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Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

AN INVESTIGATION OF THE COKING PROPENSITIES OF DRILL CORE SAMPLES FROM THE BABCOCK SYNCLINE EXTENSION PIT SUBMITTED BY DENISON MINES LIMITED

Project 03-3-1/6-23
Job No. 3397R

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An Investigation of the Coking Propensities of Drill Core Samples from the Babcock Syncline Extension Pit Submitted by Denison Mines Limited

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by

J.G. Jorgensen*and T.A. Lloyd**

INTRODUCTION

The evaluation of coals for Denison Mines Limited is a continuing divisional project in which periodic investigations are undertaken as requested by the company.

This investigation includes evaluation data on coals specified in a letter dated May 22, 1982 from R. Sagi, Chief Geologist, Coal Division, Denison Mines Limited. A copy of this letter appears in Appendix 1.

The drill core coal samples which were submitted for petrographic analysis are identified as follows:

Lab No.	Sample No.	Seam ID.
3126-82	1	D
3127-82	2	E
3128-82	3	F
3129-82	4	G
3130-82	5	J

In addition a composite sample was prepared from the above seams for testing in the 30 lb. coke oven.

The results of the chemical, physical, thermal rheological, petrographical and 30 lb. coke oven testing are tabulated in Tables 1 to 5.

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2. ASTM Designation: D388-66, "Classification of Coals by Rank".

3. ASTM Designation: D720-67, "Test for Free Swelling Index of Coal".

4. ASTM Designation: D2639-71, "Test of Plastic Properties of Coal by the Constant-Torque Gieseler Plastometer." (Constant torque plastometer used with a torque of 40 gram-inch; start, 1 dd/m; fusion, 5 dd/m; final, 1 dd/m; solidification, no movement; range-temp., between start and final temperatures).

5. Burrough, E.J., "Specific Volatile Index", Fuels Division Memorandum 97/58-CG, Fuels and Mining Practice Division, Mines Branch, Dept. of M. and T.S., Ottawa, Canada (1958).

6. ASTM Designation: D409-71, "Grindability of Coal by the Hardgrove-Machine Method".

7. ASTM "Proposed Method of Test for Measuring the Coking Pressures of Coals by a Movable-Wall Slot Oven" (presently under consideration for adoption as a standard method of test by Sub-Committee XV of ASTM Committee D-5).

8. ASTM Designation: D291-60, "Cubic Foot Weight of Crushed Bituminous Coal" Procedure A - Procedure for Uncompacted Cubic Foot Weight).

9. ASTM Designation: D293-69, "Test for Sieve Analysis of Coke".

10. ASTM Designation: D294-64, "Tumbler Test for Coke".

11. Japanese Drum Test for Coke, Designated as J.I.S. (Japanese Industrial Standard) K 2151-1972, pp. 12-16).

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13. ASTM Designation: D2014-71, "Expansion or Contraction of Coal by the Sole-Heated Oven".

14. German Industrial Specification No. DIN 51739/March 1951.

15. ASTM Designation: D-2797-72, "Preparing Coal Samples for Microscopical Analysis by Reflected Light".

16. ASTM Designation: D-2798-72, "Microscopical Determination of the Reflectance of the Organic Components in a Polished Specimen of Coal".

17. ASTM Designation: D-2799-72, "Microscopical Determination of Volume Percent of Physical Components of Coal".

18. Shapiro, N., Gray, R.J., "Petrographic Classification Applicable to Coals of all Ranks", Proc. 111, Min. Inst., 1960, 68, 83-97.

