THE UNIVERSITY OF BRITISH COLUMBIA

MINERAL MATTER CONTENT AND GROSS PROPERTIES OF HAT CREEK COAL

Third Report - Quarterly
(April 1 to June 30, 1977)

Financially supported by Dolmage Campbell Associates, Vancouver, under the sponsorship of B.C. Hydro and Power Authority

DEPARTMENT OF METALLURGY

VANCOUVER, BRITISH COLUMBIA • CANADA

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INTRODUCTION

During the period April to June, 1977 efforts were mainly concentrated to determine quantitatively the mineralogical constituents of several diamond drill hole (DDH) core samples, which were obtained at different depths. These samples were supplied in four batches - February 28 (11 samples), March 24 (50 samples), May 4 (52 samples) and May 31 (74 samples). In addition, a shipment of three samples of drilling mud additives was also received on May 4 for x-ray analyses. All these samples were supplied by Dolmage Campbell Associates (1975) Limited. The supplier has assigned a list of priorities as more samples were supplied than originally anticipated. Consequently only the samples in the highest priority group were tested by x-ray analyses for their mineralogical constituents. Furthermore, the shipment No. 3 (May 4) contained 11 pulp specimens on which proximate analyses (by TGA) were carried out following the suggestion of Dr. Lisle T. Jory of Dolmage Campbell Associates. Two samples of shipment #4 were also used for specific gravity separations and then analysed the float and sink fractions by x-ray and TGA (for proximate analysis).

According to Dr. Jory, the samples supplied in all four batches should represent a total geographic sampling of the entire No. 1 coal deposit of Hat Creek.

Table I summarizes the drill hole numbers, the number of samples and the dates they were supplied, and priority assigned to them. Qualitative and quantitative determinations of inorganic minerals by x-ray were carried out on samples given the highest priority within the time available.

TABLE I

Samples for x-ray Analysis

Drill Hole No.	No. of samples	Priority	Date Supplied	Remarks
74-44	1	High	Feb. 28	Test completed
76-135	6	"	"	"
76-136	4	"	"	"
76-135	30	"	March 24	"
76-181	5	"	"	"
76-191	8	"	"	"
76-196	6	"	"	"
76-204	1	"	"	"
76-106	23	18 low	May 4	No test done
76-124	3	High	"	Test completed
76-126	9	"	"	"
76-127	4	"	"	"
76-128	1	"	"	"
76-130	2	"	"	"
76-154	2	"	"	"
76-170	1	"	"	"
76-177	1	"	"	"
76-180	4	"	"	"
76-188	2	"	"	"
74-25	15	Low	May 31	No test done
74-39	1	High	"	"
76-124	4	"	"	Test completed
76-127	1	"	"	No test done
76-135	4	"	"	Test completed
76-146	1	"	"	No test done
76-157	6	one low	"	One completed
76-163	2	High	"	Test completed
76-164	2	"	"	One completed
76-180	1	"	"	One qualitative
76-185	1	"	"	No test done
76-187	4	Two low	"	No test done
76-188	3	One low	"	"
76-190	13	Nine low	"	"
76-191	2	High	"	Test completed
76-194	2	"	"	One quantitative One qualitative
76-201	12	Eight low	"	No test done

Total samples supplied - 187, of these 54 samples are in the low priority category.

Proximate analyses by TGA were carried out on eleven drill hole samples as requested. In addition, proximate and x-ray analyses were also performed on different fractions obtained by float-sink tests from two samples identified as 76-157-15 and 76-190-30.

The drilling mud additives supplied are identified as:

Quik Gel

Polychem C.P.

High Yield Bentonite

SEM, glycolation test and x-ray analyses (on as received and after glycolation) were performed on these samples.

Experimental Procedures

The coal samples as supplied are either pulp (- 60 mesh), chip or grab. The chip and grab samples were ground to about - 100 mesh. The samples were subjected to x-ray analyses both for identification and quantitative estimation of inorganic minerals present. For identification x-ray diffractometric traces were made from 3° to ∿ 70° for all samples. Attempts were made to identify all peaks. Because of large background scattering (due to very fine particle size components), it was not always possible to distinguish very weak peaks (i.e. when minerals present are less than ∿ 5%). To identify these minerals scanning electron microscopy with x-ray analyser (elemental analysis) was used for all specimens. Once the minerals present in a sample were identified, the minerals present in concentration more than 3% were estimated quantitatively. The method used for quantitative analysis is the same as reported previously. This essentially involves (i) measurement of the integrated peak area (average of 3 measurements) of a particular diffraction peak of a mineral, (ii) normalize this

area with an internal standard (MgO in this investigation) and (iii) compare this area with a calibration curve of peak area versus mineral content.

Please note: The estimation of minerals by this method is considered to be accurate to within ± 3% for well crystallized minerals having particle size > 1 μm. In the case of Goyazite ($2SrO \cdot 3Al_2O_3 \cdot 2P_2O_5 \cdot 7H_2O$) accurate quantitative estimation of this mineral has not been possible because of unavailability of a pure sample which could be used for preparing a calibration curve.

Table II shows a list of commonly occurring minerals that are checked in the Hat Creek samples.

RESULTS

In terms of tests performed so far, the quantitative estimation of minerals has been completed on 105 samples and identification of minerals has been completed on 2 more samples. In addition, proximate analysis by TGA has been carried out on 11 samples, and fractionation by float-sink method on 2 samples yielded 9 more x-ray and 20 TGA specimens. Identification and estimation of minerals of these size fractions have been completed. Size analysis by standard sieves has also been performed on one of these 2 samples. Identification of minerals present in three drilling mud additives has also been completed.

A. Inorganic Mineral Content

The results of the quantitative estimation of minerals are presented in a series of tables (Table III 1-27). Each table contains one drill hole, identified at the top of the table by the drill hole number (DDH ...). All tables contain footage, sample number, stratigraphic position, rock type and minerals identified and quantitatively estimated. There is also a column for

remarks, where comments are included to explain anomalies and approximately estimated goyazite present, which could not be accurately determined. These tables are arranged in the same sequence as the drill hole numbers tabulated in Table I.

Observations

It is apparent from these tables that there is a preponderance of bentonite in the upper segments of the Hat Creek coal deposit. Similarly, as the concentration of bentonite decreases with depth, the kaolinite content increases. This is particularly evident in the drill hole number 76-135, from which the maximum number of samples have been evaluated so far. The distribution of siderite is more random and no trend can be observed. In general, felspar appears to be more concentrated in the upper layers, its concentration slightly decreases with increasing depth. However, exceptions to the above trends can be noted in the drill hole number DDH 76-124, where variations of kaolin, bentonite and felspar with depth are not significant. This should not be taken as conclusive as only three samples of the latter drill hole (76-124) were tested.

Regarding other minerals such as pyrite, epidote, calcite, ankerite and goyazite, when present in a sample (i.e. at a certain depth of a drill hole) are usually in a large concentration and localized. For example, goyazite (a strontium-phosphorus compound) when present in a sample, is in most cases present in concentration above 20%. Ankerite was encountered in only one drill hole (76-135) in any significant quantity and only in three samples (i.e. at 3 depths). Calcite was detected only in two drill holes (76-196 (one sample) and 76-154 (one sample). Please note that only a few samples (2 to 3) were tested from these drill holes so far.

The variations of the major mineral constituents as a function of depth are shown graphically in Figures 1 and 2. In Figure 1 the gradual increase of kaolinite concentration and decrease of bentonite concentration with increasing depth are shown as a histogram, whereas in Figure 2, the concentration of four major mineral constituents as a function of depth are shown for DDH 76-135. Figure 3 represents a similar plot for the drill hole number DDH 76-126.

It must be emphasized here that these plots (Figs. 1-3) can be very misleading as the total inorganic mineral content of coal at different depths are not known. For example, from Figure 1 it can be easily construed that 'D' zone contains more kaolinite than the Hang-wall or A zone, but this is not true. These figures only represent the percentage of kaolinite and bentonite that are present in the total inorganic mineral content at a certain depth which is not known but can be calculated if the ash content of the samples are determined.

B. Proximate Analysis by TGA

Proximate analyses of eleven (11) samples was carried out by thermogravimetric analysis. This involves continuous recording of weight loss at a constant heating rate under two different gaseous environments N_2 and O_2 (or air). The details of the technique and calculations involved in determining moisture content, volatile matter and dehydration of clay, fixed carbon and ash content are given in the second report (dated March 1977 - B.C. Hydro report from the Department of Metallurgy, U.B.C.).

The results of the proximate analyses are shown in Table IV, in which the drill hole number, footage, sample number, stratigraphic position (rock type), moisture, volatile (+ dehydration), fixed carbon and ash (both as is and on dry basis) are included.

