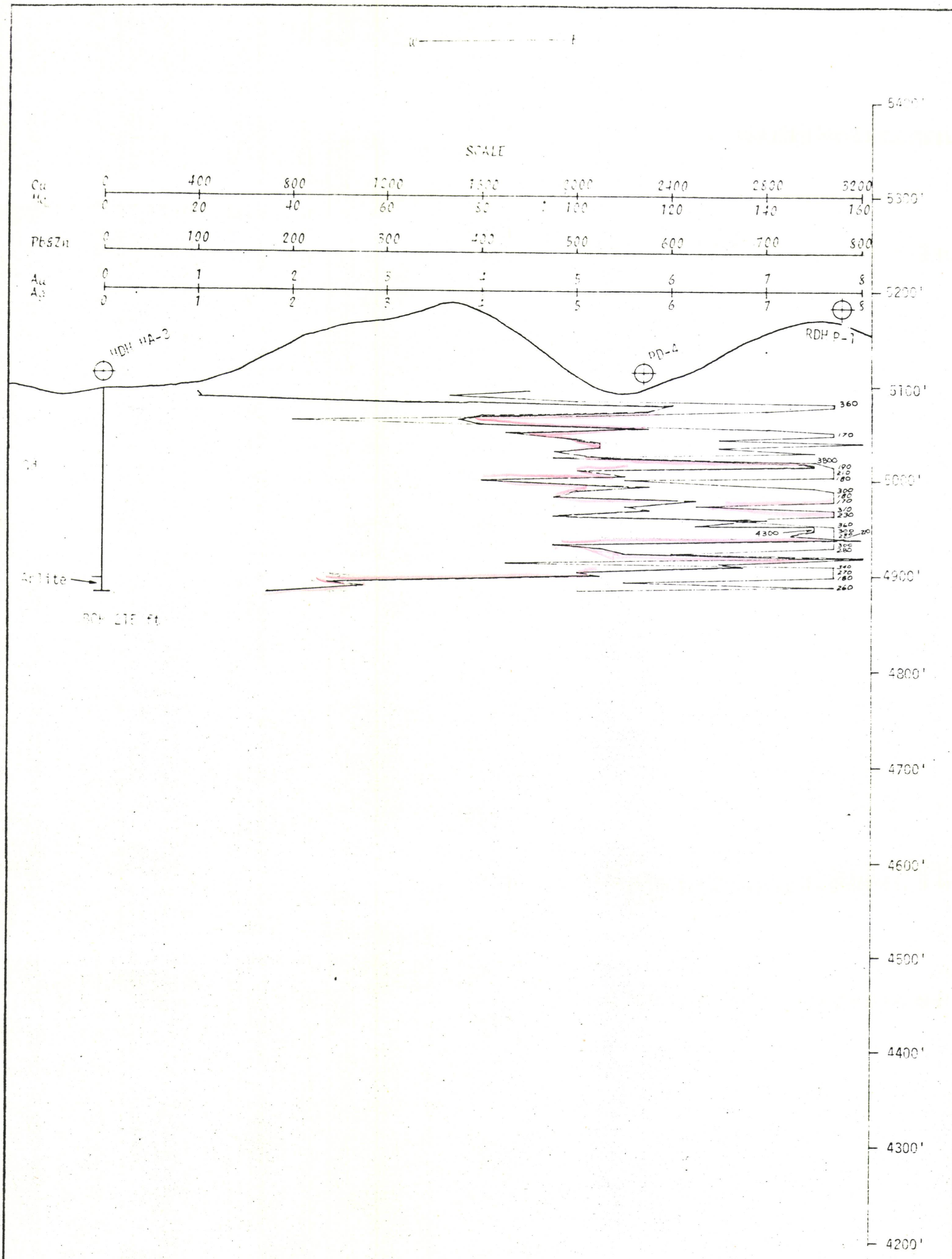
SIERRA MINERAL MANAGEMENT

PROJECT — PASSAYAMPA

DRILL HOLE PROJECTION NO. HDH HA-4

DATE: [illegible]/71 **SCALE:** 1" = 100'

GEOLOGY BY: [illegible] **DRAWN BY:** [illegible]



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

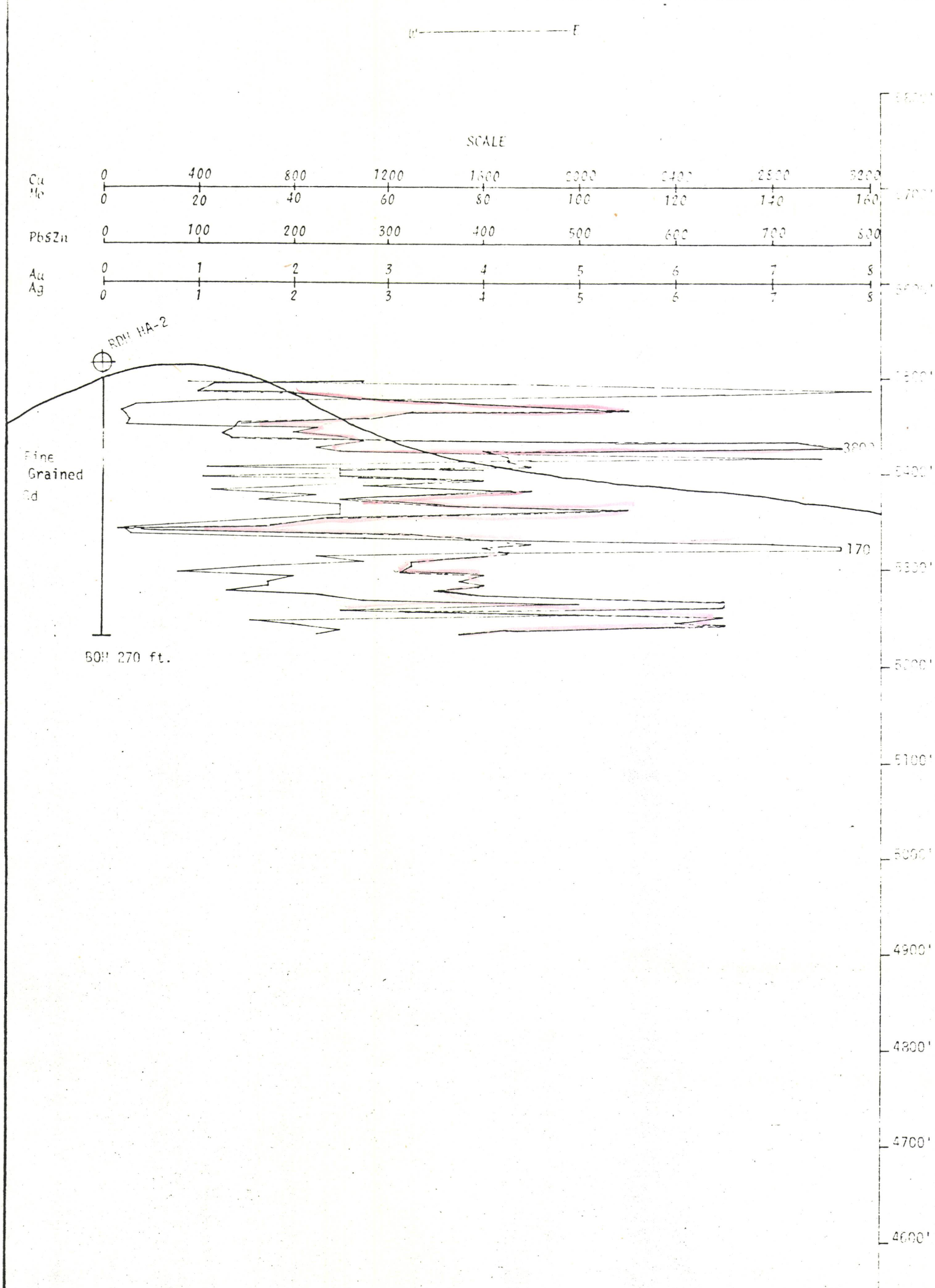
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. RDH HA-3

DATE: [illegible] SCALE: 1" = 100'

GEOLOGY BY: [illegible] DRAWN BY: [illegible]



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

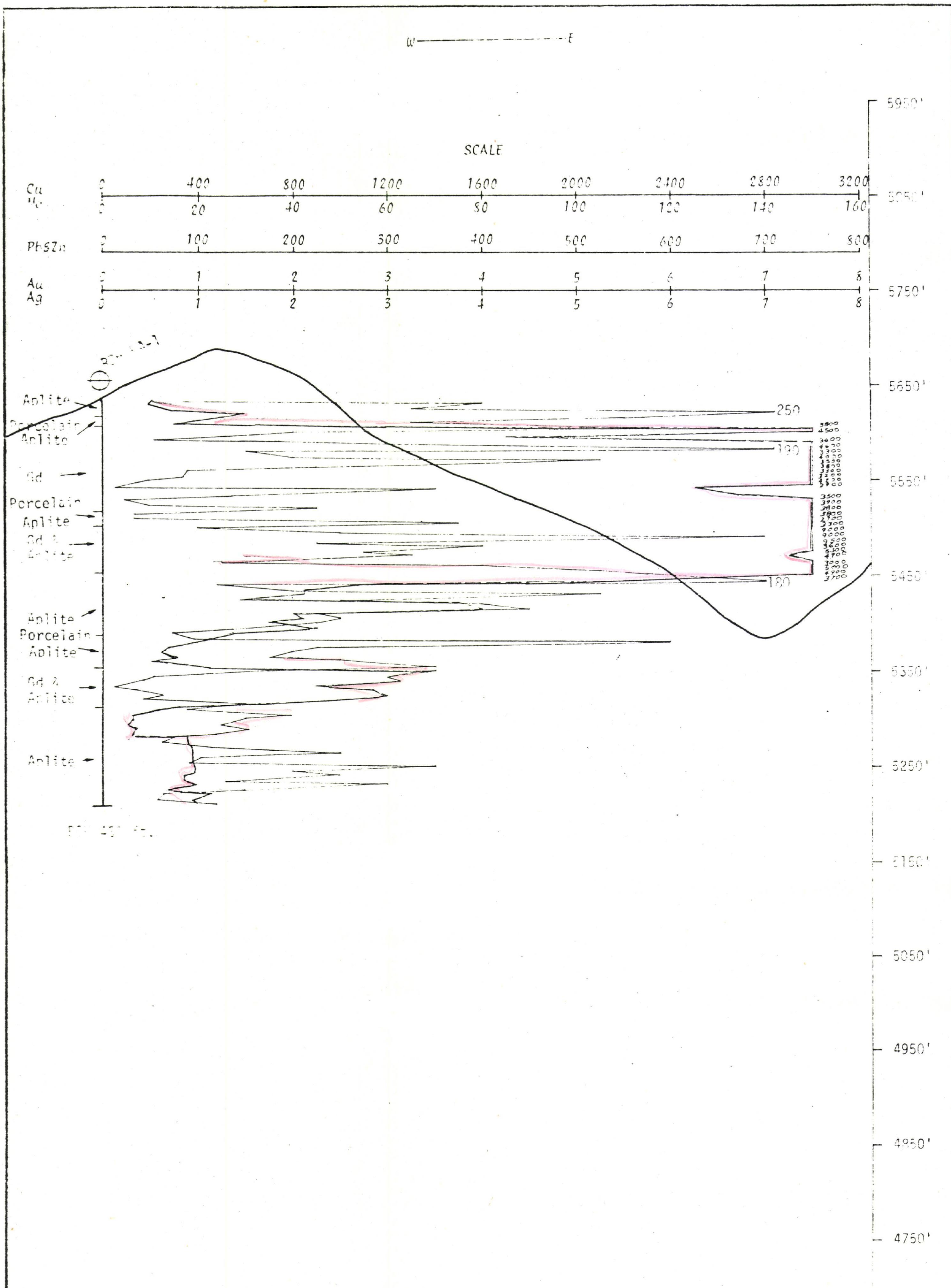
SIERRA MINERAL MANAGEMENT

PROJECT — [illegible]

DRILL HOLE PROJECTION NO. RDH HA-2

DATE: [illegible] **SCALE: 1" = 100'**

GEOLOGY BY: [illegible] **DRAWN BY:** [illegible]E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

