PETROLOGY, SEDIMENTOLOGY AND GEOCHEMISTRY OF GATES FORMATION COALS, NORTHEASTERN B.C.: PRELIMINARY RESULTS (93P/3, 4; 93I/13, 14)

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INTRODUCTION

In northeastern British Columbia, economic coal deposits are found within the lower Albian Gates Formation; the coals are currently being mined at the Bullmoose (Teck Corporation) and Quintette (Quintette Coal Ltd.) operations. The preliminary results of a petrological, sedimentological and geochemical study of coal samples collected from the two mines, as well as outcrop and Deep Basin drill core are described in this report.

The study was undertaken in order to: (1) document the lateral and stratigraphic variation in the organic (maceral, microlithotype and lithotype) and inorganic (trace and minor elements) facies of the coals and associated strata in the Foothills of northeastern British Columbia; and (2) to determine the factors which control the variation. The sample base consists of coal and associated strata collected from outcrop, road and mine cuts, petroleum and coal exploration drill cores and well cuttings. The primary purpose of this study is to develop a methodology for predicting variations in coal quality within a mine more accurately. Fieldwork, including sample collection and analysis, began during the summer of 1988.

SITE LOCATION AND GEOLOGY

The study area is in northeastern British Columbia in the Rocky Mountain Foothills and Great Plains between 54°45′ and 55°30′ north latitude, and 120°15′ and 121°30′ west longitude (Figure 4-6-1). The regional geology was described by Stott (1968, 1982). Leckie (1983) and Carmichael (1983) studied the regional sedimentology of the Gates Formation. Lower Cretaceous strata consist of a series of transgressive-regressive clastic wedges deposited in response to periodic uplift of the Cordillera (Smith *et al.*, 1984). The Moosebar (marine) and Gates (nonmarine and nearshore marine) formations and their subsurface equivalents, the Wilrich, Falher and Notikewin members of the Spirit River Formation (Figure 4-6-1), form one of the transgressive-regressive sedimentary packages. Moosebar sediments were deposited as the Boreal sea advanced southward to the vicinity of Elbow River, Alberta (McLean, 1982). Renewed uplift and erosion in the Cordillera supplied the Gates Formation sediment which prograded northward over the Moosebar sediments. The progradation was not uniform; Leckie (1986) recorded seven individual coarsening-upward regressive cycles within the Moosebar-Gates interval.

The Gates Formation outcrops in the Foothills from north of the study area at the "Gates" of the Peace River near Hudson Hope, British Columbia, southeastward across the Alberta border in the vicinity of Grande Cache (Stott, 1982). The northern limit of economic coal deposits in the Gates Formation is in the vicinity of the Bullmoose mine leases. North of the Bullmoose mine, the sediments consist primarily of marine shelf sediments (Stott, 1982; Leckie and Walker, 1982) while within the study area there is extensive intertonguing of marine and nonmarine facies.

No formal subdivision of the Gates Formation has been widely accepted. Informally three major subdivisions (Figure 4-6-2) are made (Rance, 1985; Leckie, 1986; Carmichael, 1988): Torrens member, middle Gates and upper Gates. Carmichael (1988), correlated the Torrens member with the Falher cycle "F", the middle Gates with Falher cycles "E" through "A" and the upper Gates with the Notikewin member of the Spirit River Formation (subsurface terminology). The coal seams currently being mined at Bullmoose and Quintette are found within the middle Gates. Thinner (noneconomic) seams are found within the upper Gates.

No correlation of the seams between Bullmoose and Quintette has been published. Nine coal seams are recognized on the Quintette property (Rance, 1985); from youngest to oldest, the seams are referred to as A, B, C, D, E, F, G/I, J and K. Seams A, B and C are found within the upper Gates. Five seams of economic thickness are present at Bullmoose (Drozd, 1985); the seams are designated, from oldest to youngest, A, B, C, D and E. Upper Gates coals are present at Bullmoose, but are not named. Details of the pit geology and mining methods, as well as gross chemical and compositional characteristics of the seams at both mines may be found in Rance (1985) and Drozd (1985).

COAL DEPOSITIONAL ENVIRONMENTS

The Gates Formation is inferred to represent a wave and tide-dominated linear clastic shoreline (Leckie and Walker, 1982). The Lower Cretaceous coastlines in this area are believed to have been characterized by arcuate wave-dominated deltas and associated strandplains (Kalkreuth and Leckie, in preparation). Thick, laterally extensive peat (coal) deposits accumulated on a delta plain shoreward of thick (15 to 35 metres), regionally extensive sheets of shoreface sand and gravel (traceable along strike for about 230 kilometres).