C. Float-Sink Tests and Proximate Analysis

Float and sink tests are performed as requested to primarily investigate the extent of distribution of inherent ash in the coal. Two samples, 76-157-15 and 76-190-30 each containing 16% and 20% ash respectively, are used for these tests. A sieve analysis of 76-157-15 is also carried out. The results of the particle size distribution are shown in Figure 4 (as a histogram), and Figure 5 (as a cumulative percentage). The actual values are tabulated in Table V.

The range of specific gravities used for float-sink tests is 1.3 to $\sim$ 1.6. Carbon tetrachloride (CCl_4) and ethanol, having specific gravities 1.595 and 0.7 respectively (at room temperature), are mixed in various proportions to get the desired specific gravity fluids for the float and sink tests.

Five grams of sample is mixed thoroughly with 200 ml of S.G. fluid and allowed to sit. The length of time for settling depends on the amount of near-gravity materials in the sample. When the float and sink fractions are separated, they are dried and analysed. TGA is used for proximate analysis (moisture, volatile and dehydration of clay, carbon and ash) and x-ray identification of minerals are done on these two fractions. The above procedure is repeated with other specific gravity solutions. The separated fractions are again dried and analysed. Altogether five specific gravity fluids are used: 1.3, 1.4, 1.45, 1.5 and 1.595.

Note that these float and sink tests are <u>not</u> done in any sequential order i.e. the sample is first placed into a liquid having the lowest specific gravity and the fraction that sinks is placed into the liquid having the next higher gravity. Even though the procedure at which the tests were carried out is slightly different, the results shown in Table VI are actually the same accumulative weights of float fractions. For example, the materials that float in the S.G. 1.3 solution will also float in the S.G. 1.4 solution in addition.

From Table VI and the washability curve (Fig. 6), it seems that sample washed in 1.45 S.G. fluid produces the best result as far as the weight percent and ash reduction of the float fraction are concerned. The sample is separated into the float fraction having 89% by weight and the sink fraction having 11 weight % of the original sample. The original ash content of 15% is reduced to only 10.6% in the float fraction while the ash content is increased to 40.5% in the sink fraction. The near gravity material* is high though for the S.G. 1.45 tests which may make the actual cleaning a bit difficult. The near gravity materials of the float fraction at S.G. 1.45 are (96** - 89) 7% and (89 - 35) 54%. One reference*** on the degree of difficulty in cleaning is shown below.

TABLE VII

Significance of Amount of Near-Gravity Material

Amount of Near-Gravity Material		Estimate of Coal-Preparation Plant Cleaning Problem
Greater than	Less than	
0%	7%	Simple
7%	10%	Moderately difficult
10%	15%	Difficult
15%	20%	Very difficult
20%	25%	Exceedingly difficult
25%		Formidable

In order to reduce the near-gravity material, a higher specific gravity, maybe 1.5, will probably be better.

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* the near gravity material is defined as the percentage of the coal sample that will float in a range within plus and minus 0.10 specific gravity of the cleaning value

** this 96 wt.% of the float fraction is actually obtained from interpolation of wt.% at S.G. of 1.5 and 1.6. This is an approximation only. 89 wt.% is the wt.% of the float fraction at S.G. of 1.45.

*** Reference #2.

The float and sink tests do indicate the extent of inherent ash in the samples tested but they do not indicate the washability of a coal. In this investigation, the largest particle size material is quite fine. For this reason, no adequate study can be done on these specimens. Furthermore, samples tested may not be representative of the coal deposit.

Because of the small top size of sample 76-157-15, there are phenomena existing that have to be considered. For example, colloidal suspension and wettability of the individual particles in a sample may significantly affect the float-sink property.

The concentration of inorganic minerals present in these two samples is determined by x-ray. However, only identification of minerals on float-sink size fractions has been possible due to lack of time. The results are summarized in Table VIII. It is noted however, that in the float-sink size fractions the relative proportion of kaolinite and quartz is changed.

D. Drilling Mud Additives

Three drilling mud additives - Quik Gel, Polychem C.P. and High-yield Bentonite are examined. The analyses done on these samples are scanning electron microscopy (SEM) and x-ray diffraction on as received and glycolated materials.

SEM** results:

1. Quik Gel Si, Al, Fe, Ca, Mg, k, Na and S*
2. Polychem C.P. Si, Al, Fe, Ca, Na, k and Mg
3. High-yield bentonite Si, Al, Fe, Ca, S, k, Na and Mg

When the drilling mud additives are treated with ethylene glycol overnight, the d spacings of H.Y. bentonite and Quik Gel shift from 12.5 A° to 17.7 A°,

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* trace only

** elements listed in decreasing quantities

while that of Polychem C.P. shifts from 12.5 A° to 15 A°. These shifts in d spacing are indicative of presence of montmorillonite (bentonite). From the nature of 12.5 A° peak (i.e. height and width), it is inferred that Quik Gel contains the maximum amount of bentonitic clay. Both H.Y. Bentonite and Polychem have similar concentration of bentonitic clay. High-yield Bentonite has larger particle size and well crystallized than that in Polychem C.P. Quik Gel is intermediate in this respect.

High-yield bentonite and Quik Gel swell in water in a manner similar to that observed with the bentonite standard supplied by Ward's Natural Museum, but Polychem C.P. swells considerably more than H.Y. Bentonite and Quik Gel indicating that it has higher Na^+ concentration in the system. Polychem C.P. also becomes sticky and slippery when mixed with water.

X-ray diffraction results

Phases identified

Quik Gel - Bentonite and Quartz (small amount)

High-Yield Bentonite - Bentonite and Quartz (small amount)

Polychem C.P. - Bentonite, Quartz and a mixed layered mineral

CONCLUSION: The x-ray studies of inorganic minerals are not complete. However, the trend is that with increasing depth for a drill hole, the concentration of kaolinite increases and concentration of bentonite decreases. There is also a tendency for an increase in the concentration of quartz and decrease in the concentration of felspar with depth.

References

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Table II

List of commonly occurring minerals* that are checked in the Hat Creek samples:

Mineral	Approximate formula	Mode of occurrence
Kaolin	$Al_2O_3 \cdot 2SiO_2 \cdot xH_2O$	In clay or shale
Muscovite	$K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$	
Biotite	$K_2O \cdot MgO \cdot Al_2O_3 \cdot 3SiO_2 \cdot H_2O$	
Epidote	$4CaO \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot H_2O$	
Quartz	SiO_2	
Penninite	$5MgO \cdot Al_2O_3 \cdot 3SiO_2 \cdot 2H_2O$	
Albite	$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$	
Orthoclase	$K_2O \cdot Al_2O_3 \cdot 6SiO_2$	
Hornblende	$CaO \cdot 3FeO_2 \cdot 4SiO_2$	
Augite	$CaO \cdot MgO \cdot 2SiO_2$	
Cyanite	$Al_2O_3 \cdot SiO_2$	
Staurolite	$2FeO \cdot 5Al_2O_3 \cdot 4SiO_2 \cdot H_2O$	
Pyrites Marcasite	FeS_2	
Calcite	$CaCO_3$	
Ankerite Brass-stone	$2CaCO_3 \cdot MgCO_3 \cdot FeCO_3$	
Siderite	$FeCO_3$	As inclusions, impregnations, partings, nodules, or concretions
Gypsum	$CaSO_4 \cdot 2H_2O$	
Salt	NaCl	
Apatite	$3Ca_3P_2O_8 \cdot CaF_2$	
Mispickel	$FeS_2 \cdot FeAs_2$	
Dolomite	$CaCO_3 \cdot MgCO_3$	
Haematite	Fe_2O_3	

In addition, bassanite $2CaO \cdot 2SO_3 \cdot H_2O$, and zeolite (4) are also checked as requested.

* Coal, Wilfred Francis, Arnold Publishing Co., 1961, p. 651.

Key

Qtz -	quartz	SiO_2
Kaol -	kaolinite	$Al_2Si_2O_5(OH)_4$
Bent -	bentonite	*
Sid -	siderite	$FeCO_3$
Feld -	felspar	**
Pyr -	pyrite	FeS_2
Epid -	epidote	$Ca_2(Al,Fe)_3Si_3O_{12}(OH)$
Cal -	calcite	$CaCO_3$
Ank -	ankerite	$Ca(Mg_{0.67}Fe_{0.33})(CO_3)_2$
Goy -	goyazite	$2SrO \cdot 3Al_2O_3 \cdot 2P_2O_5 \cdot 7H_2O$

* bentonite is the name given to clay containing montmorillonite type minerals. These montmorillonite type minerals include montmorillonite, beidellite, nontronite, hectorite, saponite.

** felspar includes minerals such as orthoclase, Fe-rich orthoclase, albite.

Table III - 1

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 74-44
(Shipment # 1)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
-	1600	T 1123	C zone - bentonitic sandstone	20	4	43	-	33	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 2

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-135

(Shipment # 1)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
-	304	T 1074	H.W. - cream ash	22	t	20	39	19	-	-	-	-	√	goyazite present: ≈ 25 → 35% of total inorganics present
-	358	T 1075	H.W. - grey ash	3	t	45	52	t	-	-	-	-	-	
-	441	T 1076	H.W. - dark grey shale	23	22	55	-	-	-	-	-	-	√	goyazite present: ≈ 30 → 40% of total inorganics present
-	463	T 1077	H.W. - dark grey shale	19	t	58	16	7	-	-	-	-		
-	1944	T 1078	F.W. - carb. shale	70	30	-	-	-	-	-	-	-		
-	1994	T 1080	F.W. - tuffaceous shale	80	12	2	-	6	-	-	-	-		

* P - Proximate Sample No.; T - Thin Section No.