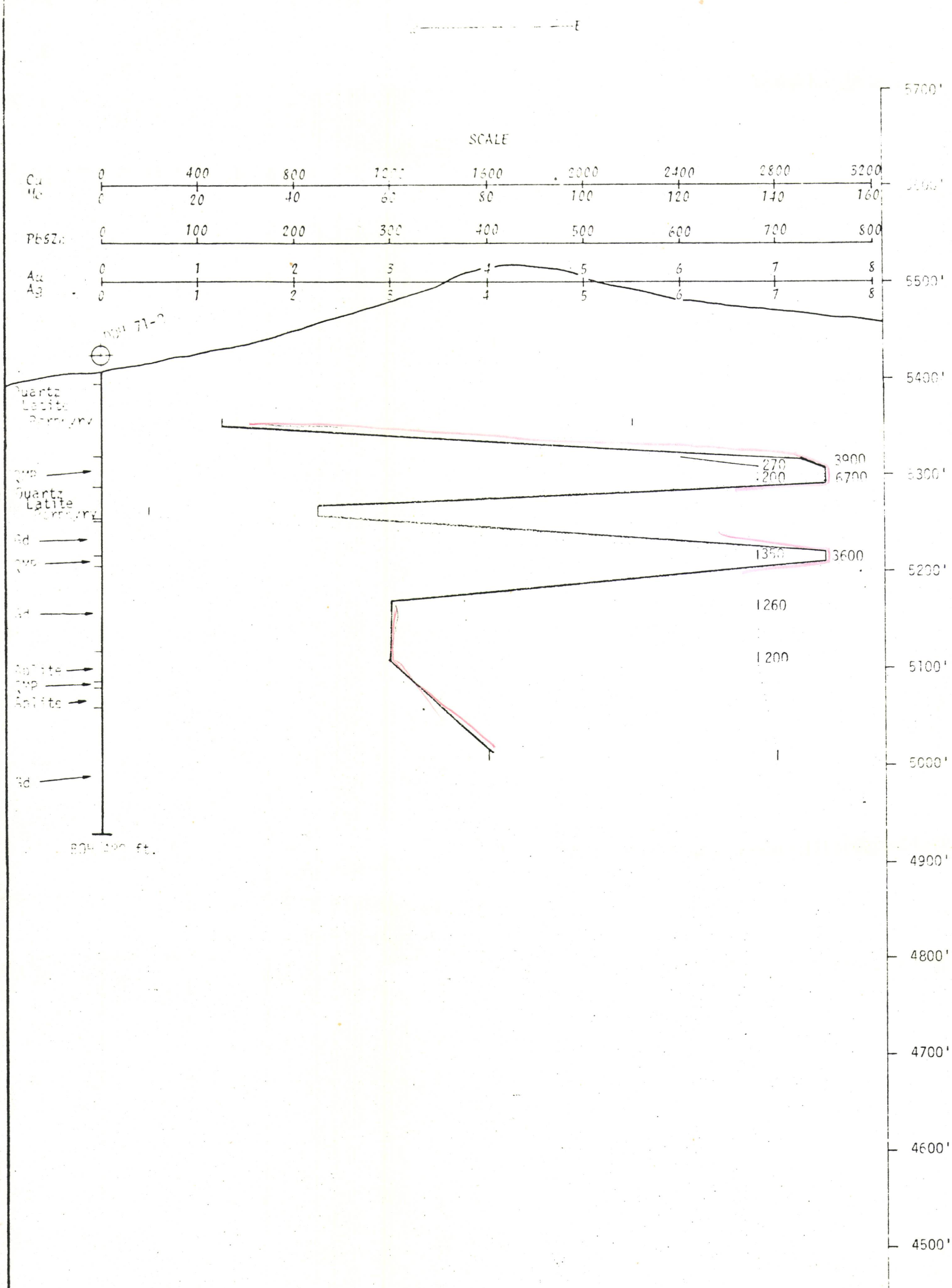
SIERRA MINERAL MANAGEMENT

PROJECT —

DRILL HOLE PROJECTION NO.

DATE: SCALE: 1" = 100'

GEOLOGY BY: DRAWN BY:



Cu 1"=400ppm - - - -
Mo 1"-20ppm ———
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

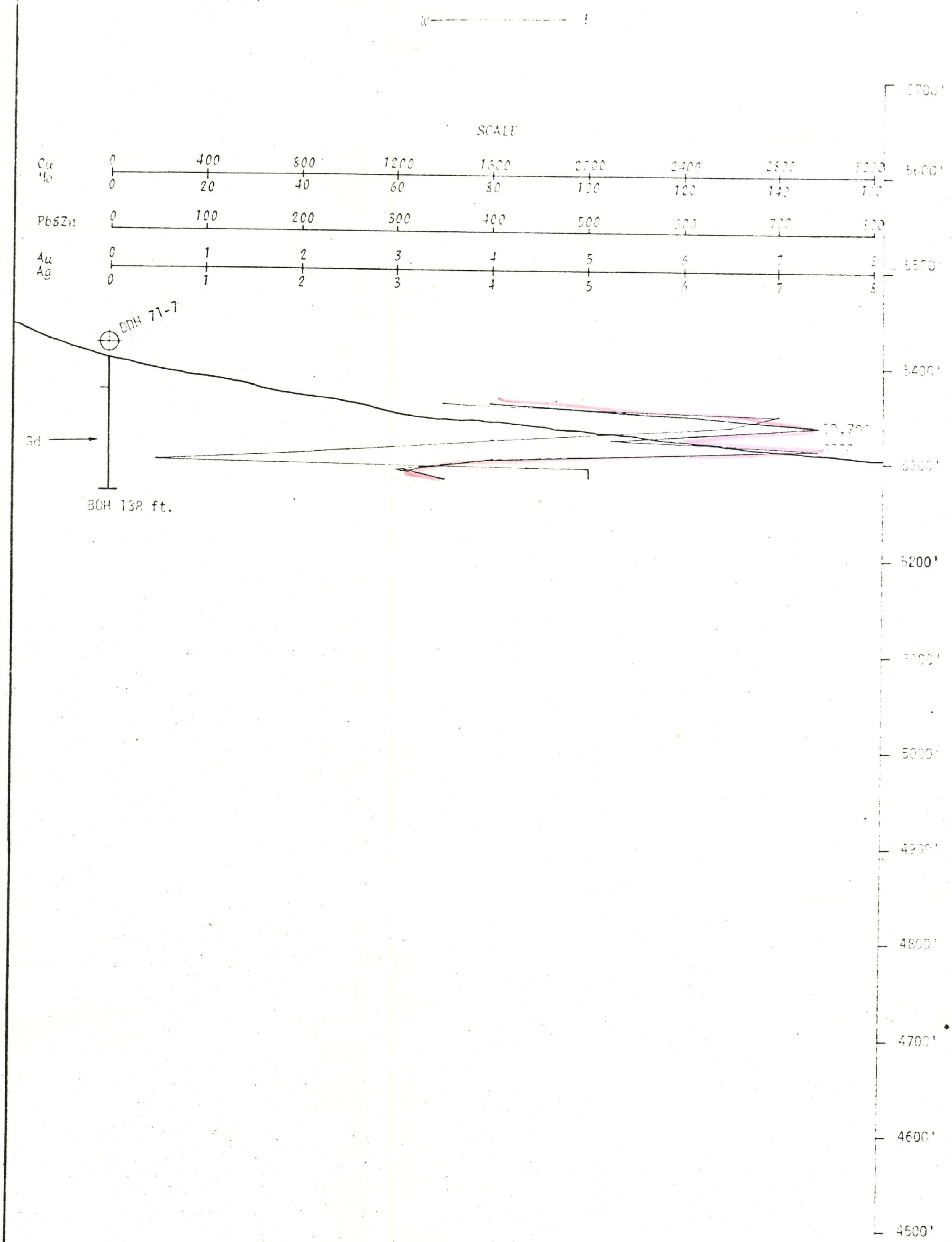
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 71-8

DATE: 10/28/71 SCALE: 1"= 100'

GEOLOGY BY: M. [illegible] DRAWN BY: W.E.S.