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1988, Paper 1989-1.

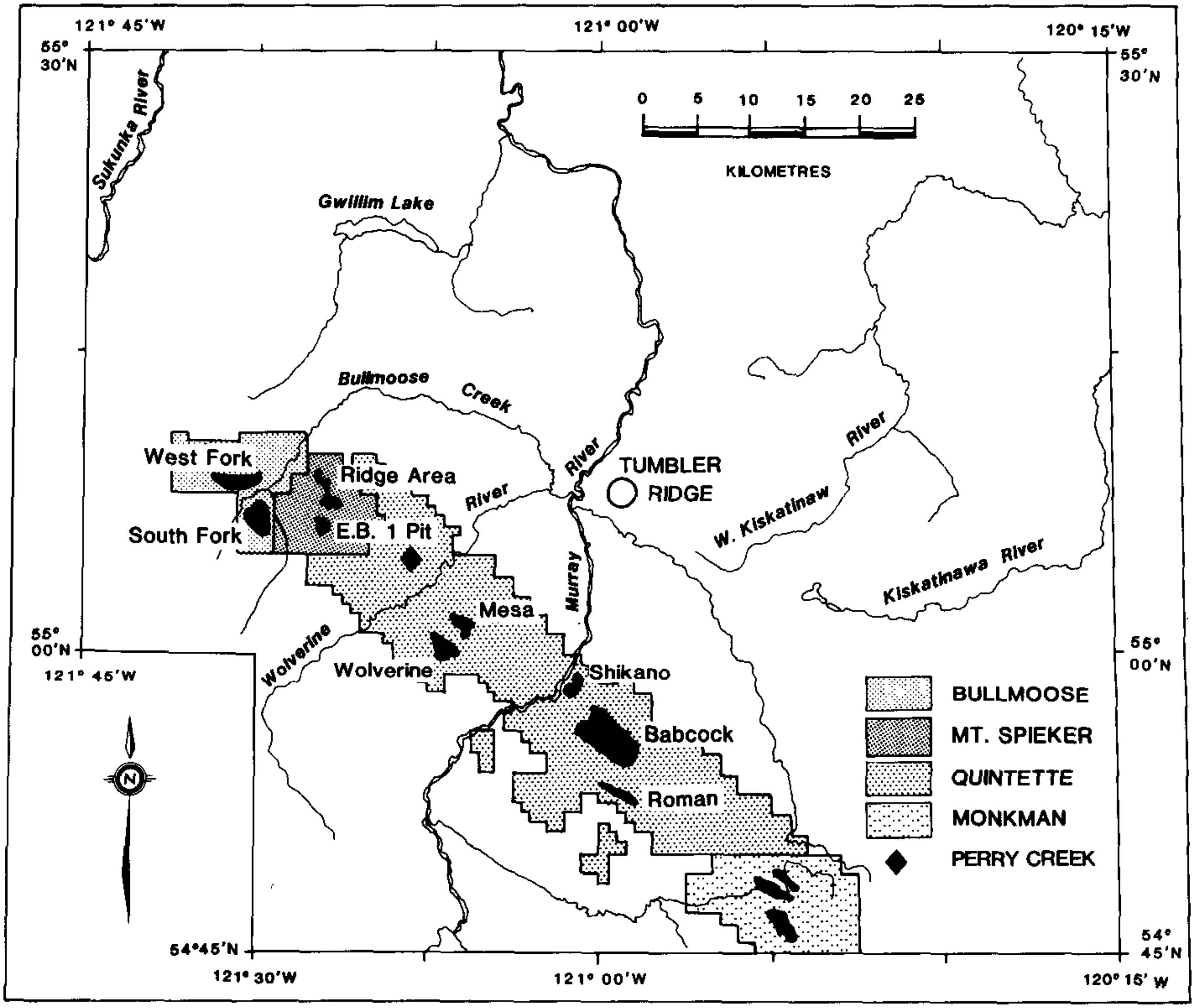

Figure 4-6-1. Location map of study area. Shaded areas indicate major coal leases. Diamond indicates location of outcrop sample of J seam on Perry Creek road. Named areas are current production sites or areas of proposed development. Modified from Matheson (1986).

METHODS

During June, July and August of 1988, 16 whole-seam samples, 50 coal grab samples (from core) and representative coal and carbonaceous rock fragments in the cuttings of 20 Deep Basin petroleum wells were collected. Approximately 1300 samples of strata associated with the coal were taken from outcrop and core. In addition, a number of plant fossils were collected in order to assess plant assemblages present in the original wetland environments during Gates time.