Table III - 3

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-136

(Shipment # 1)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
-	195	T 1081	H.W. - white ash	t	2	98	-	-	-	-	-	-	✓	goyazite present ≃ 10 → 20% of total inorganics present
-	219	T 1082	H.W. - grey ash	13	9	61	14	3	-	-	-	-	-	
-	308.5	T 1083	H.W. - grey, carb. shale	14	8	76	-	2	-	-	-	-	-	
-	1639	T 1084	F.W. - carb. shale	39	37	t	24	t	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 4

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-135

(Shipment # 2)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
150	166	-	H.W. - shale and carb. shale	9	20	61	5	5	-	-	-	-	-	
213	222	-	H.W. - shale, some carb. material	19	4	63	-	14	-	-	-	-	-	
280	288	-	H.W. - shale	11	12	71	2	4	-	-	-	-	-	
329	331	-	H.W. - shale	8	26	33	33	t	-	-	-	-	-	
594	595	-	A zone - coaly shale	25	47	24	-	4	-	-	-	-	-	
-	598	-	A zone - slightly carb. fine grained sandstone	50	21	5	t	24	-	-	-	-	-	
722	726	-	A zone - slightly carb. shale	7	70	-	23	-	-	-	-	-	-	
742	744	-	A zone - carb. shale	32	62	t	t	6	-	-	-	-	-	
-	751	-	A zone - shaly siltstone, slightly carb.	33	32	22	-	10	-	-	2	1	-	
786	790	-	A zone - moderately carb. shale	32	38	22	t	8	-	-	-	-	-	
867	871	-	A zone - carbonaceous to coaly shale	44	19	31	6	t	-	-	-	-	-	
-	938	-	A zone - siltstone, moderately indurated	14	32	-	12	5	-	-	t	37	-	
-	970	-	A zone - highly carb. shale	41	50	-	4	5	-	-	-	-	-	
1016	1035	-	A zone - shale, some carb. shale	25	29	16	21	9	-	-	-	-	-	
1035	1055	-	A zone - shale and carb. shale	40	51	-	4	5	-	t	-	-	-	
1055	1082	-	A zone - shale and carb. shale	25	38	30	t	7	-	-	-	-	-	

* P - Approximate Sample No.; T - Thin Section No.

Table III - 5

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-135 (Cont'd)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
1090	1095	-	A zone - carb. shale	45	49	-	2	4	-	-	-	-	-	
1115	1116	-	B zone - carb. to coaly shale	38	55	-	7	-	-	-	-	-	-	
-	1145.5	-	B zone - ash, tan, minor dark white mottling	t	24	t	2	-	t	t	t	74	✓	goyazite present: ≈ 20 → 30% of total inorganics present
-	1184.5	-	B zone - shale, carb. to coaly	28	47	-	25	-	-	-	-	-	-	
1208	1214	-	B zone - shale carb. to coaly	44	56	t	-	t	-	-	-	-	-	
-	1240.5	-	B zone - shale, coaly to carb.	23	33	-	44	-	-	-	-	-	-	
1246	1253	-	B zone - shale, coaly to carb.	54	44	2	-	t	-	-	-	-	-	
1271	1275	-	B zone - carb. shale	33	64	2	1	t	-	-	-	-	-	
1390	1397	-	C zone - tuff-aceous siltstone to sandstone	64	28	2	2	4	-	-	-	-	-	
1420	1451	-	C zone - tuff-aceous siltstone to fine sandstone	51	42	-	2	5	-	t	t	t	-	
1451	1472	-	C zone - shale, carb. to coaly shale	58	33	-	5	4	-	-	-	-	-	
1490	1514	-	C zone - carbon-aceous shale	46	51	-	1	2	-	-	-	-	-	
1749	1750	-	D zone - shaly coal	20	80	t	t	t	-	-	-	-	-	
-	1751	-	D zone - buff ash (2 thin beds)	23	46	-	t	-	-	-	-	31	✓	goyazite present: ≈ 25 → 35% of total inorganics present

* P - Proximate Sample No.; T - Thin Section No.

Table III - 6

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-181

(Shipment # 2)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
-	254	-	C zone - coaly shale	25	75	-	-	-	-	-	-	-	-	
295	297	-	C zone - carb. shale	17	71	-	12	-	-	-	-	-	-	
-	492	-	D zone - tuffaceous, siltstone, slightly carb.	16	83	t	1	-	-	-	-	-	-	
716	717	-	D zone - carb. shale	27	71	2	t	-	-	-	t	-	-	
786	791	-	F.W. - shale and carb. shale	65	35	t	-	-	t	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 7

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-191

(Shipment # 2)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
226	232	-	A zone - shale to carb. shale	12	52	15	21	t	-	-	-	-	-	
262	263	-	A zone - shale, very slightly carb.	32	37	25	-	6	-	-	-	-	-	
297	299	-	A zone - shale, carb. shale	19	53	21	-	7	-	-	-	-	-	
347	348	-	A zone - carb. shale	22	47	15	2	14	-	-	t	-	-	
367	370	-	A zone - carb. to coaly shale	18	43	34	t	5	-	-	-	-	-	
434	435	-	A zone - coaly to carb. shale	23	60	17	t	t	-	-	-	-	-	
1072	1073	-	D zone - coaly to carb. shale	32	68	-	t	-	-	-	-	-	-	
1134	1135	-	D zone - coaly shale and shaly coal	16	84	t	t	t	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 8

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-196

(Shipment # 2)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
-	300	-	B zone - buff ash	11	89	-	t	t	-	-	-	-	✓	goyazite present: ≈ 55 → 65% of total inorganics present
300	301	-	B zone - carb. shale	16	66	15	-	3	-	-	t	-	-	
-	368	-	B zone - tuff-aceous siltstone (ash?)	t	69	3	9	-	-	-	19	-	-	
-	522	-	C zone - carb. shale	21	79	t	t	t	-	-	-	-	-	
883	887	-	D zone - carb. shale and shale	53	47	-	t	-	-	-	-	-	-	
-	771	-	D zone - slightly carb. shale	22	76	t	2	-	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 9

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-204

(Shipment # 2)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
491	495	-	D zone - slightly carb. shale	31	40	21	-	8	t	-	t	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 10

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-124

(Shipment # 3)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
190	200	-	C zone - silt-stone	17	5	48	t	30	-	-	-	-	-	
352	368	-	C zone - silt-stone	23	17	25	t	35	-	-	-	-	-	
906	917	-	IFWD - basal siltstone	t	12	67	-	21	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 11

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-126

(Shipment # 3)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
200	210	-	H.W. - siltstone	-	-	98	-	-	-	-	-	-	-	2% of other minerals**
-	486	-	H.W. - pale tan ash	-	-	28	72	-	-	-	-	-	-	
500	510	-	H.W. - siltstone	14	1	58	25	2	-	-	-	-	-	
677	679	-	H.W. - pale tan to grey ash	-	-	36	64	-	-	-	-	-	-	
-	754	-	H.W. - pale tan to grey ash	-	-	54	38	8	-	-	-	-	-	
790	800	-	H.W. - siltstone	54	9	5	-	32	-	-	-	-	-	
853	869.5	P 4	A zone - coal, shaly coal	25	64	-	5	t	6	-	-	-	-	
-	921	-	A zone - pale tan ash	9	53	-	38	-	t	-	-	-	✓	goyazite present: ≈ 30 → 40% of total inorganics present
993	1013	P 13	A zone - coal	41	52	7	-	t	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

** because of the small quantities of these minerals present, the peaks are small ∴ not identifiable

Table III - 12

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-127

(Shipment # 3)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
250	270	-	C zone - mixed detritals	-	-	78	3	19	-	-	-	-		
309	311.5	-	C zone - shale, siltsone; some shaly coal	-	t	78	6	16	-	-	-	-		
369	387	P 4	D zone - coal	13	71	28	-	t	-	-	-	-		
502	511	-	IFWD - shale and silty shale	-	13	31	56	-	-	-	-	-		

* P - Proximate Sample No.; T - Thin Section No.

Table III - 13

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-128

(Shipment # 3)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
-	386	-	C zone - sheared carb. shale	9	77	14	-	t	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 14

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-130

(Shipment # 3)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
-	1621.3	T 1130	H.W. - shale	-	-	88	11	-	1	-	-	-	-	
-	1790.5	-	H.W. - shale	-	-	98	-	-	-	-	-	-	-	2% of other minerals**

* P - Proximate Sample No.; T - Thin Section No.