--- Cu 1"=400ppm
—— Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

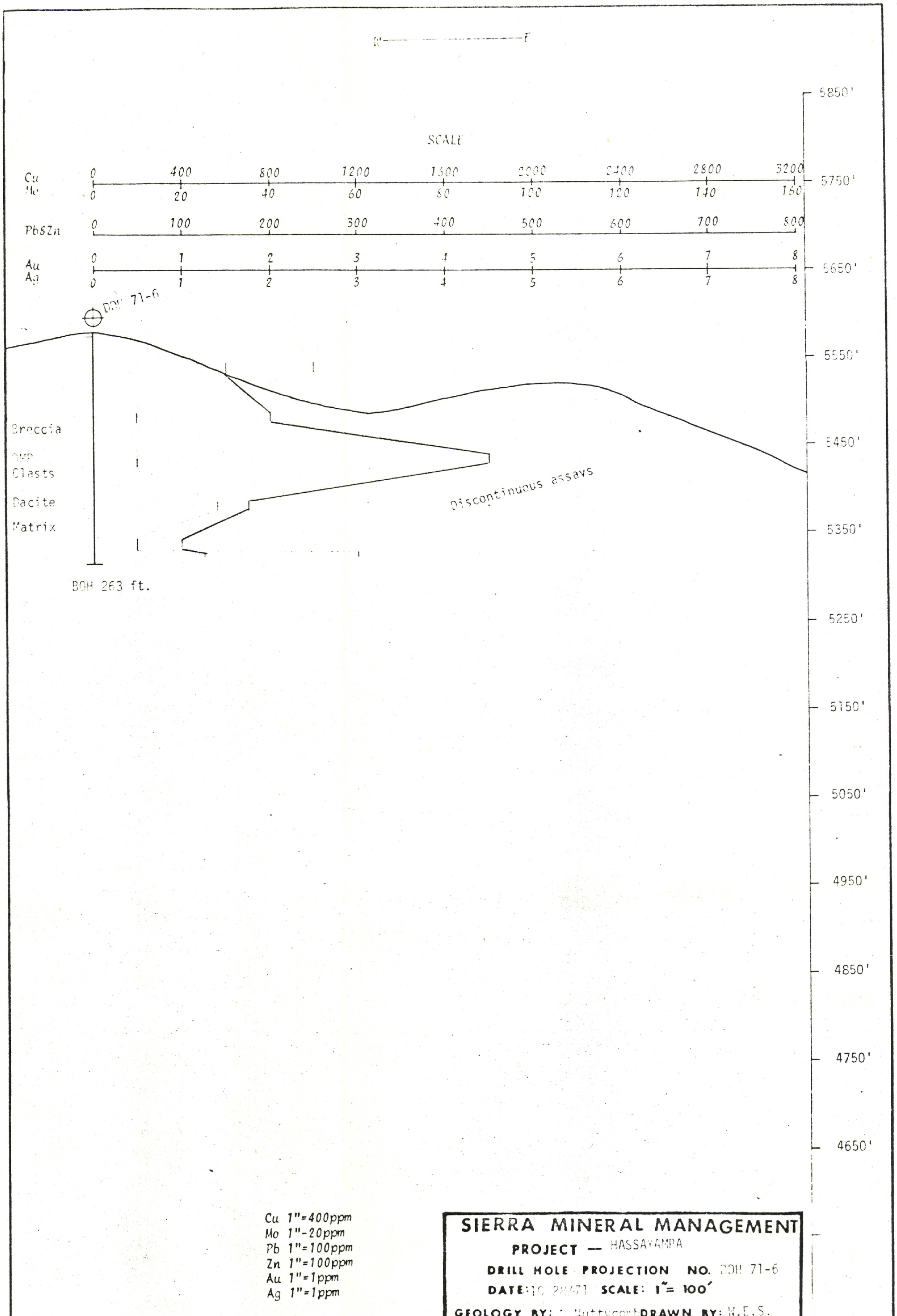
SIERRA MINERAL MANAGEMENT

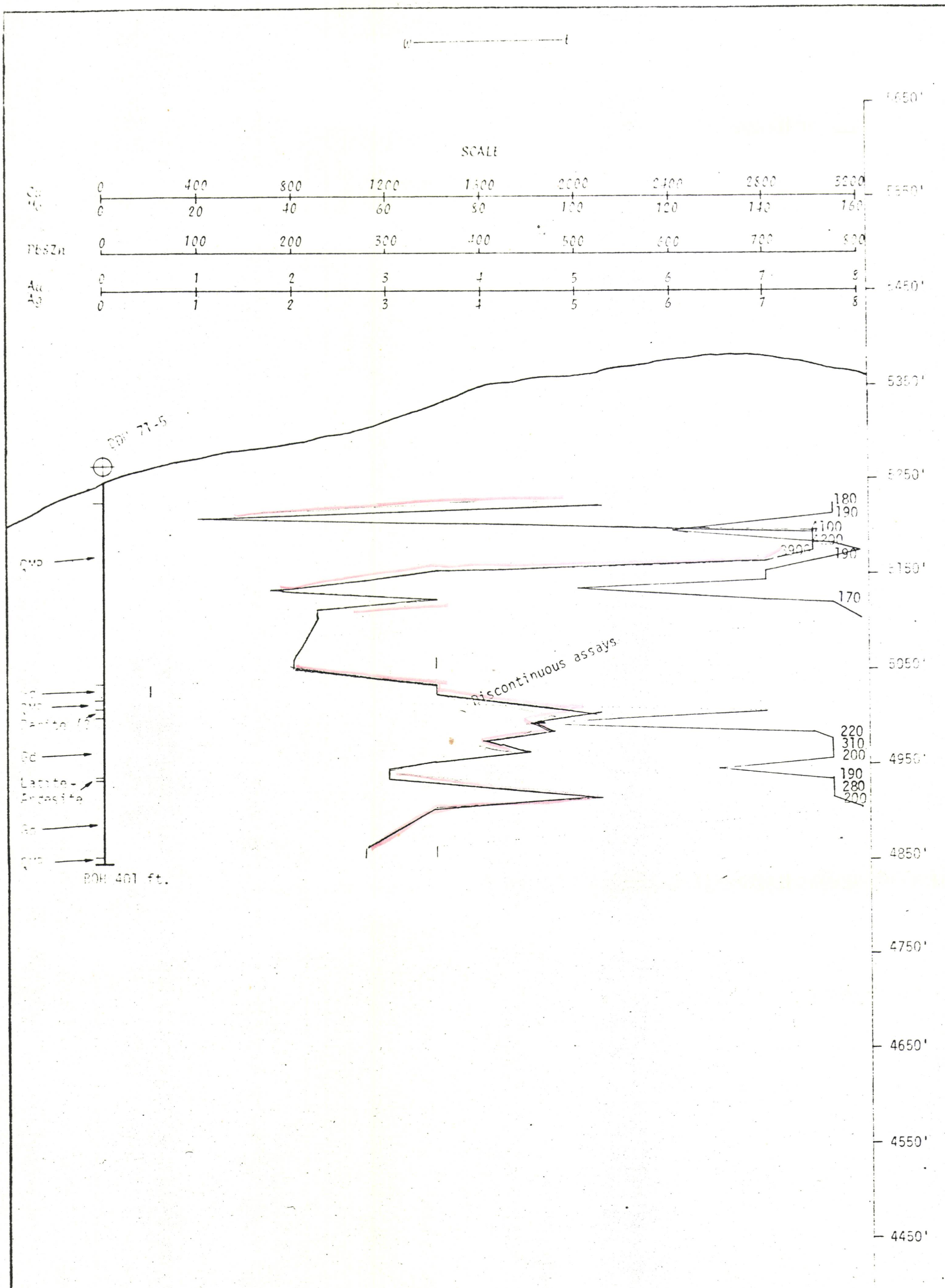
PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 71-7

DATE: [illegible] **SCALE: 1" = 100'**

GEOLOGY BY: [illegible] **DRAWN BY:** [illegible]


W — E
SCALE
Cu 0 400 800 1200 1600 2000 2400 2800 3200
Mo 0 20 40 60 80 100 120 140 160
Pb&Zn 0 100 200 300 400 500 600 700 800
Au 0 1 2 3 4 5 6 7 8
Ag 0 1 2 3 4 5 6 7 8
DDH 71-6
Breccia
QMP
Clasts
Dacite
Matrix
Discontinuous assays
BOH 263 ft.
5850'
5750'
5650'
5550'
5450'
5350'
5250'
5150'
5050'
4950'
4850'
4750'
4650'
Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT — HASSAYAMPA
DRILL HOLE PROJECTION NO. DDH 71-6
DATE: 10 28/71 SCALE: 1" = 100'
GEOLOGY BY: Nuttycomb DRAWN BY: W.E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

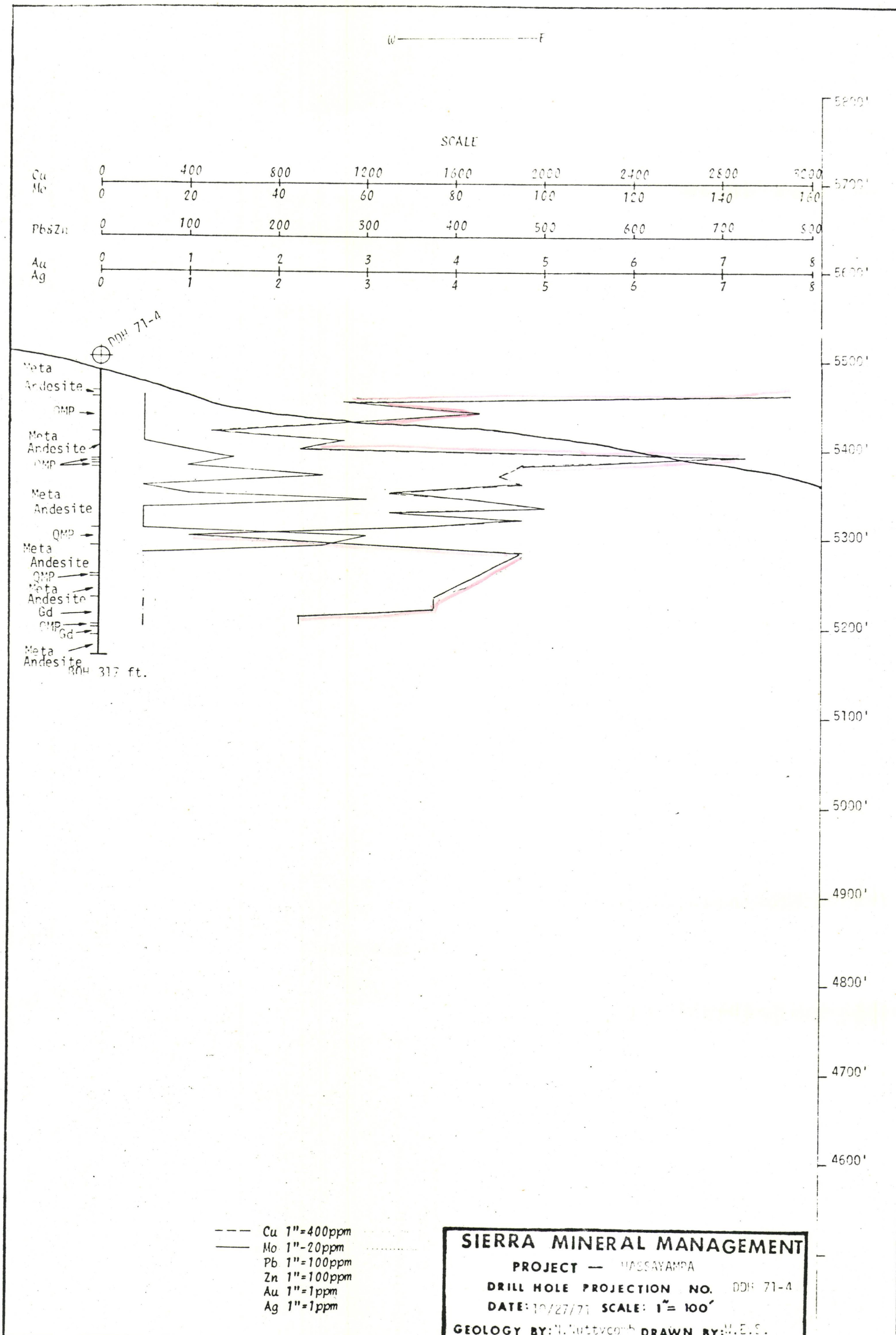
SIERRA MINERAL MANAGEMENT

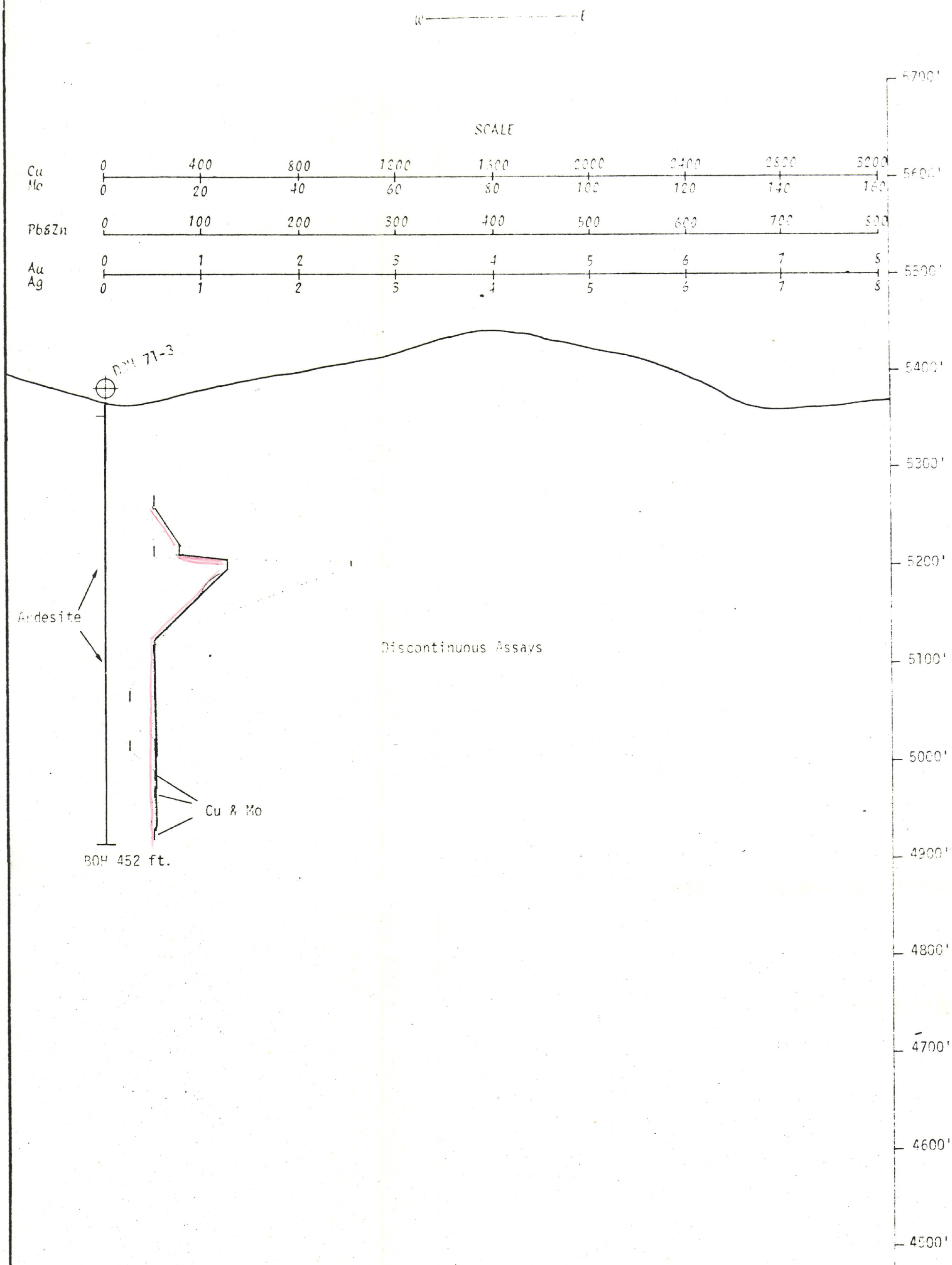
PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 71-5

DATE: 11/29/71 SCALE: 1"= 100'

GEOLOGY BY: . Nuttycomb DRAWN BY: W.E.S.