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TABLE 1 Chemical Analyses of Component Coals

Identification						
Laboratory Number	3126-82	3127-82	3128-82	3129-82	3130-82	3260-82
Description	Sample 1 Seam D	Sample 2 Seam E	Sample 3 Seam F	Sample 4 Seam G	Sample 5 Seam J	Composite
Classification						
Rank (ASTM)						lvb
International System						433
Specific Volatile Index						205
Carbon (dmmfb) .....%						90.8
Proximate Analysis (db)						
Ash .....%	6.0	8.5	6.8	8.3	7.3	7.2
Volatile Matter .....%	21.1	23.1	21.4	20.8	18.3	20.0
Fixed Carbon .....%	72.9	68.4	71.8	70.9	74.4	72.8
Gross Calorific Value (db)						
Btu per pound						14,500
Ultimate Analysis (db)						
Carbon .....%						83.6
Hydrogen .....%						4.3
Sulphur .....%	0.69	0.50	0.52	0.52	0.35	0.49
Nitrogen .....%						0.7
Ash .....%						7.2
Oxygen (by difference) .....%						3.7
Ash Analysis (db)						
SiO_2 .....%						53.6
Al_2O_3 .....%						25.6
Fe_2O_3 .....%						3.2
TiO_2 .....%						1.1
P_2O_5 .....%						1.8
CaO .....%						5.7
MgO .....%						1.2
SO_3 .....%						3.4
Na_2O .....%						0.5
K_2O .....%						0.6

TABLE 2 Physical Tests and Fusibility of Ash of Component Coals

Identification		
Laboratory Number		3260-82
Description		Composite
Coal Pulverization		
Sieve Analysis		
Passing	Retained On	
	1/4 in. %	
1/4 in.	6 mesh %	
6 mesh	12 mesh %	1.5
12 mesh	20 mesh %	32.6
20 mesh	..... %	65.9
		100.0
Total Passing	6 mesh %	
Grindability		
Hardgrove Index		79
Fusibility of Ash		
Initial Deformation Temp. ...	°F	2295
Softening Temp. Spherical ...	°F	2470
Softening Temp. Hemispherical	°F	2595
Fluid Temp.	°F	2695

TABLE 3 Thermal Rheological Properties of Component Coals

Identification	
Laboratory Number	3260-82
Description	Composite
Linear Expansion	
Bd. 52 lb/ft^3 at 2% moisture...%	
Gieseler Plasticity	
Start .....°C	438
Fusion Temp. .....°C	452
Max. Fluid Temp. .....°C	472
Final Fluid Temp. .....°C	496
Solidification Temp. .....°C	500
Melting Range .....°C	58
Max. Fluidity .....dd/m	59
Torque .....g.in.	40
Dilatation	
Ti - Softening Temp. .....°C	405
Tii - Max. Contraction Temp. °C	456
Tiii - Max. Dilatation Temp. .°C	482
Contraction .....%	22
Dilatation .....%	14
Free Swelling Index	
F.S.I.	7½

TABLE 4 Petrographic Analysis of Component Coals

Identification						
Laboratory Number	3126-82	3127-82	3128-82	3129-82	3130-82	3260-82
Description	Sample 1 Seam D	Sample 2 Seam E	Sample 3 Seam F	Sample 4 Seam G	Sample 5 Seam J	Composite
Distribution of Vitrinite Types						
V-6....%						
V-7....%						
V-8....%						
V-9....%						
V-10....%						
V-11....%	4.4	1.3	1.2			0.5
V-12....%	17.9	25.9	8.5	8.7	2.0	5.6
V-13....%	12.1	37.3	35.4	21.5	12.7	24.5
V-14....%	11.1	2.0	15.9	26.7	28.4	19.4
V-15....%	2.8			1.1	5.8	1.0
V-16....%						
V-17....%						
V-18....%						
Reactive Components						
Total Vitrinite....%	48.3	66.5	61.0	58.0	48.9	51.0
Reactive Semi-fusinite (1/3)...%	19.1*	6.2	13.5*	14.1*	19.9*	18.2*
Exinite....%	0.0	0.0	0.0	0.0	0.0	0.0
Total....%	67.4	72.7	74.5	72.1	68.8	69.2
Inert Components						
Inert Semi-fusinite (2/3)....%	19.1**	12.3	13.5**	14.1**	20.0**	18.2**
Micrinite....%	6.0	5.4	4.6	4.4	3.3	3.8
Fusinite....%	4.1	4.8	3.6	4.9	4.0	4.8
Mineral Matter....%	3.4	4.8	3.8	4.5	3.9	4.0
Total....%	32.6	27.3	25.5	27.9	31.2	30.8
Petrographic Indices						
Mean Reflectance....%	1.33	1.30	1.35	1.38	1.43	1.38
Balance Index....	2.39	1.80	1.87	2.28	3.02	2.57
Strength Index....	5.54	5.43	5.97	6.19	6.49	6.07
Stability Index....	54.0	58.4	60.5	58.5	54.8	56.3