** because of the small quantities of these minerals present, the peaks are small ∴ not identifiable

Table III - 15

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-154

(Shipment # 3)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
-	946	-	H.W. - calcareous siltstone - high gamma	-	t	15	-	-	-	-	85	-	-	
-	946.5	-	H.W. - F.g. sand-stone - high gamma	26	11	32	t	23	-	-	8	t	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 16

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-170

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
704	705	-	H.W. - blue-grey hanging wall shale	-	-	97	-	3	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 17

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-177

(Shipment # 3)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
254	264	P2	D zone -coal,coaly shale,shale	67	33	-	-	t	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 18

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-180

(Shipment # 3)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
-	207.5	-	C zone - pale to dark tan mottled ash	7	75	-	18	-	-	-	-	-	t	
321	322	-	D zone - coaly shale	t	98	t	-	-	-	-	-	-	-	2% of other mineral**
-	323.5	-	D zone - very pale tan ash	-	87	-	13	-	-	-	-	-	-	
643	647	-	D zone - coaly shale	22	46	25	-	7	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

** because of the small quantities of these minerals present, the peaks are small ∴ not identifiable

Table III - 19

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-188

(Shipment # 3)

Footage		Sample No.*	Strat. Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
58	75	P1	C zone - shale and carb. shale	14	27	47	4	8	-	-	-	-	-	
217	237	P10	D zone - coal	10	85	2	3	-	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 20

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-124

(Shipment # 4)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
435	442	P 7	C zone - calcareous siltstone and coal	16	12	3	t	-	-	-	45	24	-	
462	482	P 9	C zone - carbonaceous shale	13	16	36	t	19	-	-	t	t	-	
540	560	P 12	C zone - carbonaceous shale and siltstone	13	28	31	t	10	-	-	4	14	-	
670	690	P 19	D zone - coal	14	68	11	-	7	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 21

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-135
(Shipment # 4)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
535	545	P 13	A zone - coal, minor shaly siderite	5	-	-	-	-	-	-	16	79	-	
1600	1610	P 207	C zone - shale or coaly shale	53	34	-	8	5	-	-	t	t	-	
1790	1795	P 245	D zone - coal	36	61	t	3	-	-	-	-	t	-	
1795	1800	P 246	D zone - coal	46	54	-	-	t	-	-	-	t	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 22

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-157

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
356	376	P 5	C zone - coal with carb. to coaly shale partings											
420	422.5	-	C zone - coaly shale											
513	514	-	D zone - white to pale brown ash											
556	576	P 15	D zone - clean coal	50	50	-	t	t	t	-	-	-	-	
686	687.5	-	D zone - brown shale											
736	747	P 24	IFWD - carb. shale, minor coal											

* P - Proximate Sample No.; T - Thin Section No.

Table III - 23

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-163

(Shipment # 4)

Footage From	Footage To	Sample No. *	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
376	396	P 6	D zone - coal with minor coaly shale	63	35	-	-	2	-	-	-	-	-	
438	446	P 9	IFWD-coaly shale, carbonaceous shale and shale	61	37	-	2	t	-	-	-	-	-	

* P - proximate Sample No.; T - Thin Section No.

Table III - 24

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-164

(Shipment # 4)

Footage		Sample No.*	Strat.Position - Rock Type	Mineral - %										Remarks
From	To			Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	
253	273	P 2	A zone-shaly coal	-	82	12	-	-	-	-	-	-	-	
446	445	-	A zone-mixed detritals											

* P - Proximate Sample No.; T - Thin Section No.

Table III - 25

HAT CREEK DEVELOPMENT - X - RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76-180

(Shipment # 4)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
125	145	P 2	C zone-calcareous, carbonaceous shale and coal	✓	✓	-	✓	-	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table III - 26

HAT CREEK DEVELOPMENT - X - RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76 - 191

(Shipment # 4)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
517	520	P 25	A zone-carb. to coaly shale and coal	11	22	3	59	5	-	-	-	-	-	
563	573	P 30	A zone-coal, coaly shale and sandstone	30	41	7	t	14	-	-	-	8	-	

* P-Proximate Sample No.; T - Thin Section No.

Table III - 27

HAT CREEK DEVELOPMENT - X-RAY ANALYSIS OF MINERAL MATTER

SAMPLE ORIGIN: DDH 76 - 194

(Shipment # 4)

Footage From	Footage To	Sample No.*	Strat. Position - Rock Type	Mineral - % Qtz	Kaol	Bent	Sid	Feld	Pyr	Epid	Cal	Ank	Goy	Remarks
50	70	P 2	D zone - clean coal	63	37	-	-	t	-	-	-	-	-	
170	191	P 8	IFWD-shale coaly shale	√	√	-	-	-	-	-	-	-	-	

* P - Proximate Sample No.; T - Thin Section No.

Table IV

HAT CREEK DEVELOPMENT - PROXIMATE ANALYSIS by THERMOGRAVIMETRIC METHOD (TGA)

Drillhole (DDH)	Footage From	Footage To	Sample No**	Strat. Position - Rock Type		Percentage (Wt.) Moisture	Volatile & Dehy* of Clay	Fixed Carbon	Ash
76-126	853	869.5	P 4	A zone - coal, shaly coal	as is	5.5	26.7	27.2	40.6
					dry basis	-	28.2	28.8	43.0
76-126	993	1013	P 13	A zone - coal	as is	6.7	32.5	38.9	21.9
					dry basis	-	34.8	41.7	23.5
76-127	369	387	P 4	D zone - coal	as is	6.7	28.7	31.1	33.5
					dry basis	-	30.8	33.3	35.9
76-106	566	591	P 8	A zone - interbedded coal and siltstone	as is	6.2	26.8	14.5	52.5
					dry basis	-	28.6	15.4	56.
76-106	744.5	764	P 14	A zone - silty coal shale	as is	5.7	23.3	13.5	57.5
					dry basis	-	24.7	14.3	61.
76-106	1190	1220	P 27	B zone - carb. shale and shale	as is	4.5	25.6	16.6	53.3
					dry basis	-	26.8	17.4	55.8
76-106	1431	1450	P 31	C zone - coal; coaly to carb. siltstone	as is	2.5	22.7	13.7	61.1
					dry basis	-	23.3	14.	62.7
76-106	1587	1627	P 36	D zone - coal with thin shale partings	as is	4.8	31.	31.7	32.5
					dry basis	-	32.6	33.3	34.1
76-177	254	264	P 2	D zone - coal, coaly shale, shale	as is	6.2	32.5	35.8	25.5
					dry basis	-	34.6	38.2	27.2
76-188	58	75	P 1	C zone - shale and carb. shale	as is	4.6	18.7	2.9	73.8
					dry basis	-	19.6	3.0	77.4
76-188	217	237	P 10	D zone - coal	as is	6.9	32.9	32.9	27.3
					dry basis	-	35.3	35.3	29.4

** P - Proximate Sample No. ; T - Thin Section No.

* Dehydration of Clay

Table V

Size Distribution of sample 76-157-15

Size (U.S. Sieve Std. mesh)	Wt.%	Cumulative wt.%
+ 50	.47	.47
- 50 + 70	4.5	4.97
- 70 + 80	5.3	10.27
- 80 + 100	7.0	17.27
- 100 + 120	10.7	27.97
- 120 + 140	8.8	36.77
- 140 + 200	16.3	53.07
- 200 + 230	7.9	60.97
- 230 + 270	8.3	69.27
- 270 + 325	2.7	71.97
- 325 + 400	5.8	77.77
- 400	22.2	99.97

Table VI

THERMOGRAVIMETRIC ANALYSIS(TGA) OF FLOAT OF SINK FRACTIONS

Sample No.	Specific gravity fluid used	Fraction**	wt. %		Percent(%) Moisture	Volatile & Dehydration*	Carbon	Ash
76-190-30	1.3	F	12	as is	11.8	35.5	50.8	1.9
				dry basis	-	40.2	57.6	2.2
	1.3	S	78	as is	9.5	38.0	34.1	18.4
				dry basis	-	42.0	37.7	20.3
76-157-15	1.3	F	19	as is	12.1	36.6	47.3	4.0
				dry basis	-	41.6	53.8	4.6
	1.3	S	81	as is***	-	-	-	-
				dry basis	-	-	-	-
76-157-15	1.35	F	35	as is	11.0	37.9	45.2	5.9
				dry basis	-	42.6	50.8	6.6
		S	65	as is***	-	-	-	-
				dry basis	-	-	-	-
76-157-15	1.4	F	72	as is	11.0	35.5	45.0	8.5
				dry basis	-	39.9	50.6	9.5
	1.4	S	28	as is	8.3	32.0	31.6	28.1
				dry basis	-	34.9	34.4	30.7
76-157-15	1.45	F	89	as is	10.7	36.0	43.8	9.5
				dry basis	-	40.3	49.1	10.6
	1.45	S	11	as is	7.5	30.6	24.4	37.5
				dry basis	-	33.1	26.4	40.5
76-157-15	1.5	F	94	as is	11.3	33.6	41.8	13.3
				dry basis	-	37.9	47.1	15.0
		S	6	as is	5.8	30.5	20.8	42.9
				dry basis	-	32.4	22.1	45.5
76-157-15	1.595	F	99	see TGA of sample 76-157-15				
		S	1	-	-	-	-	-