W E
SCALE
Cu 0 400 800 1200 1600 2000 2400 2800 3200
Mo 0 20 40 60 80 100 120 140 160
Pb&Zn 0 100 200 300 400 500 600 700 800
Au 0 1 2 3 4 5 6 7 8
Ag 0 1 2 3 4 5 6 7 8
DDH 71-4
Meta Andesite
QMP
Meta Andesite
QMP
Meta Andesite
QMP
Meta Andesite
QMP
Meta Andesite
Gd
QMP
Gd
Meta Andesite
DDH 317 ft.
5500'
5400'
5300'
5200'
5100'
5000'
4900'
4800'
4700'
4600'
Cu 1"=400ppm
Mo 1"=20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT —
DRILL HOLE PROJECTION NO. 71-4
DATE: SCALE: 1" = 100'
GEOLOGY BY: DRAWN BY:



Cu 1"=400ppm
Mo 1"=20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

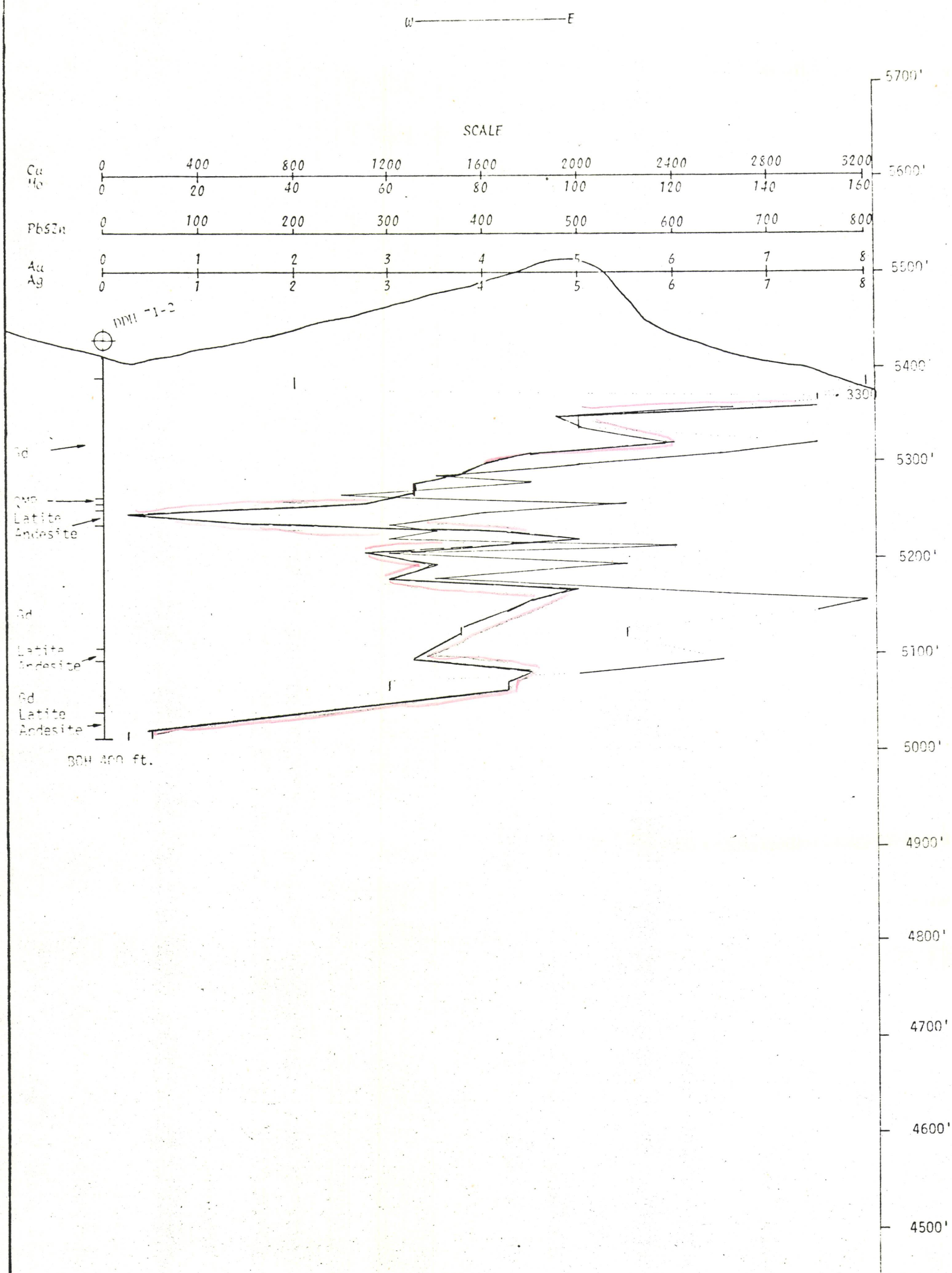
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 71-3

DATE: 10/21/71 **SCALE:** 1" = 100'

GEOLOGY BY: M. Huttycord **DRAWN BY:** W.E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

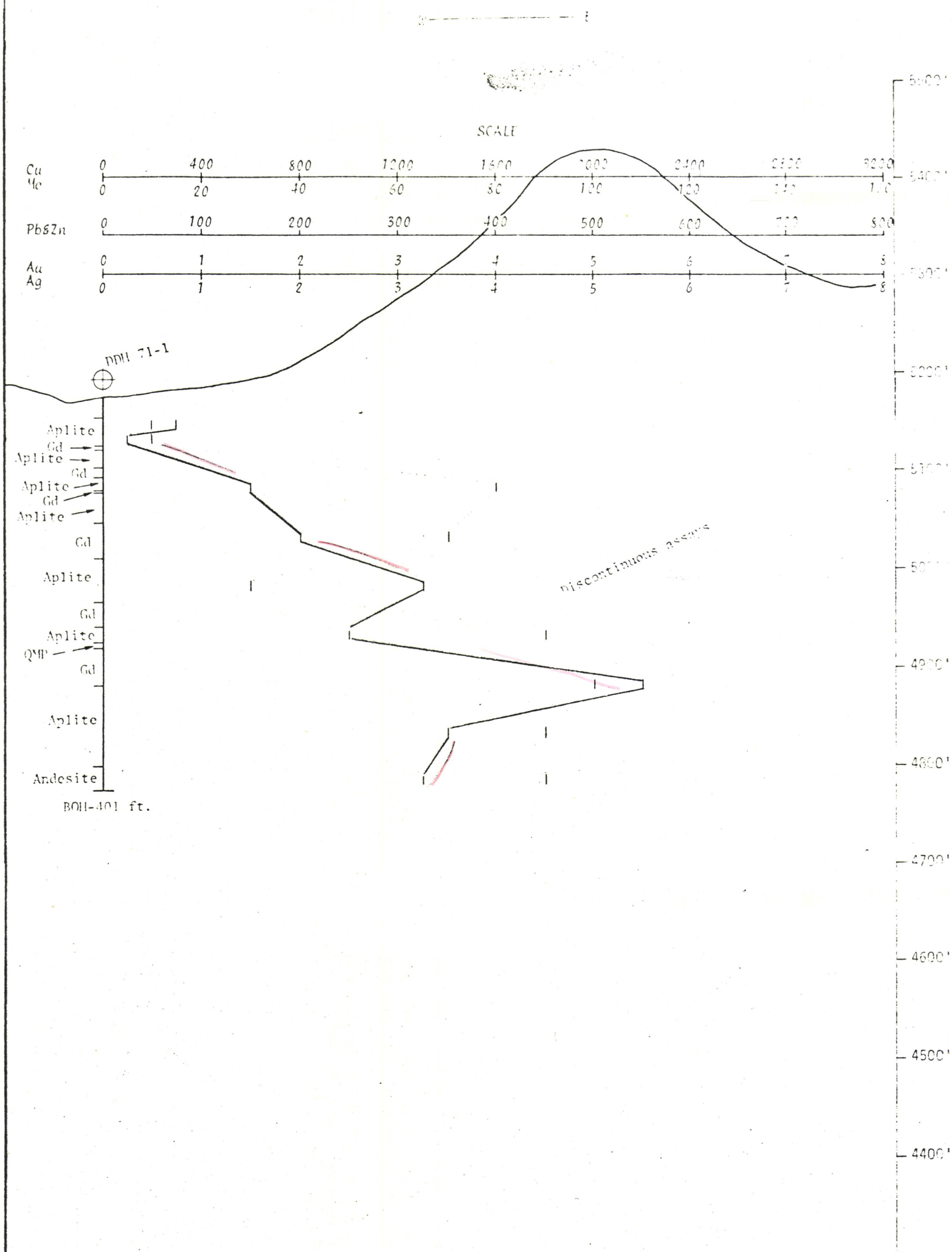
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 71-2

DATE: 10/27/71 **SCALE:** 1" = 100'

GEOLOGY BY: H.Huttycomb **DRAWN BY:** W.E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