*Reactive Semi-fusinite ($\frac{1}{2}$) and **Inert Semi-fusinite ($\frac{1}{2}$)

TABLE 5 - Carbonization Data - 30 lb. Coke oven

Test Identification Number.....	683	684
Data of Test.....	82-07-21	82-07-22
Laboratory Number.....		
Description.....		
	Composite Blend	Composite Blend
CARBONIZATION DATA		
Net Weight of Charge (wet).....lb	35.0	35.0
Moisture in Charge.....%	0.9	0.8
ASTM Bulk Density (wet).....lb/ft^3	-	-
Oven Bulk Density (db).....lb/ft^3	50.2	50.5
CARBONIZATION RESULTS		
Gross Coking Time.....hr:min		1:30
Maximum Wall Pressure.....lb/in^2	-	-
Coke Yield Actual.....%	78.7	83.9
Mean Coke size.....in	1.31	1.17
Apparent Specific Gravity.....	-	-
Screen Analysis of Coke (cumulative percentage retained on)		
3 inch sieve.....	-	-
2 inch sieve.....	10.9	4.7
1 1/2 inch sieve.....	28.0	22.4
1 inch sieve.....	70.6	64.3
3/4 inch sieve.....	87.0	80.0
1/2 inch sieve.....	94.4	89.0
Percentage -1/2 inch (breeze).....	5.6	11.0
Tumbler Test (Modified)		
Stability Factor.....	43.1	40.6
Hardness Factor.....	66.2	65.1
Japanese Drum Test (JIS) (cumulative percentage retained on)		
50 mm sieve.....		
25 mm sieve.....		
15 mm sieve.....		