TGA of Sample 76-157-15(as received)

	Moisture	Volatile & Dehydration*	Carbon	Ash
as is	13.5	35.8	38.4	12.3
dry basis	-	41.4	44.4	14.2

* Dehydration of clay

** F - Float fraction; S - Sink fraction

*** Insufficient time to do TGA for these fractions.

Table VIII

X-RAY ANALYSIS OF FLOAT AND SINK FRACTIONS

Sample No.	Specific gravity fluid used	Float Fraction			Sink Fraction		
		wt.% Distribution	% Ash	Minerals present	wt.% Distribution	% Ash	Minerals present
76-190-30	1.3	12	2.0	-	78	1.8	quartz, kaolinite, siderite, fedlspar(t)
76-157-15	1.3	19	4.6	-	81	**	quartz, kaolinite
	1.35	35	6.6	kaolinite, quartz	65	**	**
	1.4	72	9.5	kaolinite, quartz	28	30.7	kaolinite, quartz, siderite (t)
	1.45	89	10.6	kaolinite, quartz	11	40.5	kaolinite, quartz, pyrite(t),siderite(t)
	1.5	94	15.0	kaolinite, quartz	6	45.5	-
	1.6*	99	14.2	kaolinite, quartz	1	-	-

Quantitative analysis of sample 76-157-15

Percentage of total inorganic minerals:
50% kaolinite 50% quartz siderite (t) pyrite (t)

Percentage of coal sample:
7.5% kaolinite 7.5% quartz

* 1.6 is actually 1.595, S.G. of CCl_4 at room temperature. Note that X-ray are not performed for samples having low ash content or low weight percent distribution.

** Insufficient time to find these values.

FIGURE 1

Drillhole Depth As Function of Percent of Total Inorganic Minerals

DDH - 135

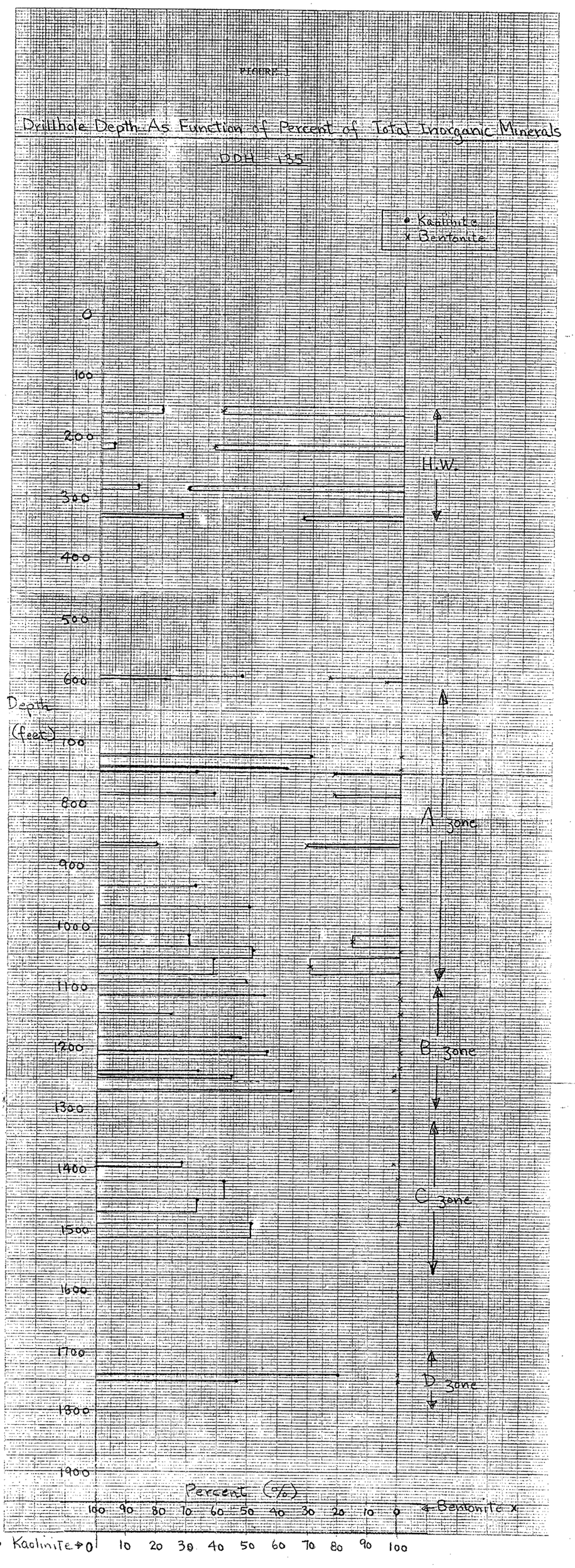


FIGURE 2

Percent of Total Inorganic Minerals As Function of Drillhole Depth

DDH-135

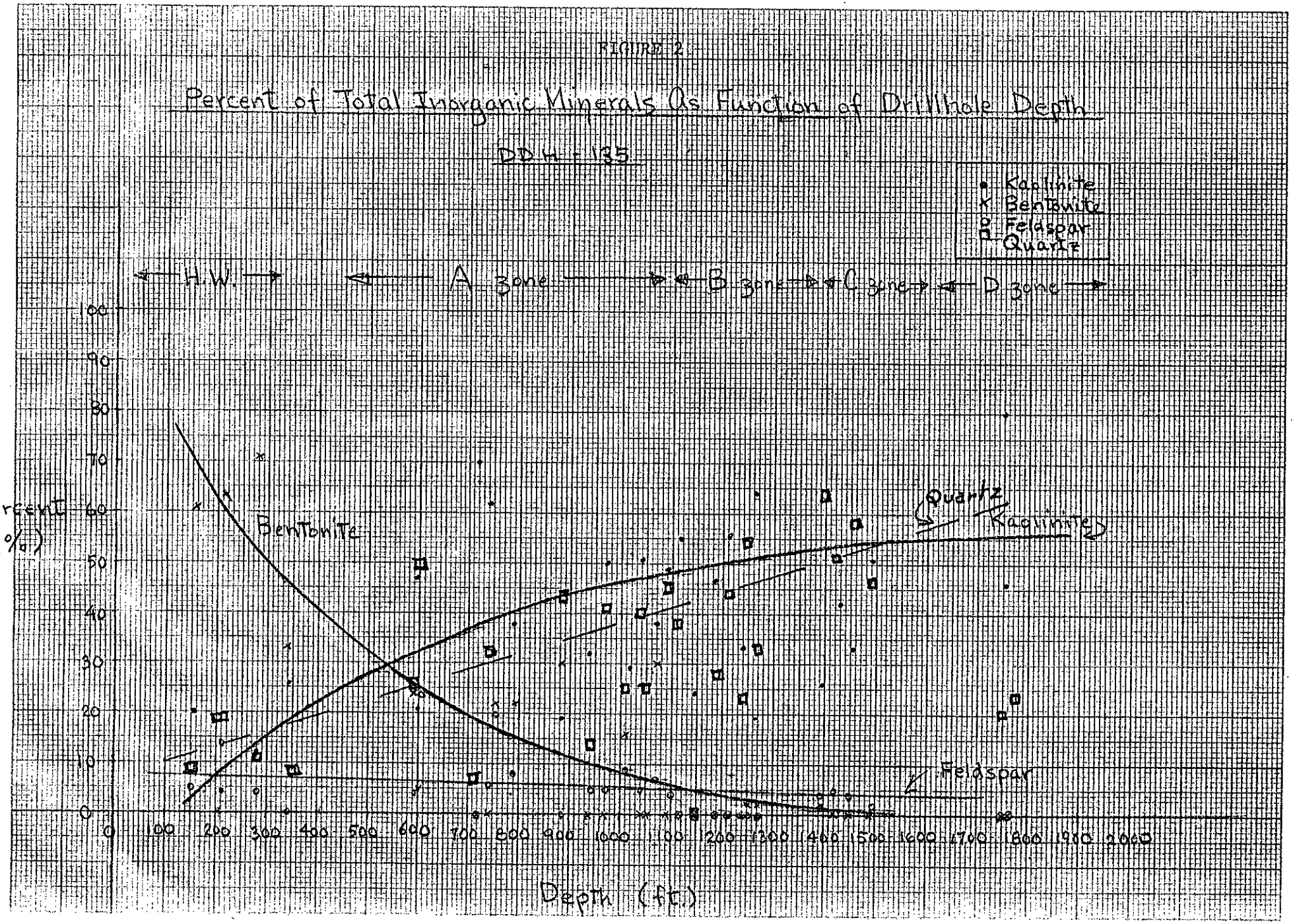


FIGURE 3

Percent of Total Inorganic Minerals As Function of Drillhole Depth

• Kaolinite
× Bentonite
○ Felaspar

DDH 76-191

A Zone → ← D Zone →

DDH 76-126

H.W. → ← A Zone

Bentonite

Kaolinite

Percent (%)

Depth (ft.)

