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AN INVESTIGATION OF THE COKING PROPENSITIES OF TWO COAL SAMPLES
FROM THE QUINTETTE PROJECT, NORTH EASTERN BRITISH COLUMBIA,
SUBMITTED BY DENISON MINES LIMITED.

Project 03-5-1/6-20
Job No. 3378R

J.G. JORGENSEN, T.A. LLOYD AND A.B. FUNG
COMBUSTION AND CARBONIZATION RESEARCH
LABORATORIES WESTERN RESEARCH LABORATORY

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by

J.G. Jorgensen*, T.A. Lloyd**, and A.B. Fung***

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 November 17, 1981 from R. Sagi, Chief Geologist, Coal Division, Denison Mines Limited. A copy of this letter appears in Appendix 1.

The two coals which were carbonized are identified as CM 920 and CM 921.

The cleaned coal samples received from Birtley Coal and Mineral Testing, Calgary, were crushed, blended, and carbonized in the 18-inch width Carbolite movable-wall coke oven, located at the Western Research Laboratory at Edmonton. Representative samples were taken for chemical, physical, thermal rheological, and petrographical analyses which were carried out at the Energy Research Laboratories located at the CANMET Bells Corners Complex near Ottawa. The results of the testing program are tabulated in Tables 1 to 6.

*Head, Petrographic Section, **Head, Conventional Coke making Section, Combustion and Carbonization Research Laboratory, Energy Research Laboratories
***Carbonization Engineer, Western Research Laboratory, Coal Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa, Canada.
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TABLE I Petrographic Analyses of Component Coals

| <u>Identification</u> | | |
|---------------------------------------|---------|---------|
| Laboratory Number | 2198-82 | 2199-82 |
| Description | CM 920 | CM 921 |
| <u>Classification</u> | | |
| Rank (ASTM) | mvb | mvb |
| International System | 432 | 432 |
| Specific Volatile Index | 192 | 196 |
| Carbon (dmmfb)% | 92.3 | 91.4 |
| <u>Proximate Analysis (db)</u> | | |
| Ash% | 8.9 | 8.7 |
| Volatile Matter% | 22.3 | 21.7 |
| Fixed Carbon% | 68.8 | 69.6 |
| <u>Gross Calorific Value (db)</u> | | |
| Btu per pound | 14080 | 14160 |
| <u>Ultimate Analysis (db)</u> | | |
| Carbon% | 83.3 | 82.6 |
| Hydrogen% | 4.8 | 4.6 |
| Sulphur% | 0.41 | 0.33 |
| Nitrogen% | 0.8 | 0.7 |
| Ash% | 8.9 | 8.7 |
| Oxygen (by difference)% | 1.8 | 3.1 |
| <u>Ash Analysis (db)</u> | | |
| SiO ₂% | 63.0 | 59.0 |
| Al ₂ O ₃% | 24.2 | 21.0 |
| Fe ₂ O ₃% | 4.4 | 6.9 |
| TiO ₂% | 1.4 | 1.4 |
| P ₂ O ₅% | 0.4 | 1.6 |
| CaO% | 1.2 | 3.6 |
| MgO% | 0.7 | 1.2 |
| SO ₃% | 0.9 | 2.5 |
| Na ₂ O% | 0.6 | 0.5 |
| K ₂ O% | 1.3 | 0.6 |

TABLE 2 Physical Tests and Fusibility of Ash of Component Coals

| <u>Identification</u> | | | | |
|-------------------------------|---------|--------------------|---------|---------|
| Laboratory Number | | | 2198-82 | 2199-82 |
| Description | | | CM 920 | CM 921 |
| <u>Coal Pulverization</u> | | | | |
| Sieve Analysis | | | | |
| <u>Passing</u> | | <u>Retained On</u> | | |
| | 1/4 in. | 1/4 in. | % | |
| | 6 mesh | 6 mesh | % | |
| | 12 mesh | 12 mesh | % | |
| | 20 mesh | 20 mesh | % | |
| | | | % | |
| Total Passing | 6 mesh | % | | |
| | | | 82.1 | 85.5 |
| <u>Grindability</u> | | | | |
| Hardgrove Index | | | 72 | 76 |
| <u>Fusibility of Ash</u> | | | | |
| Initial Deformation Temp. ... | °F | | 2700+ | 2170 |
| Softening Temp. Spherical ... | °F | | 2700+ | 2465 |
| Softening Temp. Hemispherical | °F | | 2700+ | 2550 |
| Fluid Temp. | °F | | 2700+ | 2620 |