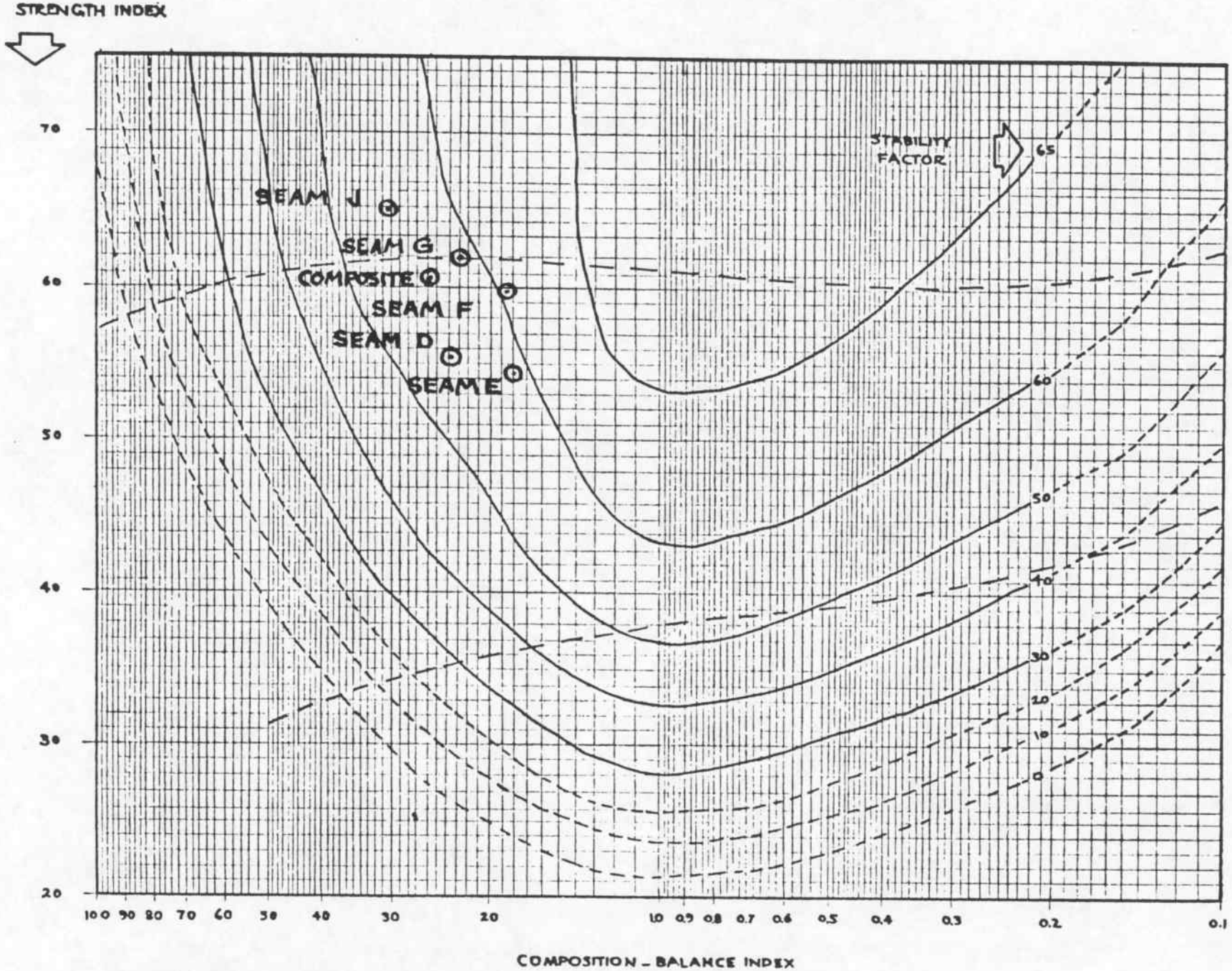