Depth (ft.)

FIGURE 4

Size Distribution of Sample # 76-157-15

Percentage Vs Mesh size

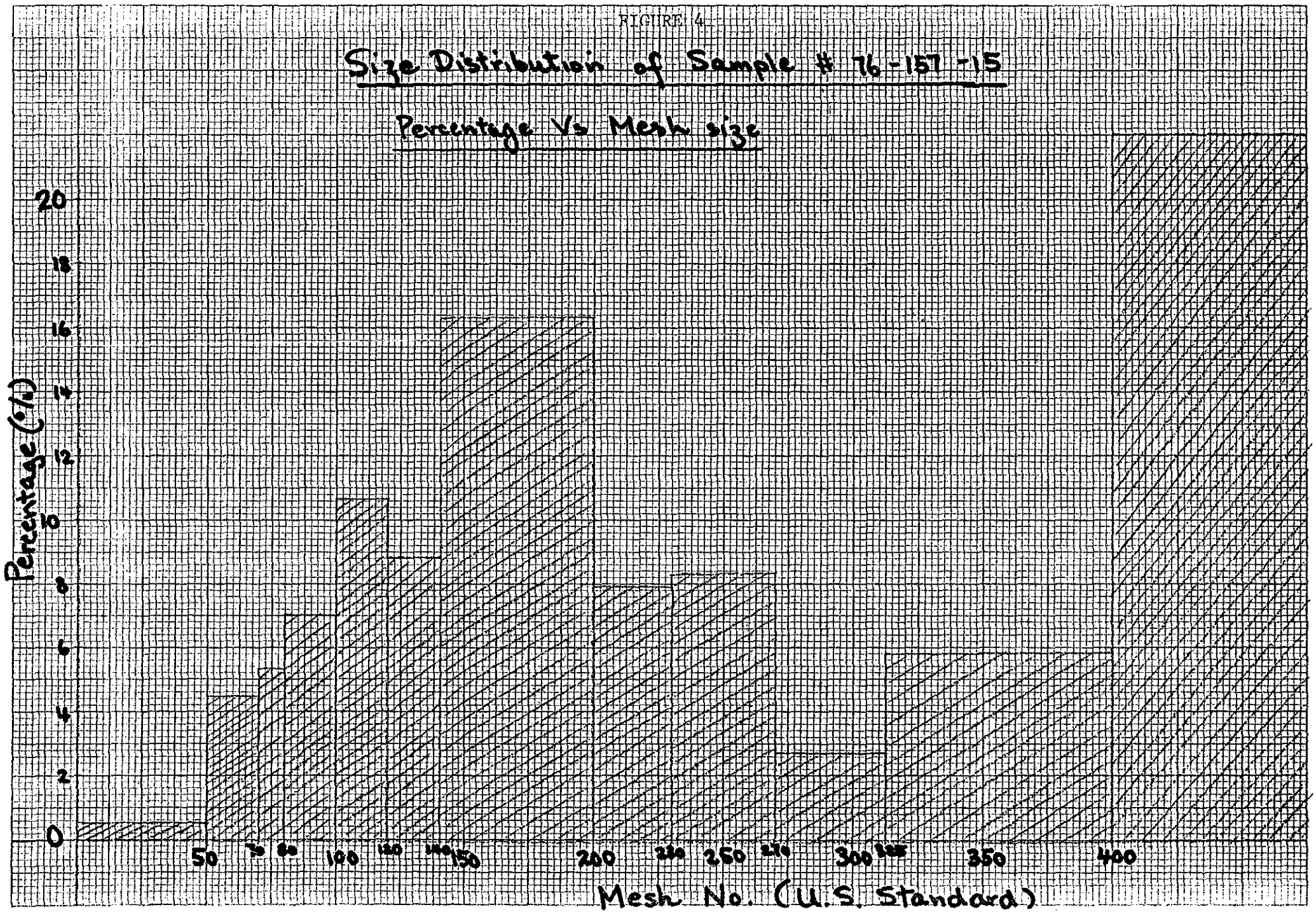


FIGURE 5

Cumulative Wt. Percent Vs. Mesh Size

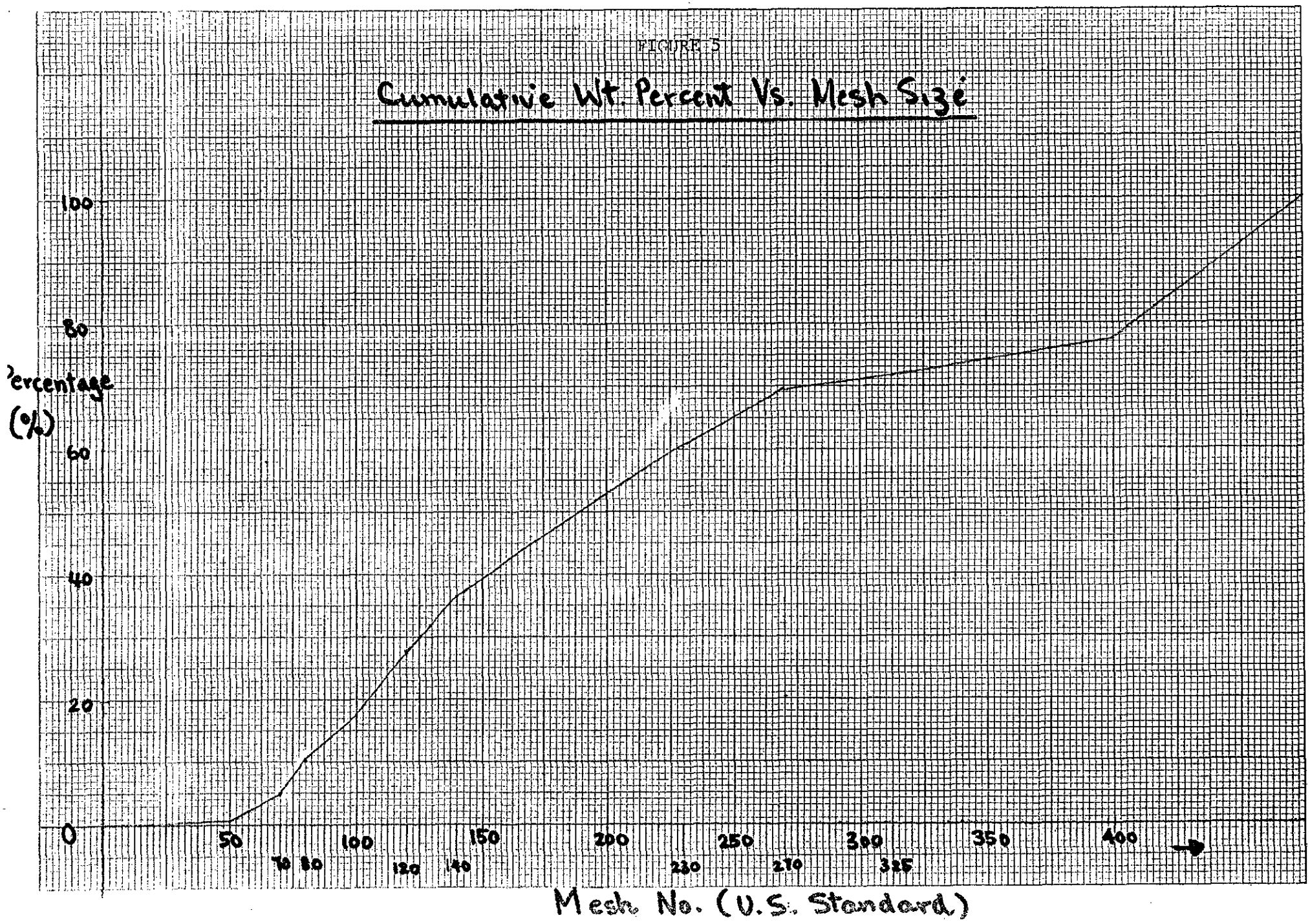
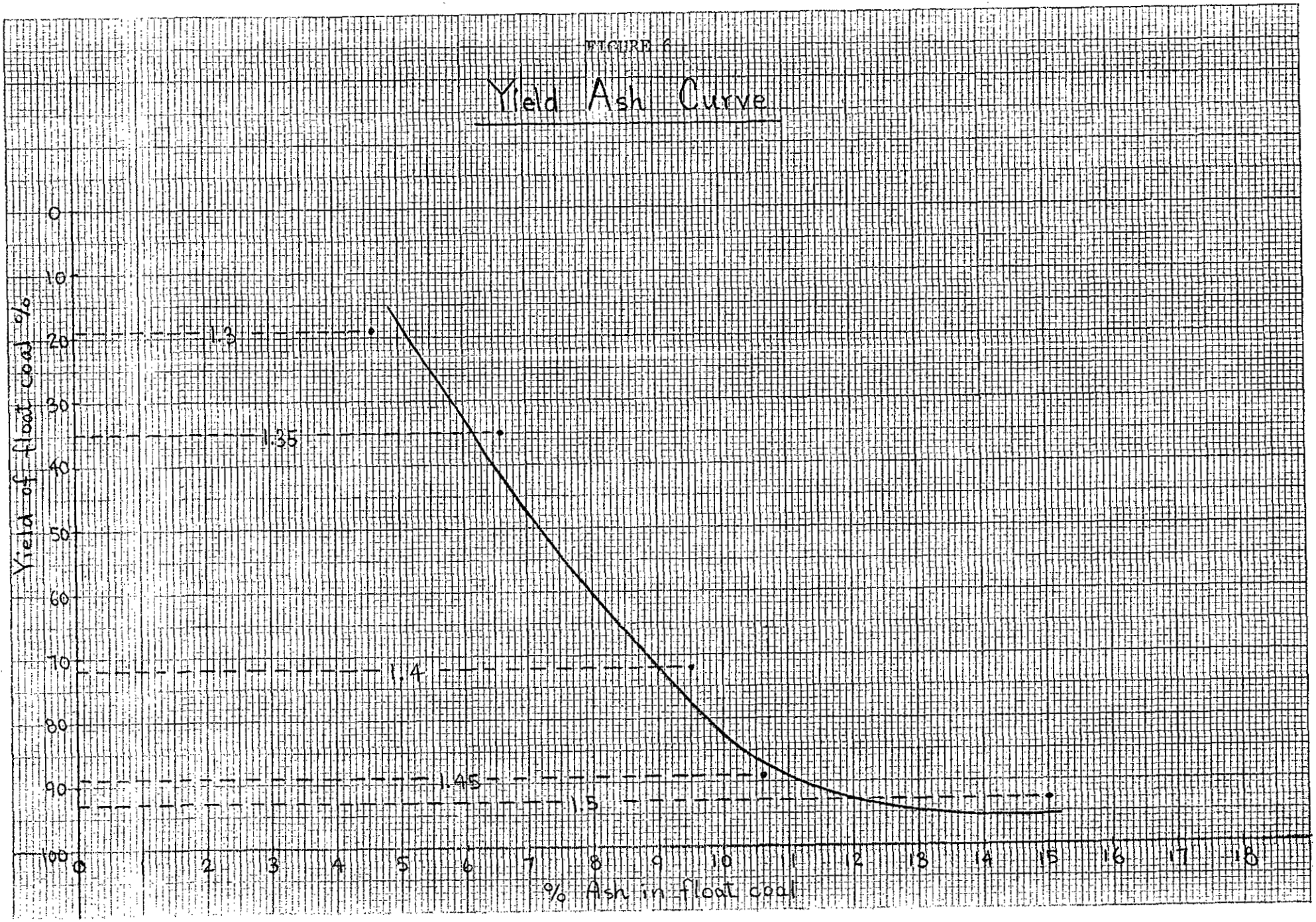