TABLE 3 Thermal Rheological Properties of Component Coals

| <u>Identification</u> | | |
|--|--------------------|---------|
| Laboratory Number | 2198-82 | 2199-82 |
| Description | CM 920 | CM 921 |
| | | |
| <u>Linear Expansion</u> | | |
| Bd. 52 lb/ft ³ at 2% moisture...% | | |
| | | |
| <u>Gieseler Plasticity</u> | | |
| Start | ^o C 433 | 433 |
| Fusion Temp. | ^o C 451 | 449 |
| Max. Fluid Temp. | ^o C 463 | 465 |
| Final Fluid Temp. | ^o C 478 | 485 |
| Solidification Temp. | ^o C 485 | 489 |
| Melting Range | ^o C 45 | 52 |
| Max. Fluidity | dd/m 11.3 | 34.5 |
| Torque | g.in. 40 | 40 |
| | | |
| <u>Dilatation</u> | | |
| Ti - Softening Temp. | ^o C 402 | 404 |
| Tii - Max. Contraction Temp. | ^o C 456 | 458 |
| Tiii - Max. Dilatation Temp. | ^o C 477 | 479 |
| Contraction | % 23 | 23 |
| Dilatation | % -12 | -10 |
| | | |
| <u>Free Swelling Index</u> | | |
| F.S.I. | 7 | 7 |

TABLE 4 Petrographic Analysis of Component Coals

| <u>Identification</u> | | |
|--|---------|---------|
| Laboratory Number..... | 2198-82 | 2199-82 |
| Description..... | CM920 | CM921 |
| <u>Distribution of Vitrinite Types</u> | | |
| V-6.....% | | |
| V-7.....% | | |
| V-8.....% | | |
| V-9.....% | 0.6 | 0.5 |
| V-10.....% | 12.3 | 2.3 |
| V-11.....% | 29.7 | 22.1 |
| V-12.....% | 13.4 | 21.2 |
| V-13.....% | | |
| V-14.....% | | |
| V-15.....% | | |
| V-16.....% | | |
| V-17.....% | | |
| V-18.....% | | |
| <u>Reactive Components</u> | | |
| Total Vitrinite.....% | 56.0 | 46.1 |
| Reactive Semi-fusinite (1/2)....% | 14.6 | 20.0 |
| Exinite.....% | 0.4 | 0.2 |
| Total.....% | 71.0 | 66.3 |
| <u>Inert Components</u> | | |
| Inert Semi-fusinite (1/2).....% | 14.6 | 20.0 |
| Micrinite.....% | 5.3 | 5.0 |
| Fusinite.....% | 4.2 | 3.8 |
| Mineral Matter.....% | 4.9 | 4.9 |
| Total.....% | 29.0 | 33.7 |
| <u>Petrographic Indices</u> | | |
| Mean Reflectance.....% | 1.15 | 1.18 |
| Balance Index..... | 1.32 | 1.78 |
| Strength Index..... | 4.39 | 4.46 |
| Stability Index..... | 56.6 | 51.5 |

TABLE 5- Carbonization Conditions

| | | |
|---------------------------------|-------------------|-------------------|
| Test Identification Number..... | C-121 | C-122 |
| Date of Test..... | Dec.10/81 | Dec.15/81 |
| Coke Oven Identification..... | | |
| Description..... | Denison CM 920 | Denison CM 921 |

CHARGE PROPERTIES

| | | |
|-----------------------------------|------|------|
| Proximate Analysis (db) Ash.....% | 8.9 | 8.7 |
| Volatile Matter.....% | 22.3 | 21.7 |
| Fixed Carbon.....% | 68.8 | 69.6 |
| Moisture in Charge.....% | 2.8 | 2.3 |
| Minus 1/8 in. (6 mesh).....% | 82.1 | 85.5 |
| Other:..... | | |
| | | |