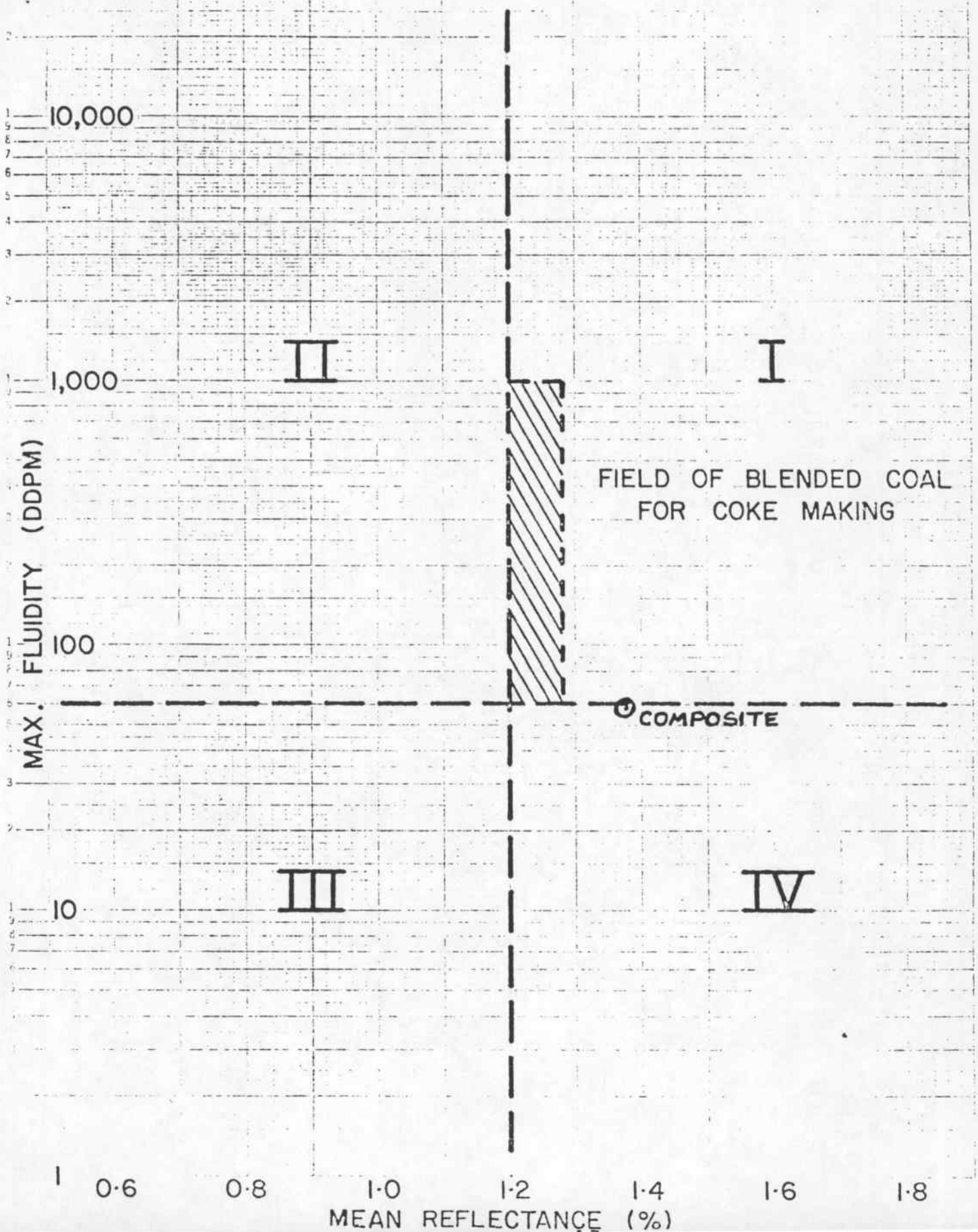