FIGURE 6

Yield Ash Curve



SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

(SAMPLES ASSIGNED TO ZONES)

Shipment No. 1
Date: Feb. 28, 197

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
74-44	-	1123	-	1600	-	Grab	Bentonitic (?) sandstone CZ
76-135	-	1074	-	304	-	Grab	Cream ash ↑
135	-	1075	-	358	-	Grab	Grey ash HW
135	-	1076	-	441	-	Grab	Dark grey shale ↓
135	-	1077	-	463	-	Grab	Dark grey shale
135	-	1078	-	1944	-	Grab	Carb. shale ↑ FW
135	-	1080	-	1994	-	Grab	Tuffaceous shale ↓
76-136	-	1081	-	195	-	Grab	White ash ↑
136	-	1082	-	219	-	Grab	Grey shale HW
136	-	1083	-	308.5	-	Grab	Grey, carb. shale ↓
136	-	1084	-	1639	-	Grab	Carb. shale FW

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 2
Date: March 24, 197

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (Af)	Footage Length	Sample Type	Remarks
76-135	-	-	150	166	16	Chip	Shale and carb. shale
135	-	-	213	222	9	Chip	Shale, some carb. material
135	-	-	280	288	8	Chip	Shale
135	-	-	329	331	2	Chip	Shale
135	-	-	594	595	1	Chip	Coaly shale
135	-	-	-	598	-	Grab	Slightly carb. fine grained sandst
135	-	-	722	726	4	Chip	Slightly carb. shale
135	-	-	742	744	2	Chip	Carb. shale
135	-	-	-	751	-	Grab	Shaly siltstone, slightly carb.
135	-	-	786	790	4	Chip	Moderately carb. shale
135	-	-	867	871	4	Chip	Carbonaceous to coaly shale
135	-	-	-	938	-	Grab	Siltstone, moderately indurated
135	-	-	-	970	-	Grab	Highly carb. shale
135	-	-	1016	1035	19	Chip	Shale, some carb. shale
135	-	-	1035	1055	20	Chip	Shale and carb. shale
135	-	-	1055	1082	27	Chip	Shale and carb. shale
135	-	-	1090	1095	5	Chip	Carb. shale
135	-	-	1115	1116	1	Chip	Carb. to coaly shale
135	-	-	-	1145.5	-	Grab	Ash, tan, minor dark white mott
135	-	-	-	1184.5	-	Grab	Shale, carb. to coaly
135	-	-	1208	1214	6	Chip	Shale, carb. to coaly
135	-	-	-	1240.5	-	Grab	Shale, coaly to carb.
135	-	-	1246	1253	7	Chip	Shale, coaly to carb.
135	-	-	1271	1275	4	Chip	Carb. shale
135	-	-	1390	1397	7	Chip	Tuffaceous siltstone to sandstone

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 2
Date: March 24, 1977

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
76-135	-	-	1420	1451	31	Chip	Tuffaceous siltstone to fine sand
-135	-	-	1451	1472	21	Chip	Shale, carb. to coaly shale.
-135	-	-	1490	1514	24	Chip	Carbonaceous shale.
-135	-	-	1749	1750	1	Chip	Shaly coal.
-135	-	-	--	1751	--	Grab	Buff ash (2 thin beds).
76-181	-	-	--	254	--	Grab	Coaly shale.
-181	-	-	295	297	2	Chip	Carb. shale.
-181	-	-	--	492	--	Grab	Tuffaceous siltstone, slightly ca
-181	-	-	716	717	1	Chip	Carb. shale.
-181	-	-	786	791	5	Chip	Shale and carb. shale. FW
76-191	-	-	226	232	6	Chip	Shale to carb. shale.
-191	-	-	262	263	1	Chip	Shale, very slightly carb.
-191	-	-	297	299	2	Chip	Shale, carb. shale.
-191	-	-	347	348	1	Chip	Carb. shale.
-191	-	-	367	370	3	Chip	Carb. to coaly shale.
-191	-	-	434	435	1	Chip	Coaly to carb. shale.
-191	-	-	1072	1073	1	Chip	Coaly to carb. shale.
-191	-	-	1134	1135	1	Chip	Coaly shale and shaly coal.
76-196	-	-	--	300	--	Grab	Buff ash.
-196	-	-	300	301	1	Chip	Carb. shale.
-196	-	-	--	368	--	Grab	Tuffaceous siltstone (ash?).
-196	-	-	--	522	--	Grab	Carb. shale.

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 2
Date: March 24, 1977

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage			Sample Type	Remarks
			From	To (At)	Length		
76-196	-	-	883	887	4	Chip	Carb. shale and shale.
-196	-	-	--	771	--	Grab	Slightly carb. shale.
76-204	-	-	491	495	4	Chip	Slightly carb. shale.

DOLMAGE CAMPBELL AND ASSOCIATES (1975) LTD.