CARBONIZATION CONDITIONS

| | | |
|--|-------|-------|
| Net Weight of Charge (wet).....lb | 653.7 | 668.1 |
| ASTM Cone Bulk Density (wet).....lb/ft ³ | 48.9 | 49.3 |
| Calc. Charge Dry Bulk Density in Oven...lb/ft ³ | 51.2 | 51.9 |
| Flue Temp Control..... | | |
| Charge Push (Centre Temp:Soak Time).....°C:hr | 950:3 | 950:3 |
| Quenched Coke Conditioning Drop.....ft | 10 | 10 |

CARBONIZATION RESULTS

| | | |
|--|-------|-------|
| Gross Coking Time (at Push).....hr:min | 18:17 | 18:29 |
| Final Centre Temp.....°C | 1044 | 1056 |
| Time to 900°C Centre Temp.....hr:min | 14:52 | 14:52 |
| Time to 950°C Centre Temp.....hr:min | 15:17 | 15:29 |
| Time to 1000°C Centre Temp.....hr:min | 16:12 | 16:21 |
| Maximum Wall Pressure.....lb/in ² | 0.53 | 0.36 |
| Coke Yield Actual.....% | 76.1 | 78.1 |

TABLE 6 - Coke Properties

| Test Identification Number..... | C-121 | C-122 |
|--|-------|-------|
| <u>SCREEN ANALYSIS OF COKE</u> | | |
| (cum % retained on) | | |
| 4 inch sieve..... | 1.1 | 3.2 |
| 3 inch sieve..... | 14.8 | 16.0 |
| 2 inch sieve..... | 63.6 | 61.3 |
| 1½ inch sieve..... | 85.2 | 83.0 |
| 1 inch sieve..... | 94.5 | 94.6 |
| ¾ inch sieve..... | 95.6 | 95.9 |
| ½ inch sieve..... | 96.3 | 96.7 |
| Percentage -½ inch (breeze)..... | 3.7 | 3.3 |
| Mean Coke Size.....in. | 2.27 | 2.27 |
| <u>COKE CHEMICAL ANALYSIS</u> | | |
| Proximate Analysis (db) | | |
| Ash.....% | 11.3 | 11.1 |
| Volatile Matter.....% | 0.8 | 1.0 |
| Fixed Carbon.....% | 87.9 | 87.9 |
| Sulphur (db).....% | 0.37 | 0.32 |
| <u>COKE APPARENT SPECIFIC GRAVITY.....</u> | 0.98 | 1.01 |
| <u>ASTM COKE TUMBLER TEST</u> | | |
| Stability Factor.(cum % + 1 in.)..... | 55.9 | 57.1 |
| Hardness Factor.(cum % + 1/4 in.)..... | 66.2 | 68.9 |
| <u>JIS COKE TUMBLE TEST</u> | | |
| (cum % retained on) | | |
| 30 revs: 50 mm sieve..... | 18.9 | 10.7 |
| 25 mm sieve..... | 88.7 | 86.8 |
| 15 mm sieve..... | 93.5 | 92.6 |
| 150 revs: 50 mm sieve..... | 4.6 | 5.3 |
| 25 mm sieve..... | 71.6 | 70.4 |
| 15 mm sieve..... | 79.7 | 81.3 |