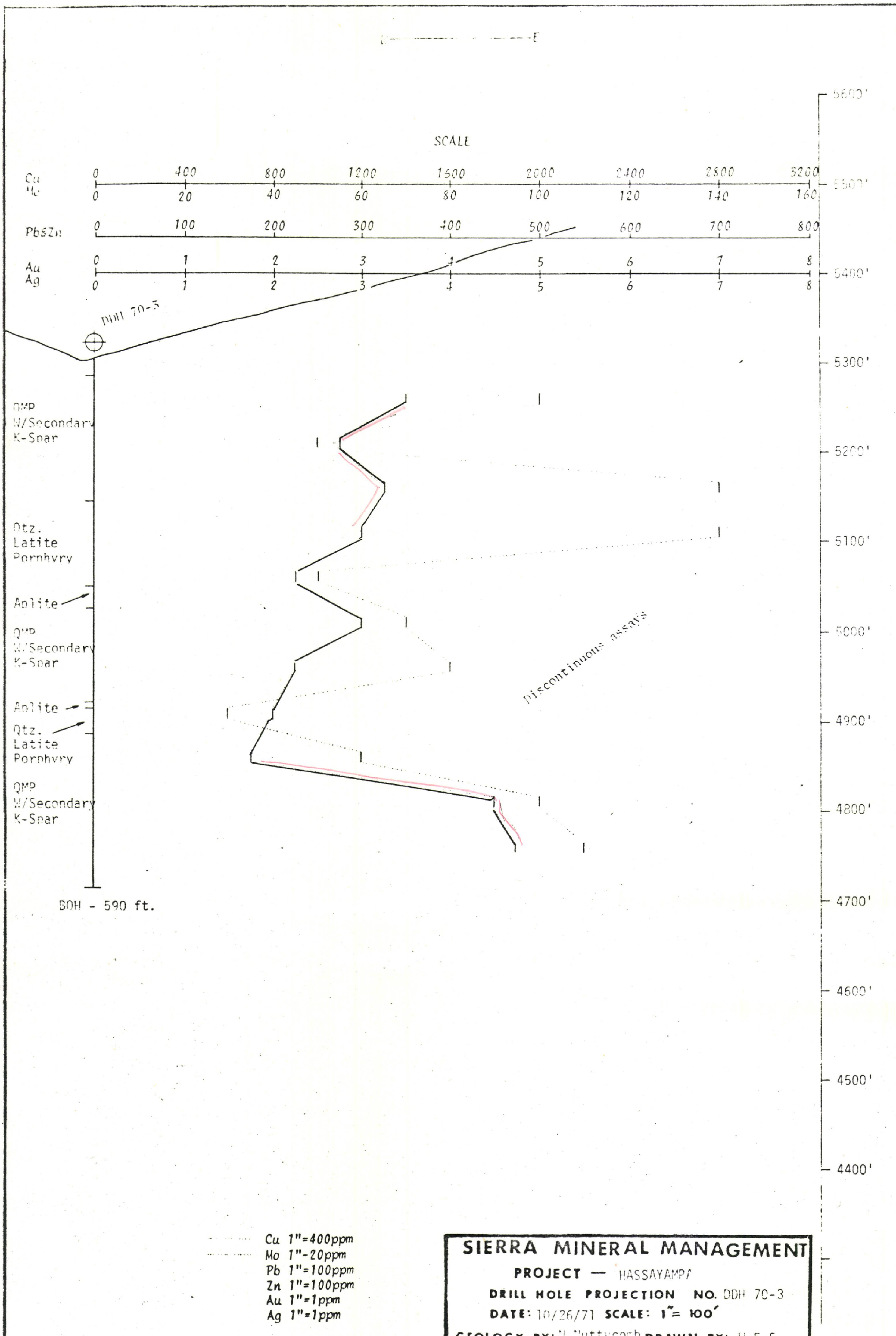
SIERRA MINERAL MANAGEMENT

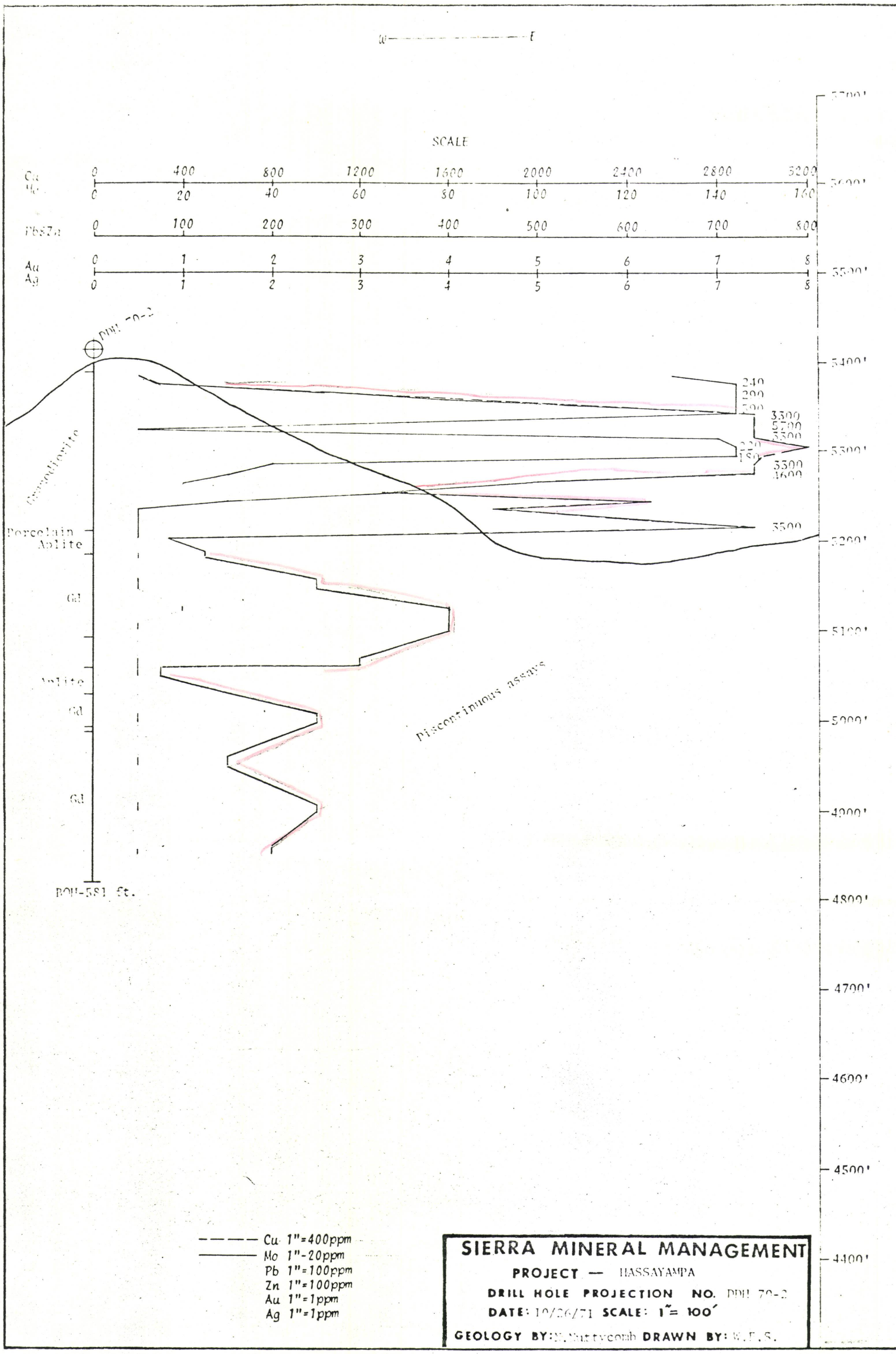
PROJECT — HASSAYAMPA

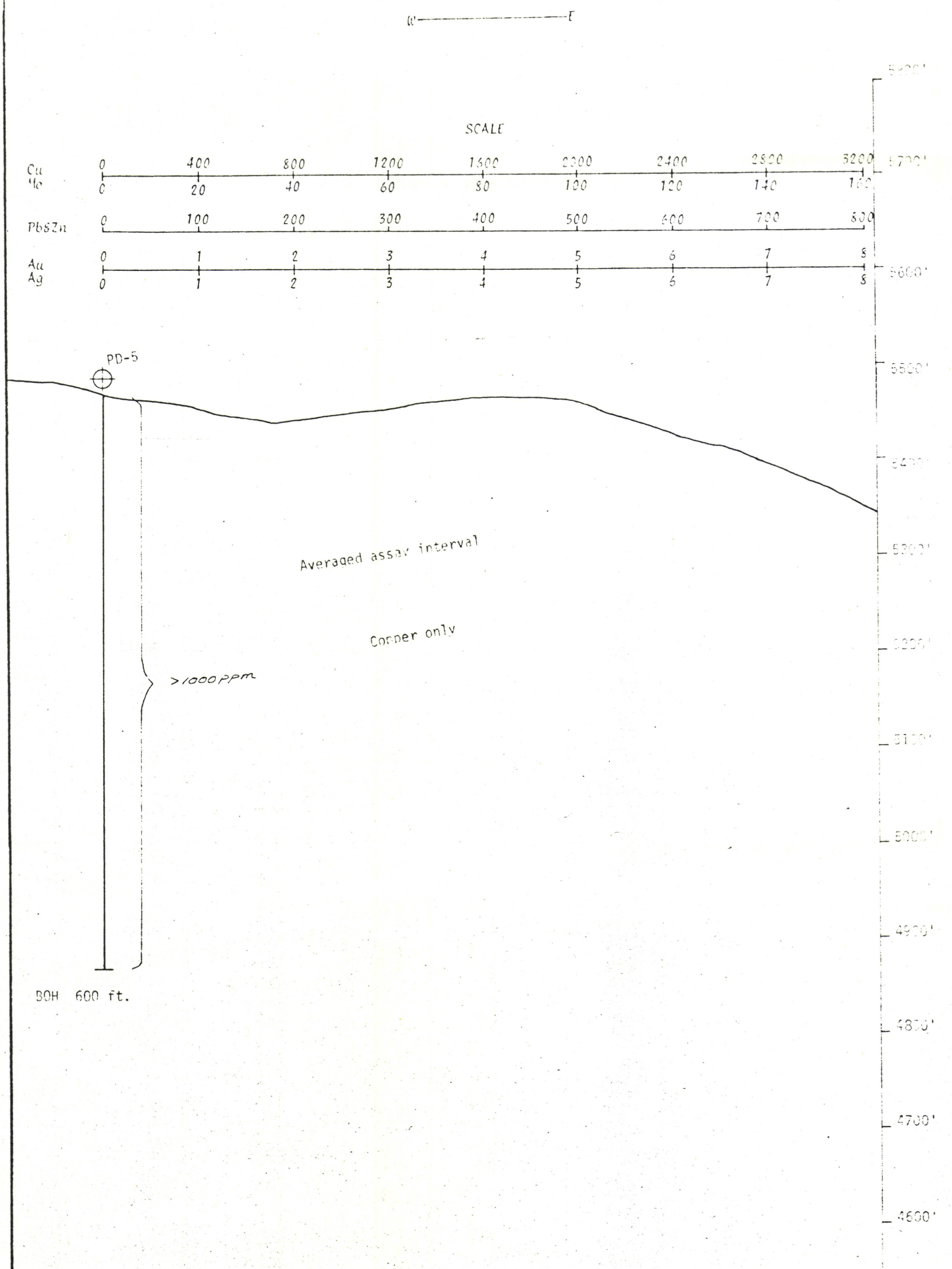
DRILL HOLE PROJECTION NO. DDH 71-1

DATE: 10/27/71 **SCALE:** 1" = 100'

GEOLOGY BY: . Nuttycomb **DRAWN BY:** .E.S.


W — E
SCALE
Cu
Mo
0 400 800 1200 1600 2000 2400 2800 3200
0 20 40 60 80 100 120 140 160
Pb&Zn
0 100 200 300 400 500 600 700 800
Au
Ag
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
DDH 70-3
5600'
5500'
5400'
5300'
5200'
5100'
5000'
4900'
4800'
4700'
4600'
4500'
4400'
QMP W/Secondary K-Spar
Qtz. Latite Porphyry
Aplite
QMP W/Secondary K-Spar
Aplite
Qtz. Latite Porphyry
QMP W/Secondary K-Spar
BOH - 590 ft.
Discontinuous assays
Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT — HASSAYAMPA
DRILL HOLE PROJECTION NO. DDH 70-3
DATE: 10/26/71 SCALE: 1"= 100'
GEOLOGY BY: N. Nuttycomb DRAWN BY: W.E.S.


W — E
SCALE
Cu
0 400 800 1200 1600 2000 2400 2800 3200
0 20 40 60 80 100 120 140 160
0 100 200 300 400 500 600 700 800
Au
Ag
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
240
3300
3500
3500
Porcelain
Aplite
Gd
Gd
Gd
Discontinuous assays
5500'
5400'
5300'
5200'
5100'
5000'
4900'
4800'
4700'
4600'
4500'
4400'
Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT — HASSAYAMPA
DRILL HOLE PROJECTION NO.
SCALE: 1"= 100'
GEOLOGY BY: DRAWN BY:



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

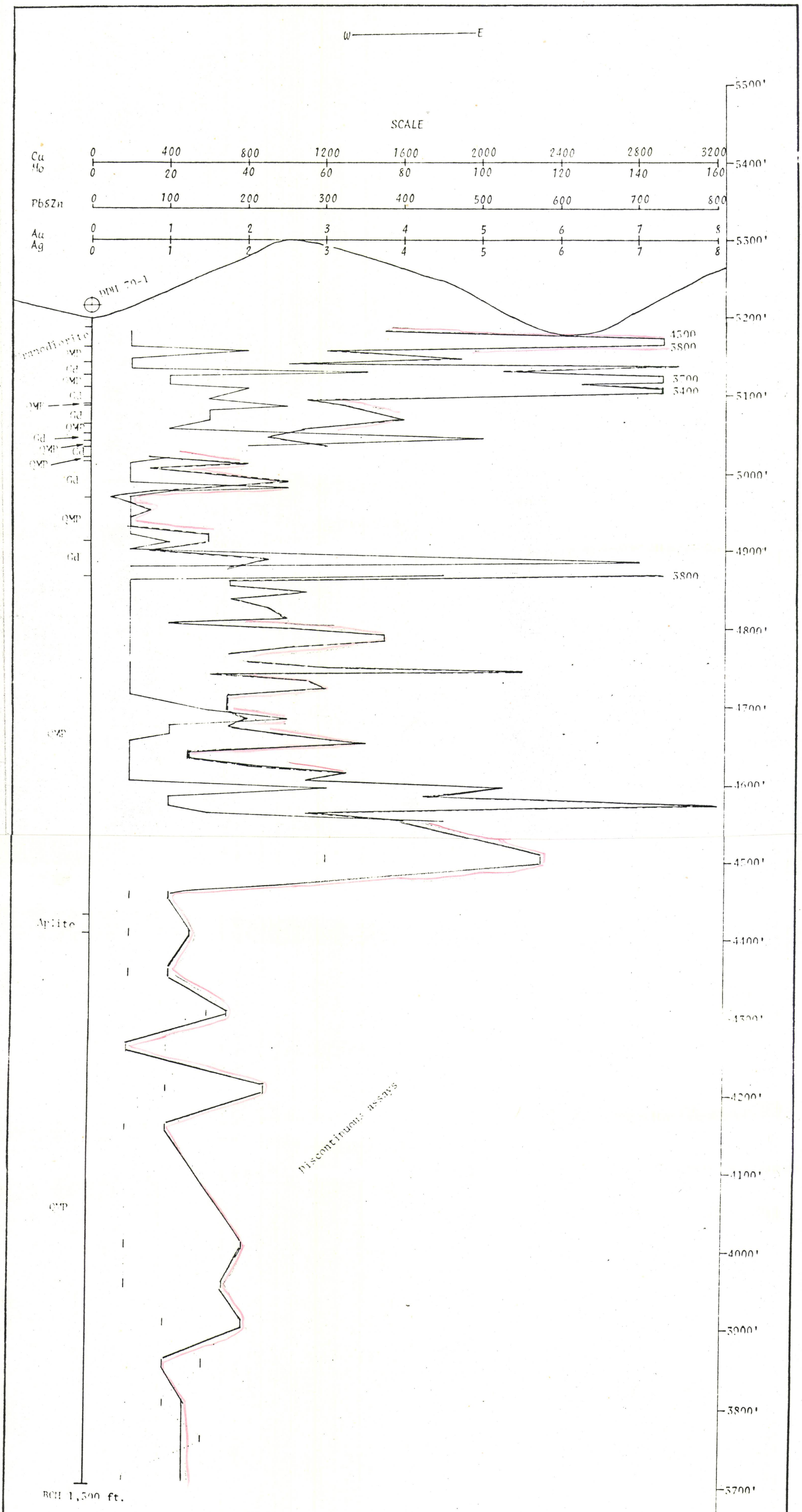
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. PD - 5

DATE: [illegible]/71 **SCALE:** 1" = 100'

GEOLOGY BY: [illegible] **DRAWN BY:** [illegible]



Cu 1"=400ppm
Mo 1"=20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

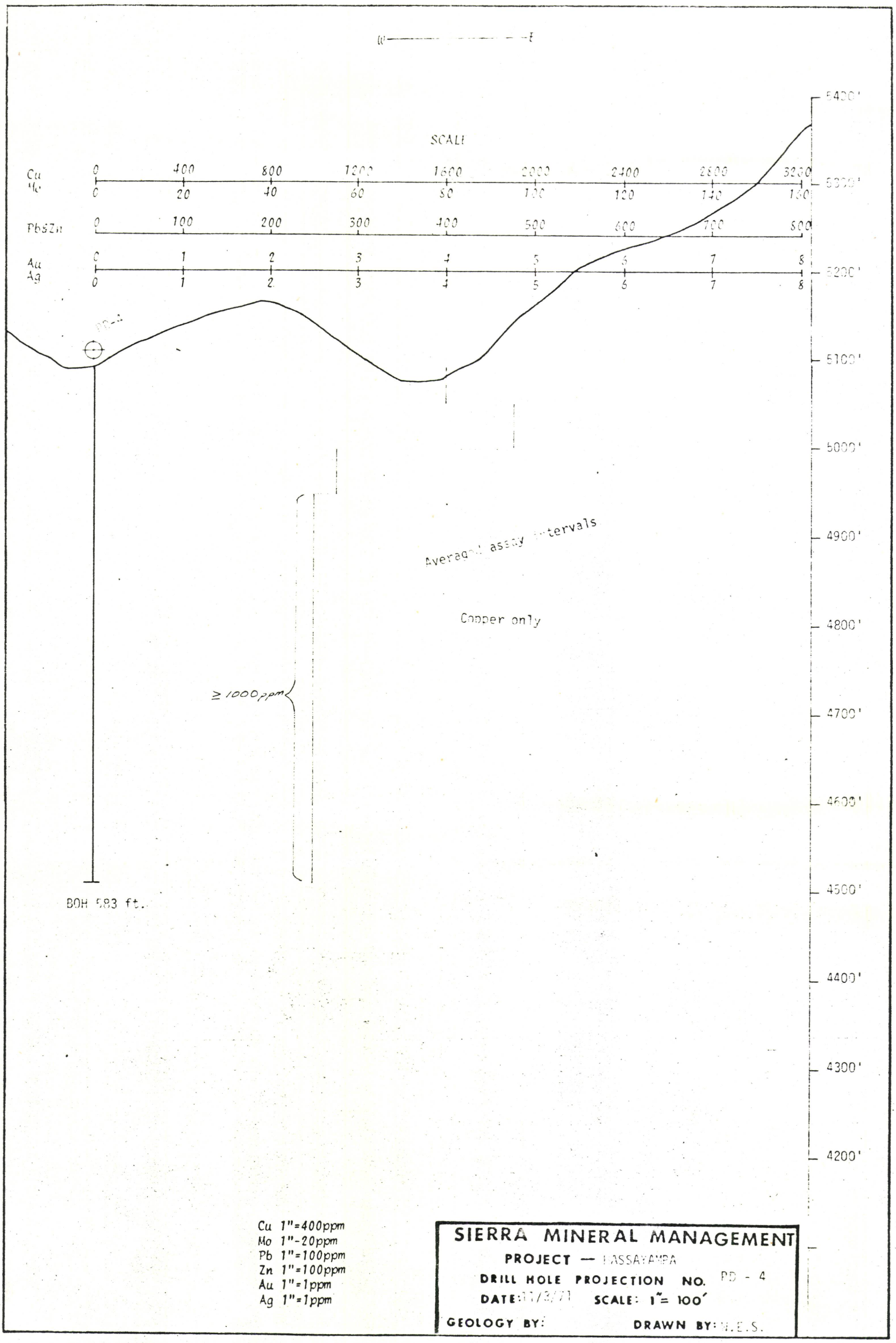
SIERRA MINERAL MANAGEMENT

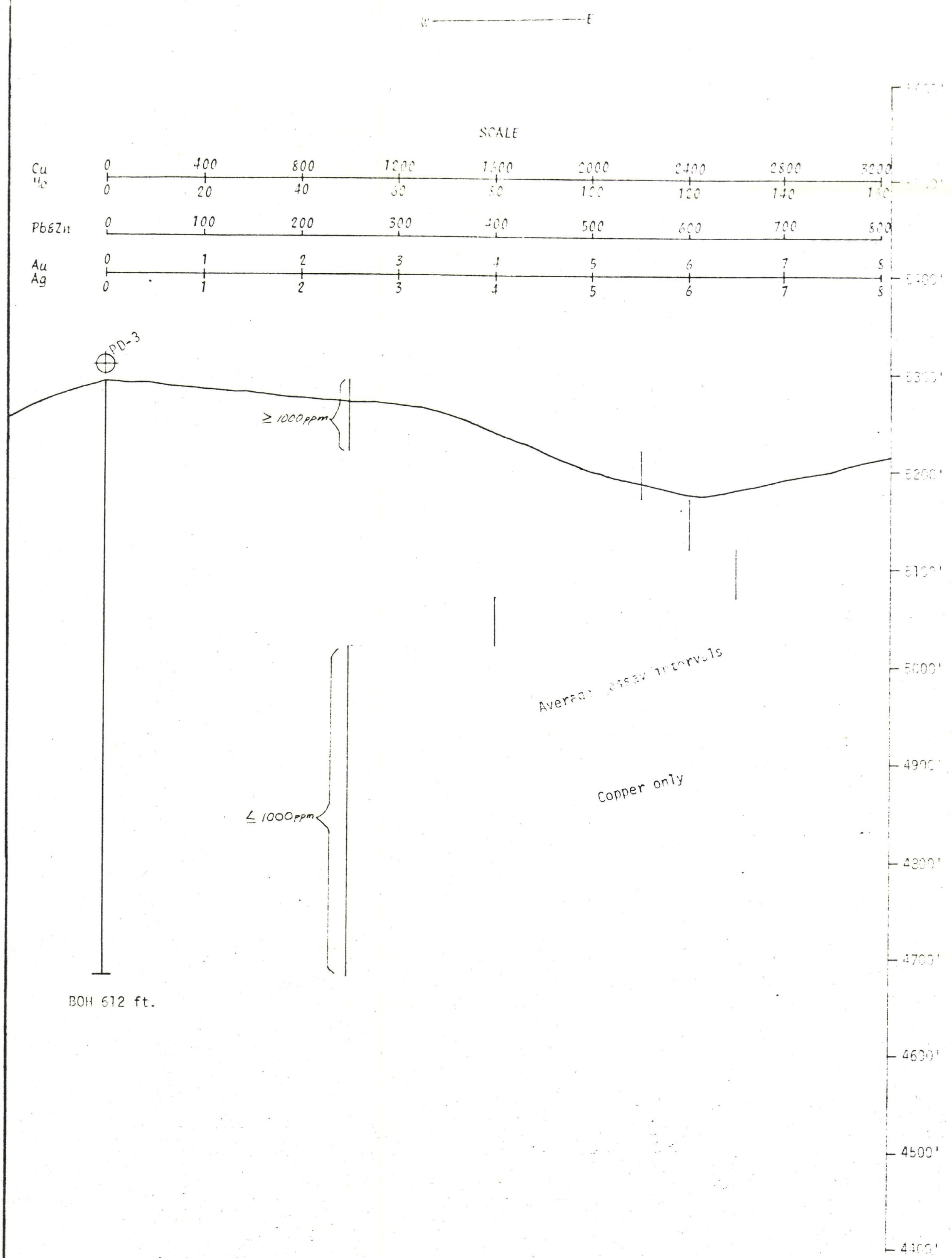
PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. DDH 70-1

DATE: 10/26/71 **SCALE: 1" = 100'**

GEOLOGY BY: N. Nuttycomb **DRAWN BY:** W.E.S.


W — E
SCALE
Cu 0 400 800 1600 2400 2800 3200
Mo 0 20 40 60 80 120 140 160
Pb&Zn 0 100 200 300 400 500 600 700 800
Au 0 1 2 3 4 5 6 7 8
Ag 0 1 2 3 4 5 6 7 8
5300'
5200'
5100'
5000'
4900'
4800'
4700'
4600'
4500'
4400'
4300'
4200'
Copper only
≥ 1000ppm
BOH 583 ft.
Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT —
DRILL HOLE PROJECTION NO.
DATE:
SCALE: 1" = 100'
GEOLOGY BY:
DRAWN BY:



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

SIERRA MINERAL MANAGEMENT

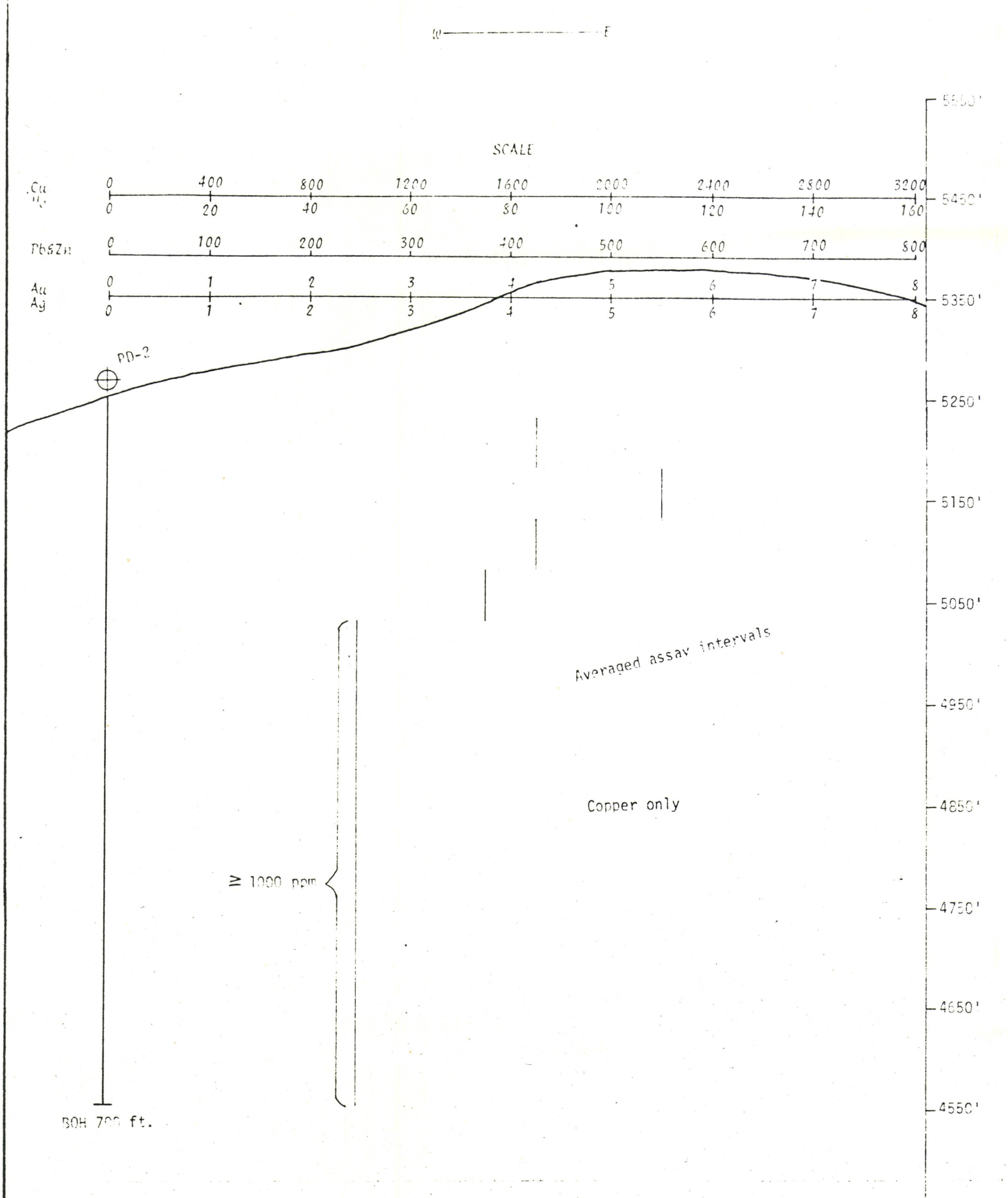
PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. PD - 3

DATE: 11/3/71 **SCALE:** 1" = 100'

GEOLOGY BY:

DRAWN BY: [illegible]



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

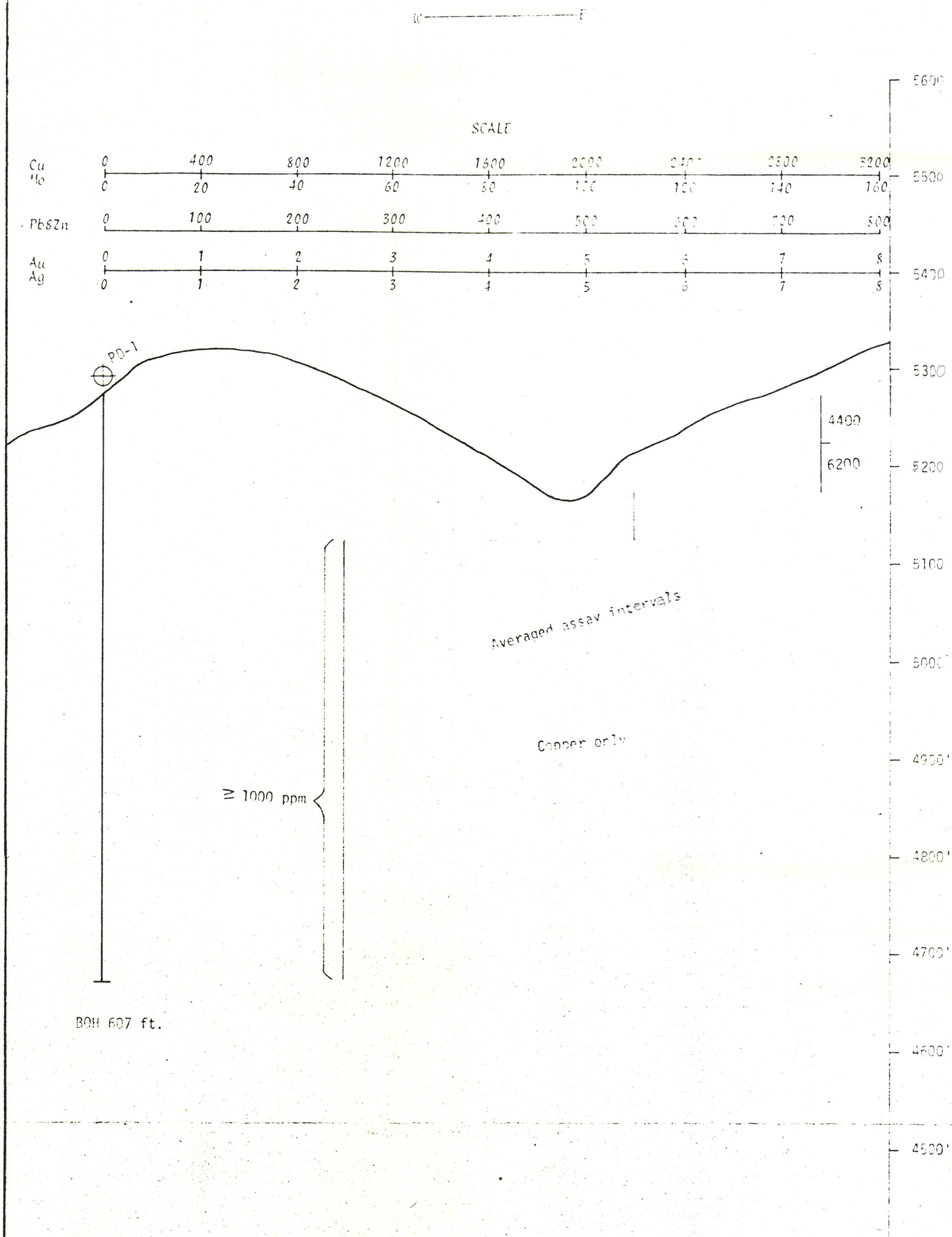
SIERRA MINERAL MANAGEMENT

PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. PD - 2

DATE: 11/3/71 **SCALE:** 1" = 100'

GEOLOGY BY: **DRAWN BY:** W.E.S.



Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm

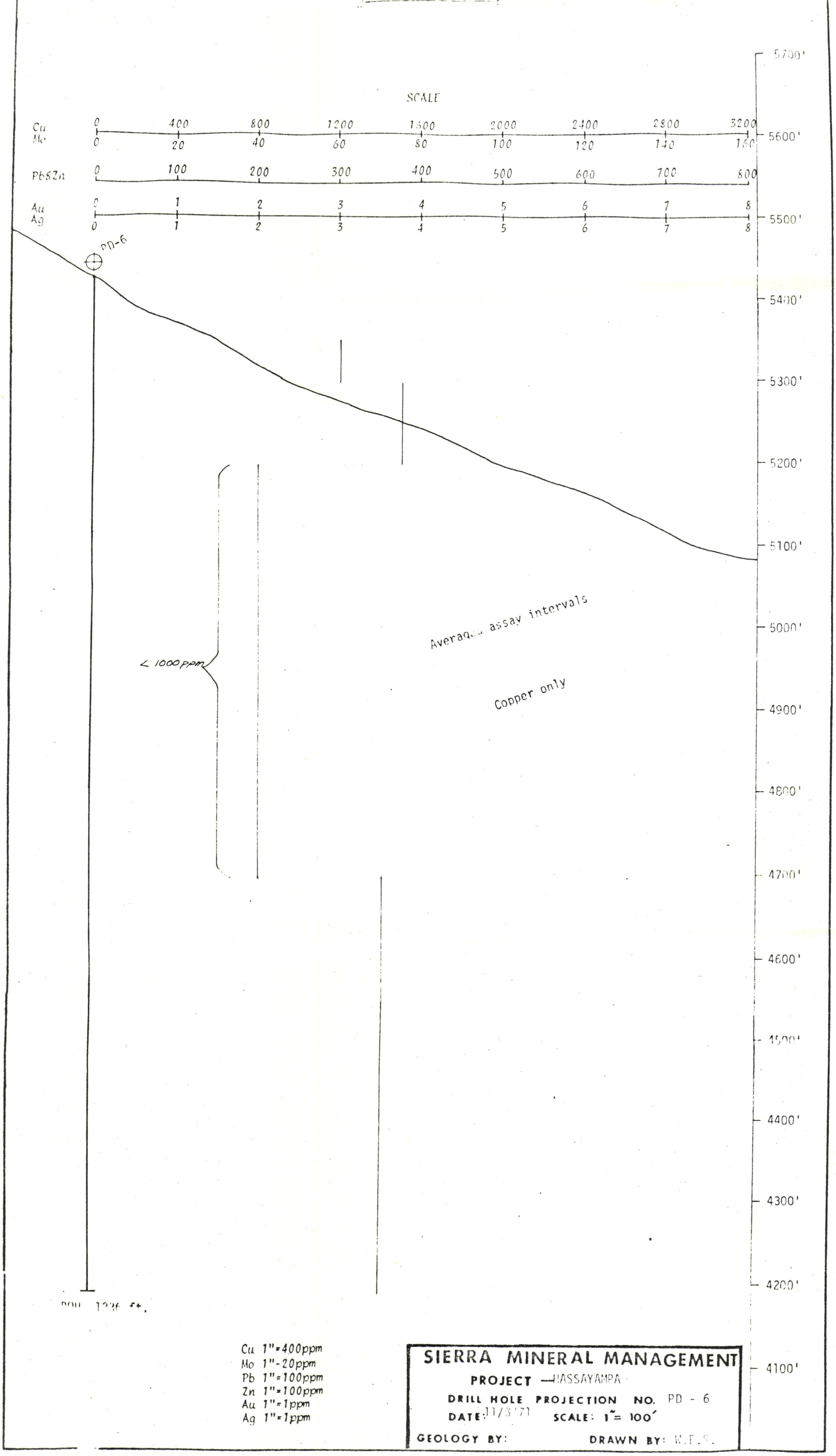
SIERRA MINERAL MANAGEMENT

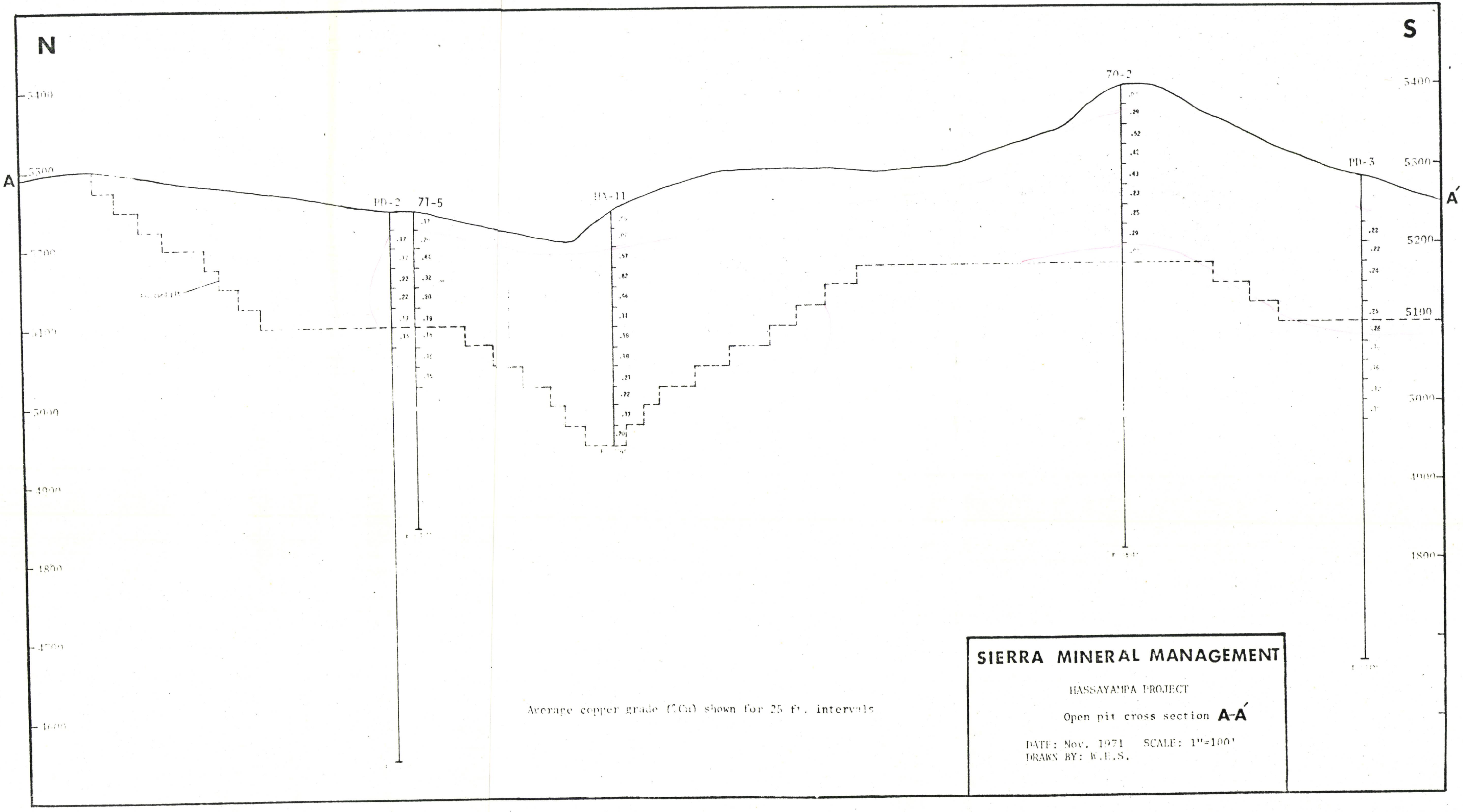
PROJECT — HASSAYAMPA

DRILL HOLE PROJECTION NO. PD - 1

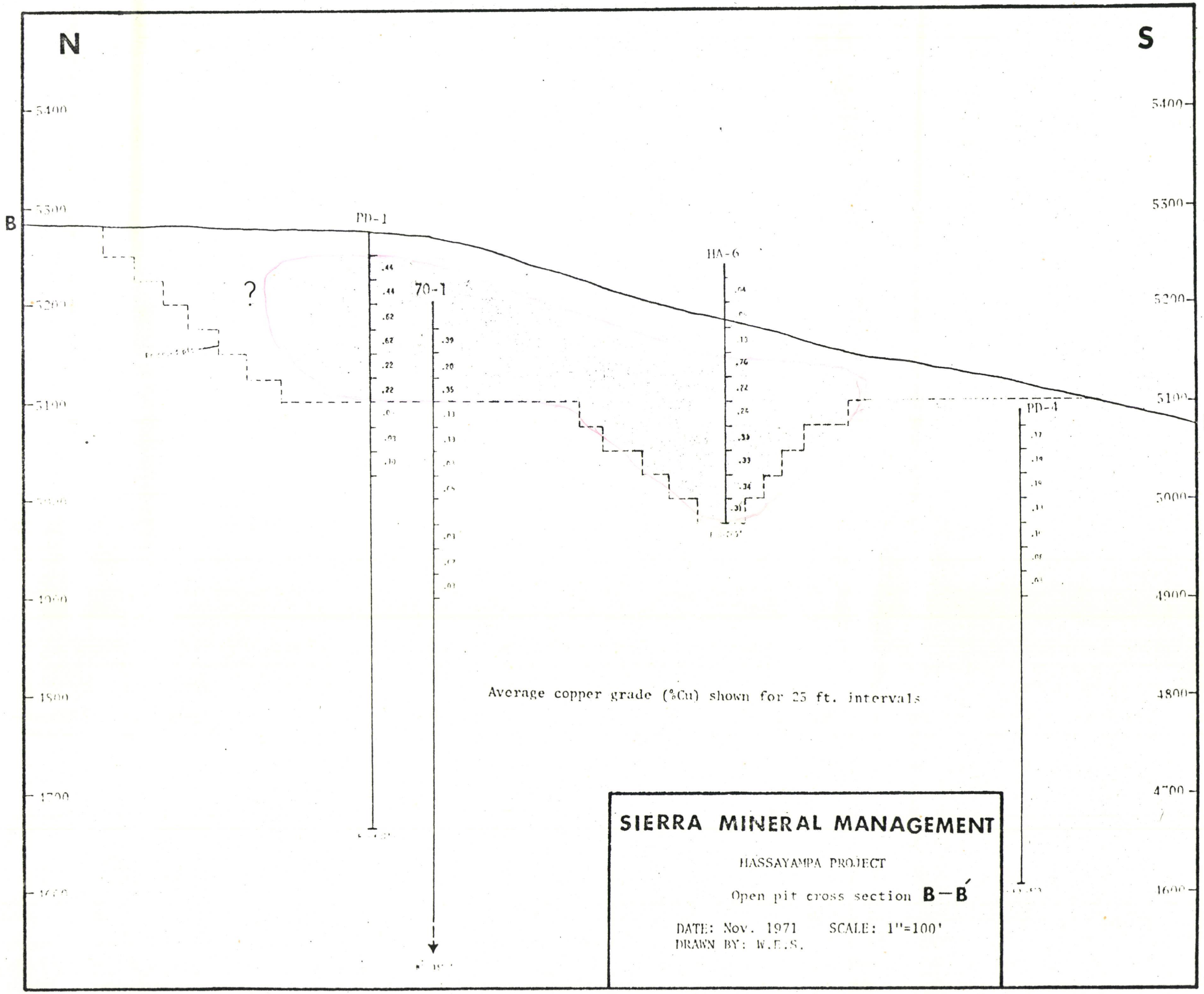
DATE: 11/3/71 **SCALE:** 1" = 100'

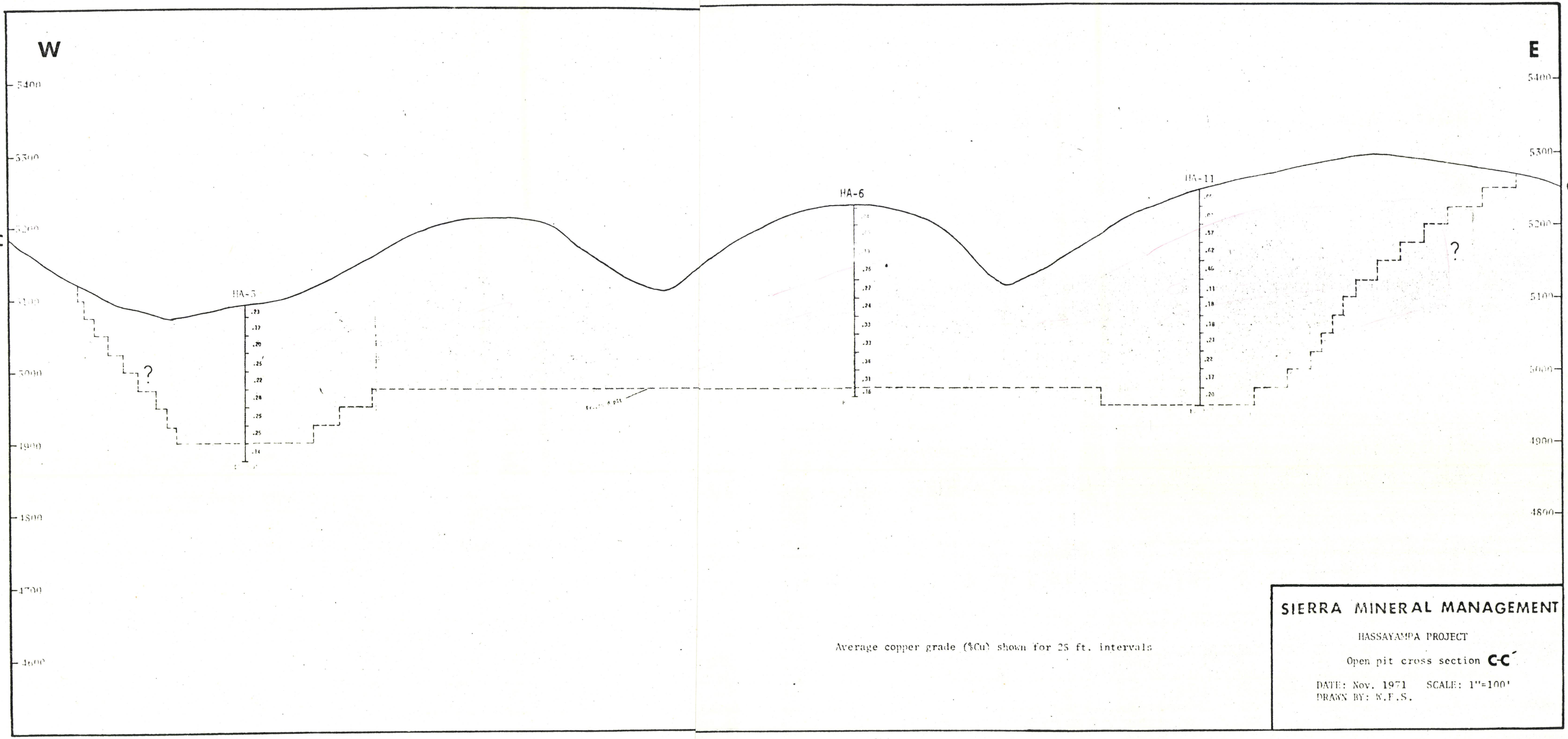
GEOLOGY BY: **DRAWN BY:** W.E.S.


SCALE
Cu
Mo
Pb&Zn
Au
Ag
0 400 800 1200 1600 2000 2400 2800 3200
0 20 40 60 80 100 120 140 160
0 100 200 300 400 500 600 700 800
0 1 2 3 4 5 6 7 8
PD-6
5700'
5600'
5500'
5400'
5300'
5200'
5100'
5000'
4900'
4800'
4700'
4600'
4500'
4400'
4300'
4200'
4100'
< 1000 ppm
Averaged assay intervals
Copper only
Cu 1"=400ppm
Mo 1"-20ppm
Pb 1"=100ppm
Zn 1"=100ppm
Au 1"=1ppm
Ag 1"=1ppm
SIERRA MINERAL MANAGEMENT
PROJECT — HASSAYAMPA
DRILL HOLE PROJECTION NO. PD - 6
DATE: 11/3/71
SCALE: 1"= 100'
GEOLOGY BY:
DRAWN BY:



N
S
A
A´
PD-2
71-5
HA-11
70-2
PD-3
5400
5300
5200
5100
5000
4900
4800
Average copper grade (%Cu) shown for 25 ft. intervals
SIERRA MINERAL MANAGEMENT
HASSAYAMPA PROJECT
Open pit cross section A-A´
DATE: Nov. 1971 SCALE: 1"=100'
DRAWN BY: W.E.S.


N
S
B
B′
PD-1
70-1
HA-6
PD-4
5400
5300
5200
5100
5000
4900
4800
4700
4600
Average copper grade (%Cu) shown for 25 ft. intervals
SIERRA MINERAL MANAGEMENT
HASSAYAMPA PROJECT
Open pit cross section B—B′
DATE: Nov. 1971 SCALE: 1"=100'
DRAWN BY: W.E.S.


W
E
C
C´
5400
5300
5200
5100
5000
4900
4800
4700
4600
HA-3
HA-6
HA-11
?
?
Average copper grade (%Cu) shown for 25 ft. intervals
SIERRA MINERAL MANAGEMENT
HASSAYAMPA PROJECT
Open pit cross section C-C´
DATE: Nov. 1971 SCALE: 1"=100'
DRAWN BY: W.F.S.