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 3
Date: May 4, 1977

X Low Priority

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
75-106	--	--	120	130	10	Chip	Shale - hanging wall.
-106	--	--	220	230	10	Chip	Shale - hanging wall.
-106	--	--	350	360	10	Chip	Shale - hanging wall.
-106	--	--	411.5	413	1.5	Chip	Carb. siltstone.
-106	--	--	431	435	4	Chip	Carb. shale.
-106	--	--	457	461	4	Chip	Siltstone and carb. siltstone.
-106	--	--	492.5	495	2.5	Chip	Siltstone.
-106	8	--	566	591	25	Pulp	Interbedded coal and siltstone.
-106	--	--	632	636	4	Chip	Coaly to carb. siltstone.
-106	--	--	700	701	1	Chip	Coaly siltstone.
-106	14	--	744.5	764	19.5	Pulp	Silty coal and shale.
-106	--	--	787	788.5	1.5	Chip	Carb. siltstone.
-106	--	--	854	855	1	Chip	Carb. shale.
-106	--	--	952.5	957	4.5	Chip	Shale.
-106	--	--	1092	1095	3	Chip	Carb. shale.
-106	--	--	1184	1185	1	Chip	Carb. shale.
-106	27	--	1190	1220	30	Pulp	Carb. shale and shale.
-106	--	--	1267	1287	20	Chip	Shale; minor siltstone - sandstone.
-106	--	--	1362	1365	3	Chip	Siltstone.
-106	31	--	1431	1450	19	Pulp	Coal; coaly to carb. siltstone.
-106	--	--	1535	1545	10	Chip	Basal siltstone.
-106	--	--	--	1545	--	Grab	Ash bed.
-106	36	--	1587	1627	40	Pulp	Coal with thin shale partings.
76-124	--	--	190	200	10	Chip	Siltstone. = C zone

HW

A

B

C

D

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 3
Date: May 4, 1977

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
76-124	--	--	352	368	16	Chip	Siltstone. C zo
-124	--	--	906	917	11	Chip	Basal siltstone. IFW
76-126	--	--	200	210	10	Chip	Siltstone.
-126	--	--	--	486	--	Grab	Pale tan ash.
-126	--	--	500	510	10	Chip	Siltstone.
-126	--	--	677	679	2	Chip	Pale tan to grey ash. HW
-126	--	--	--	754	--	Grab	Pale tan to grey ash.
-126	--	--	790	800	10	Chip	Siltstone.
-126	4	--	853	869.5	16.5	Pulp	Coal, shaly coal. A
-126	--	--	--	921	--	Grab	Pale tan ash.
-126	13	--	993	1013	20	Pulp	Coal.
76-127	--	--	250	270	20	Chip	Mixed detritals. C
-127	--	--	309	311.5	2.5	Chip	Shale, siltstone; some shaly co
-127	4	--	369	387	18	Pulp	Coal. D
-127	--	--	502	511	9	Chip	Shale and silty shale. IFW
76-128	--	--	--	386	--	Grab	Sheared carb. shale. C z
76-130	--	1130	--	1621.3	--	Grab	Hanging wall shale. H
-130	--	--	--	1790.5	--	Grab	Hanging wall shale.
76-154	--	--	--	946	--	Grab	Calcareous siltstone-high gam
-154	--	--	--	946.5	--	Grab	F.g. sandstone-high gamma.

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 3
Date: May 4, 1977

Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
76-170	--	--	704	705	1	Chip	Blue-grey hanging wall shale.
76-177	2	--	254	264	10	Pulp	Coal, coaly shale, shale.
76-180	--	--	--	207.5	--	Grab	Pale to dark tan mottled ash.
-180	--	--	321	322	1	Chip	Coaly shale.
-180	--	--	--	323.5	--	Grab	Very pale tan ash.
-180	--	--	643	647	--	Chip	Coaly shale.
76-188	1	--	58	75	17	Pulp	Shale and carb. shale.
-188	10	--	217	237	20	Pulp	Coal.

HAT CREEK DRILLING MUD ADDITIVES

TYPE	COMMENTS
Quik Gel	Used commonly.
Polychem C.P.	Used commonly.
Quik Trol	Used in earlier holes instead of above. NO SAMPLE.
High-yield Bentonite	Used commonly.
Super Sel	Used occasionally - special circumstances.
Celex	Used occasionally - special circumstances.
Kwik Seal	Used occasionally - special circumstances.
Barite	Used occasionally - special circumstances.

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 4
Date: May 31, 1977

X Low Priority

	Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
X	74-25			190	205	15	Chip	Graded sandstone, trace of coal
X	25			226	236	10	Chip	Brown to black siltstone, shale and coal.
X	25			238	250	12	Chip	Siltstone grading to sandstone
X	25			385	397	12	Chip	Silty shale.
X	25			515	518	3	Chip	Carbonaceous shale A
X	25			522	532	10	Chip	Coaly siltstone and sandstone
X	25			593	603	10	Chip	Calcareous, f.g. to gritty sands
X	25			671	675	4	Chip	Carbonaceous siltstone.
X	25	28		730	750	20	Pulp	Carbonaceous shale and coal
X	25				815		Grab	Tan ash. B
X	25			990	1000	10	Chip	Thin beds coaly shale in coal C
X	25				1028		Grab	Pale tan, mottled ash
X	25				1112.5		Grab	Tan, silty ash ± 1455 D
X	25			1454	1465	11	Chip	Shale and carbonaceous shale
X	25			1890	1910	20	Chip	Hangingwall (?) siltstone FW
	74-39			438	446	8	Chip	Footwall shale, carbonaceous to coaly. L.F.W.
	76-124	7		435	442	7	Pulp	Calcareous siltstone and coal
	124	9		462	482	20	Pulp	Carbonaceous shale
	124	12		540	560	20	Pulp	Carbonaceous shale and siltstone to 556
	124	19		670	690	20	Pulp	Coal Ld ~ 556'
	76-127			499.5	500	0.5		Carbonaceous shale FW
	76-135	13		535	545	10	Pulp	Coal, with some siltstone A A ZONE
	135	207		1600	1610	10	Pulp	Shale or coaly shale C ZONE

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 4
Date: May 31, 197

X Low Priority

	Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
	76-135	245		1790	1795	5	Pulp	Coal. D
	135	246		1795	1800	5	Pulp	Coal
	76-146			94	110	16	Chip	Shale FW
	76-157	5		356	376	20	Pulp	Coal with carbonaceous to coal shale partings.
	157			420	422.5	2.5	Chip	Coaly shale
X	157			513	514	1	Grab	White to pale brown ash.
	157	15		556	576	20	Pulp	Clean coal. D
	157			686	687.5	1.5	Chip	Brown shale.
	157	24		736	747	11	Pulp	Carbonac. shale, minor coal IF
	76-163	6		376	396	20	Pulp	Coal with minor coaly shale. D
	163	9		438	446	8	Pulp	Coaly shale, carbonaceous shale and shale IF
	76-164	2		253	273	20	Pulp	Shaly coal. A
	164			446	455	9	Chip	Mixed detritals
	76-180	2		125	145	20	Pulp	Calcareous, carbonaceous shale and coal = C zone
	76-185			299	301.5	2.5	Chip	Light olive grey shale Fw
X	76-187				164		Grab	Pale tan-grey ash
	187	13		336	356	20	Pulp	Coal and carbonaceous shale; fault zone D
X	187				612		Grab	Very light grey ash
	187			816	821	5	Chip	Light grey shale, carbonaceous flecks. I.F.W.D

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 4
Date: May 31, 1977

* LOW PRIORITY

	Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks	
	76-188			132	133	1	Chip	Coaly shale.	
X	188				190		Grab	Pale tan ash	
	188			382	399	17	Chip	Silty shale with some sandstone	I FW
X	76-190	1		14	30	16	Pulp	Fault zone	B
X	190			165	176	11	Chip	Mixed fine detritals	
X	190			280	300	20	Chip	Mixed fine detritals	
	190			352	353	1	Chip	Shale	
	190			447	448	1	Chip	Shale	C
X	190			462	468	6	Chip	Shale.	
X	190	19		504	513	9	Pulp	Coal and shale	
X	190				586		Grab	Light brownish grey ash	
	190			607	609	2	Chip	Carbonaceous shale	
X	190				648		Grab	White-mottled medium brown ash	D
X	190	30		713	733	20	Pulp	Coal, minor carbonac. shale	
	190			732	733	1	Chip	Carbonaceous shale	
X	190			867	875	8	Chip	Footwall detritals	FW
	76-191	25		517	520	3	Pulp	Carb. to coaly shale & coal.	
	191	30		563	573	10	Pulp	Coal, coaly shale & sandstone.	A
	76-194	2		50	70	20	Pulp	Clean coal	D zone
	194	8		170	191	21	Pulp	Shale and coaly shale.	IFW

SAMPLES FOR X-RAY ANALYSIS

RECORD OF SHIPMENTS TO Dr. A.C.D. CHAKLADER

Shipment No. 4
Date: May 31, 1977

X LOW PRIORITY

	Drill Hole No.	Prox. Sample No.	Thin Sect. No.	Footage From	Footage To (At)	Footage Length	Sample Type	Remarks
X	76-201				137		Grab	Shale, carbonaceous
X	201	6		172	192	20	Pulp	Coal
X	201	17		352	357	5	Pulp	Shale, minor coaly shale
	201			426	427	1	Chip	Carbonaceous shale
X	201				429		Grab	Chalky-white ash
	201			458	460	2	Chip	Shale
X	201	24		477	493	16	Pulp	Carbonates in coal
X	201	25		493	496	3	Pulp	Shaly coal
X	201				612		Grab	Chalky silty ash
	201			826	828	2	Chip	Shaly coal
	201			852	853	1	Chip	Carbonaceous shale
X	201	49		937	940	3	Pulp	Calcareous siltstone and grit