OTHER

STRENGTH INDEX

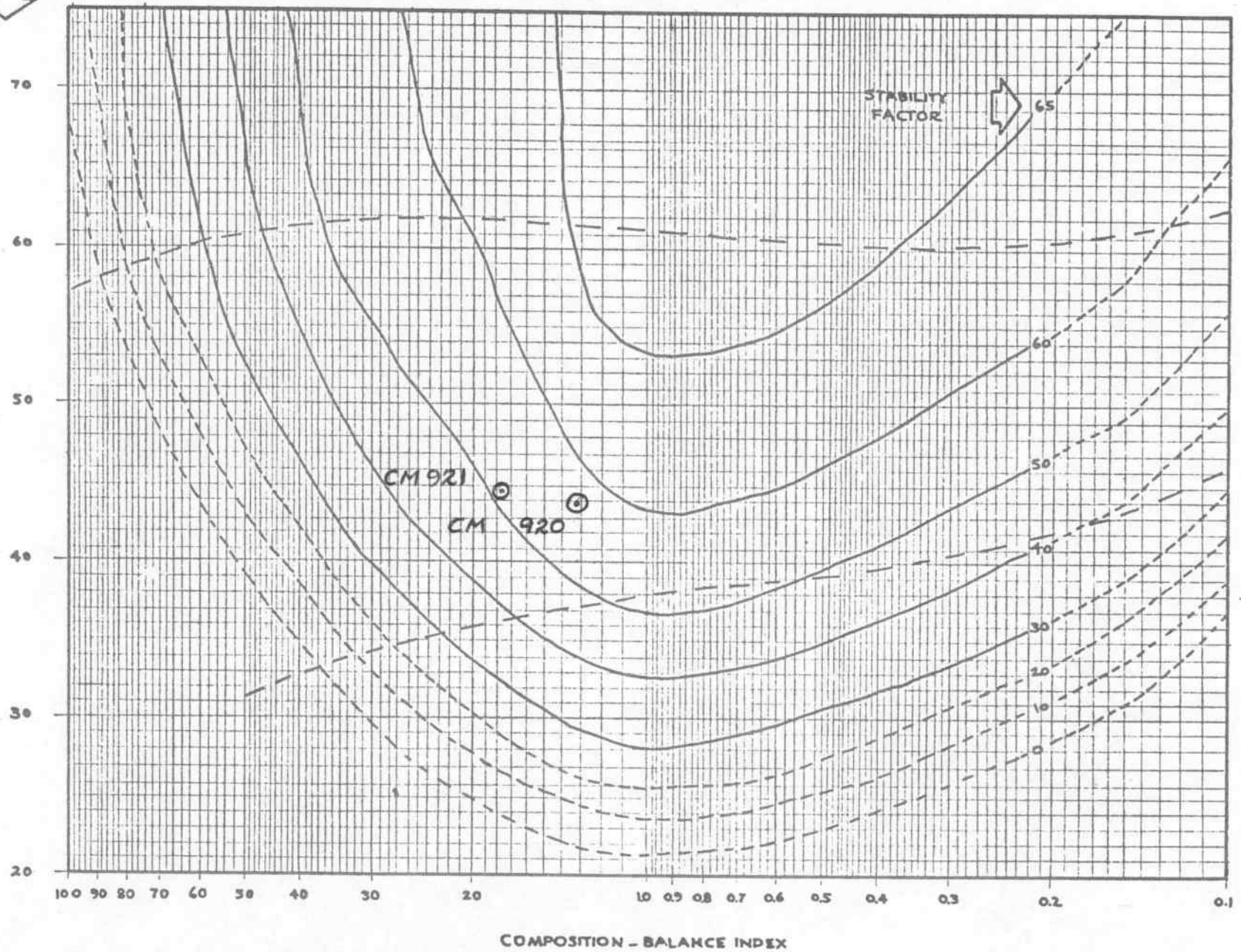