Figure 1. Plot of the stability factors of the component coals and composite sample from petrographic data.

Figure 2. RELATIONSHIP BETWEEN MAX. FLUIDITY AND MEAN REFLECTANCE.



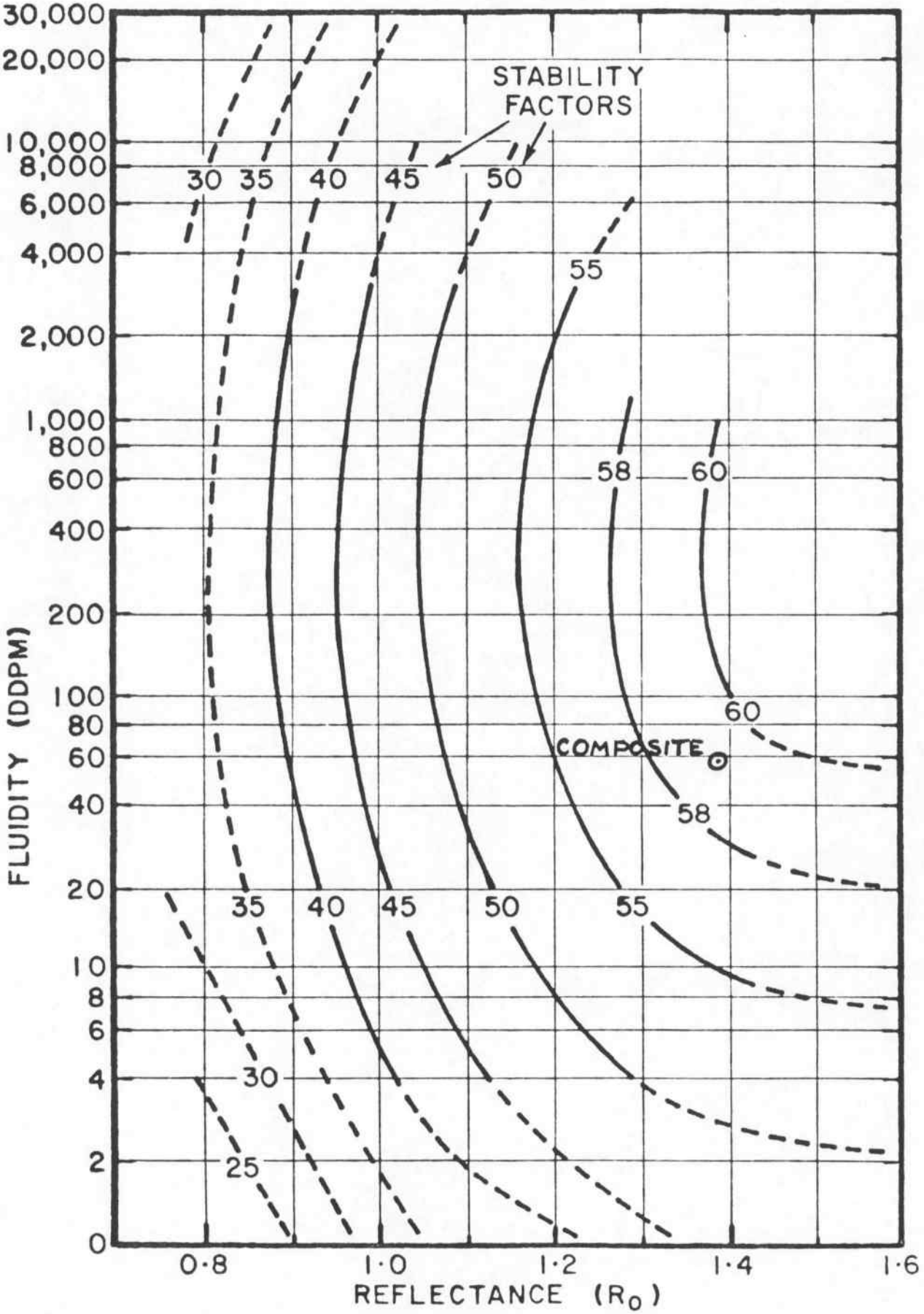


Figure 3. PREDICTION OF COKE STABILITY FACTORS.
– REGRESSION RESULTS FROM CANMET DATA ON WESTERN CANADIAN COALS.

APPENDIX 1

Letter dated May 22, 1982 from R. Sagi,
Chief Geologist, Coal Division, Denison
Mines Limited

DENISON MINES LIMITED
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May 22, 1982

Mr. John G. Jorgensen
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K1A 0G1

Dear John:

Re: Evaluation of Samples of Quintette Coal
from the Babcock Syncline Extension Pit

As you will recall, we discussed the above subject generally to-day during our telephone conversation, when Jack Botham was in my office. In retrospect, the coal now under consideration is a syncline extension of the Babcock Pit. Previous studies by CANMET have dealt with the seams of the Babcock, Sheriff and Frame Pits. Analysis of four drill core samples now indicate a higher ranking for the seams of the syncline extension (i.e. low volatile bituminous as compared to medium volatile bituminous for the other pits).

The purpose of this letter is to request analyses and test work by CANMET on individual seam samples (i.e. D, E, F, G and J) composited from cleaned coal of three drill cores and a composited sample of all seams. The following information is required:

Seam Samples (individual seams)

Number --- 5
Weight --- 0.5 kgm ~~each~~
Req'd --- Petrographic Anaylsis
--- Proximate, Sulphur

Composite Sample

Number --- 1
Weight --- 45 kgm
Req'd --- Proximate, Ultimate, Calorific, Ash Analysis, HGI, FPA Petrography, 30-lb coke oven evaluation (in duplicate)

The above analysis and test results will assist Denison in the overall feasibility study of the Quintette property, and efforts by CANMET to expedite the work will be greatly appreciated.

A map showing the location of the syncline extension in relation to the Babcock Pit and the location of drill core samples is enclosed. Also, preliminary analyses of the seams are attached.