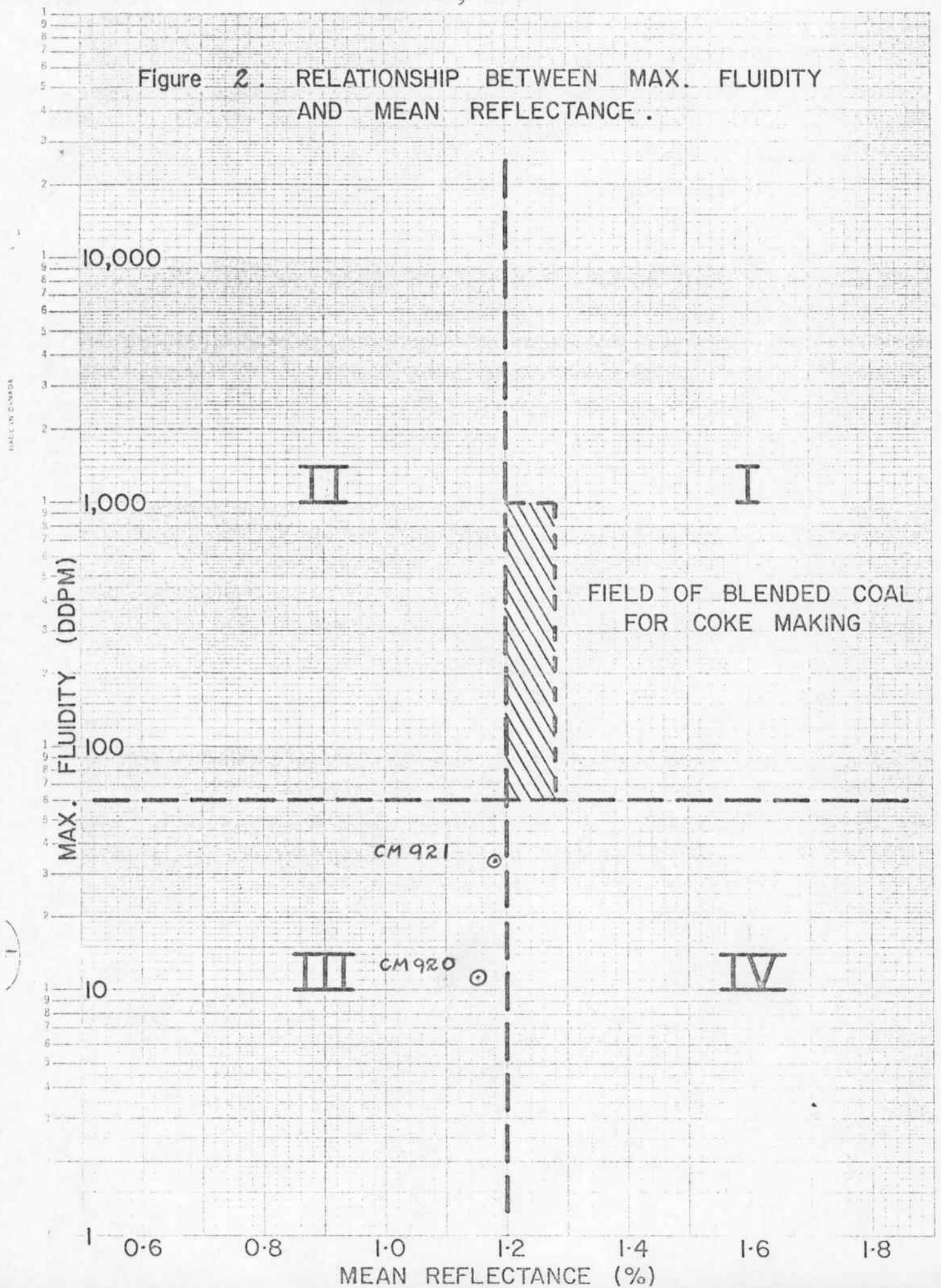