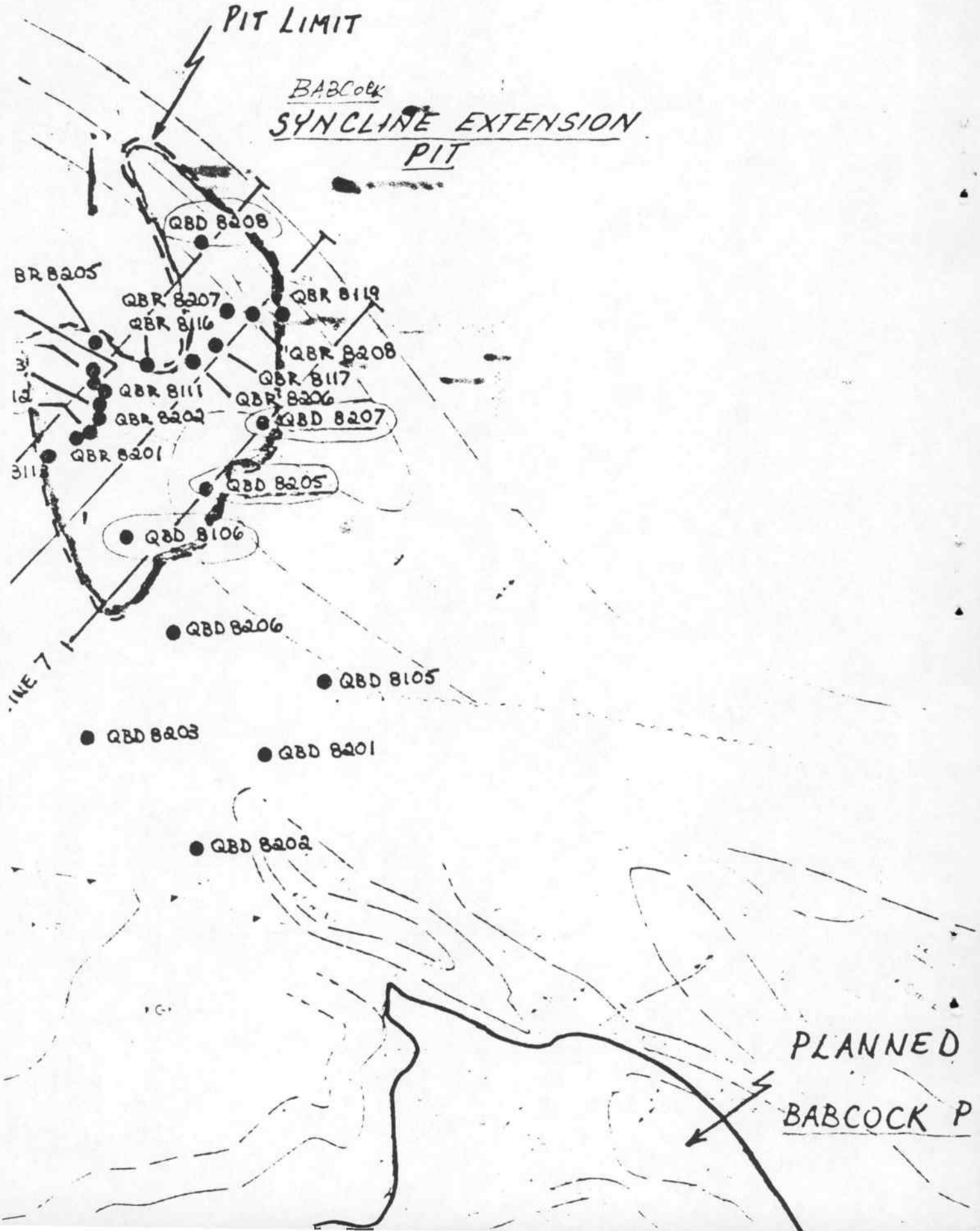
If any further information is necessary to formalize this request, please advise.

Yours truly,

R. S. Sagi

Sample Reference List for Petrographic Analysis

Sample No.	Seam ID	GTL Reference Nos.
1	D	Qc1 + Qc9 + Qc17
2	E	Qc2 + Qc10 + Qc20
3	F	Qc3 + Qc11 + Qc21
4	G	Qc4 + Qc12 + Qc22 Qc23
5	J	Qc5 + Qc14 + 25 6 15 26 13 24


PIT LIMIT
BABCOCK
SYNCLINE EXTENSION
PIT
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BR 8205
QBR 8207
QBR 8119
QBR 8116
QBR 8208
QBR 8117
QBR 8111
QBR 8206
QBR 8202
QBD 8207
QBR 8201
QBD 8205
QBD 8106
QBD 8206
QBD 8105
QBD 8203
QBD 8201
QBD 8202
PLANNED
BABCOCK P