Figure 1. Plot of Stability Factors from Petrographic Data of Component Coals.

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



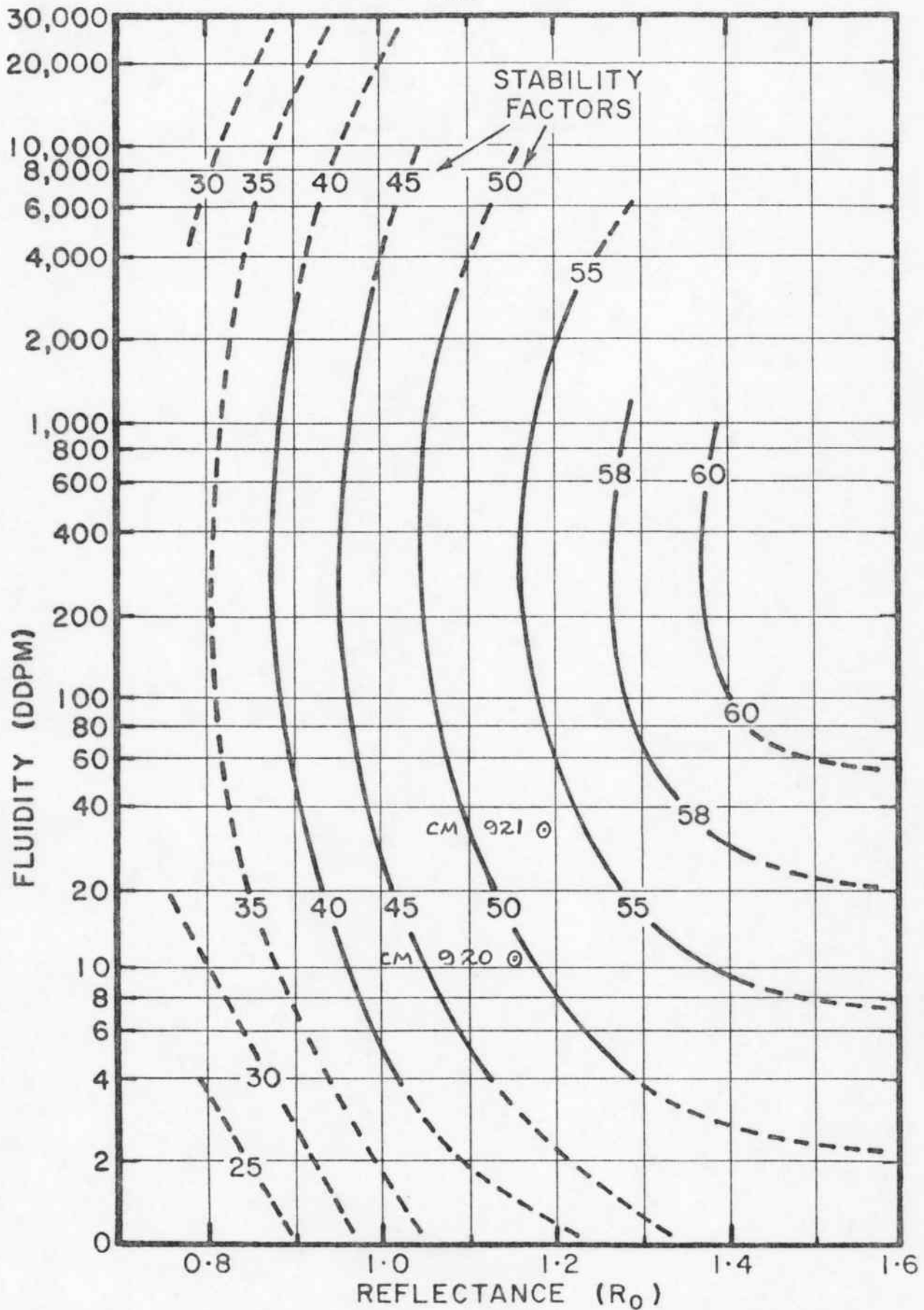


Figure 3. PREDICTION OF COKE STABILITY FACTORS.

- REGRESSION RESULTS FROM CANMET DATA ON WESTERN CANADIAN COALS.

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APPENDIX 1

Letter dated November 17, 1981 from Mr. R. Sagi, Chief Geologist,
Coal Division, Denison Mines Limited.

DENISON MINES LIMITED
COAL DIVISION

P.O. BOX 11575
850 WEST GEORGIA STREET
VANCOUVER, B.C. CANADA V6B 4N7
TEL. (604) 669-2226
TELEX 04-51547



November 17, 1981

Miss J.L. Picard
Western Research Laboratory
Room 27, Alberta Research Council Bldg.
11315 - 87th Avenue
Edmonton, Alberta
T6C 2C2

Dear Miss Picard:

RE: QUINTETTE PROJECT - COKE TESTS

We have recently completed a field program on our Quintette Property (see attached for location) to obtain two bulk samples from the Frame deposit.


These bulk samples are being washed to the product ash level at Birtley Coal & Minerals Testing Laboratories In Calgary. We would expect the clean coal samples to be available in the next two weeks.

We wish to request three to four moveable wall coke oven tests, together with complete laboratory scale testing of these samples.

We appreciate your cooperation in handling these tests.

Yours truly,

DENISON MINES LIMITED


R. Sagi
Chief Geologist
Coal Division

RS:smc
attachment
cc: Dr. B.I. Parsons, CANMET ✓
J. Jorgenson, CANMET