Fresh samples of coal were extracted from the Bullmoose and Quintette (Wolverine and Shikano pits) mines. An attempt was made to collect whole-seam bench samples from within the mine pits. However, where the seam was either too sheared or too fractured to collect blocks, the seams were described using the lithotype terminology explained below and whole-seam channel samples were taken. Bench samples of seams A1 (two sites), A2, C, D, and E at Bullmoose, and the E2 and E3 seams at Quintette (Wolverine pit) were collected. Lithotypes were described and channel samples were taken of seams K2, E1, E2, E3, D, C, B and A from Quintette (Shikano pit) in conjunction with W. Kalkreuth of the Geological Survey of Canada. A channel sample of the Quintette J seam was collected from an outcrop on the Perry Creek road between Mount Spieker and the Wolverine River.

Coal lithotypes (layers of different brightness or texture within the coal seam) were described using a modified version of the Australian classification scheme (Diessel, 1965; Marchioni, 1980). Seven lithotypes were distinguished: bright, banded bright, banded coal, banded dull, dull, fibrous and sheared (Table 4-6-1). A minimum band thickness of 1 centimetre was used in defining lithotypes. Mineral partings in the seam were noted. The seven lithotypes are illustrated in Plate 4-6-1.

TABLE 4-6-1
LITHOTYPE CLASSIFICATION SCHEME
(modified from Diessel, 1965 and Marchioni, 1980)

BRIGHT	subvitreous to vitreous lustre, conchoidal fracture, less than 10% dull coal laminae
BANDED BRIGHT	predominately bright coal with 10-40% dull laminae
BANDED COAL	interbedded dull and bright coal in approximately equal proportions
BANDED DULL	dull coal with approximately 10-40% bright laminae
DULL	matte lustre, uneven fracture, less than 10% bright coal laminae, hard
FIBROUS	satin lustre, very friable, sooty to touch
SHEARED COAL	variable lustre, disturbed bedding, numerous slip/ slickenside surfaces, very brittle

RESULTS

Lithotype descriptions of Bullmoose seams A1 (two locations), C, D and E are graphically illustrated in Figure 4-6-3. Other bench samples are currently being analyzed. Banded lithotypes predominate in the seams studied; no fibrous coal was noted in any of the seams. Fibrous material (fusain in Stopes-Heerlan terminology) is present however, as scattered fragments and very thin laminae. There is no consistent pattern of repetition of the lithotypes and additional analysis and sample collection is necessary before any conclusions concerning depositional environment or compositional variation can be drawn.

FUTURE RESEARCH

Currently, the bench and spot coal samples are being processed for further analysis. The bench samples will be split. Half of the sample will be kept intact, polished and microlithotypes described. The other half will be analyzed by lithotype for petrographic composition. In addition, the samples will be analyzed by Rock-Eval pyrolysis. The spot samples will be analyzed for petrographic composition, as well as Rock-Eval pyrolysis.

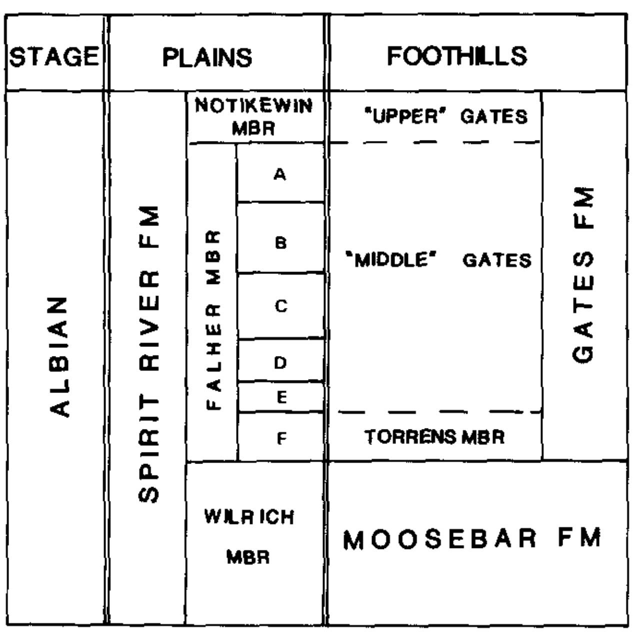

Figure 4-6-2. Stratigraphic chart of Lower Cretaceous formations in northeastern British Columbia. Modified from Leckie (1986) and Carmichael (1988).

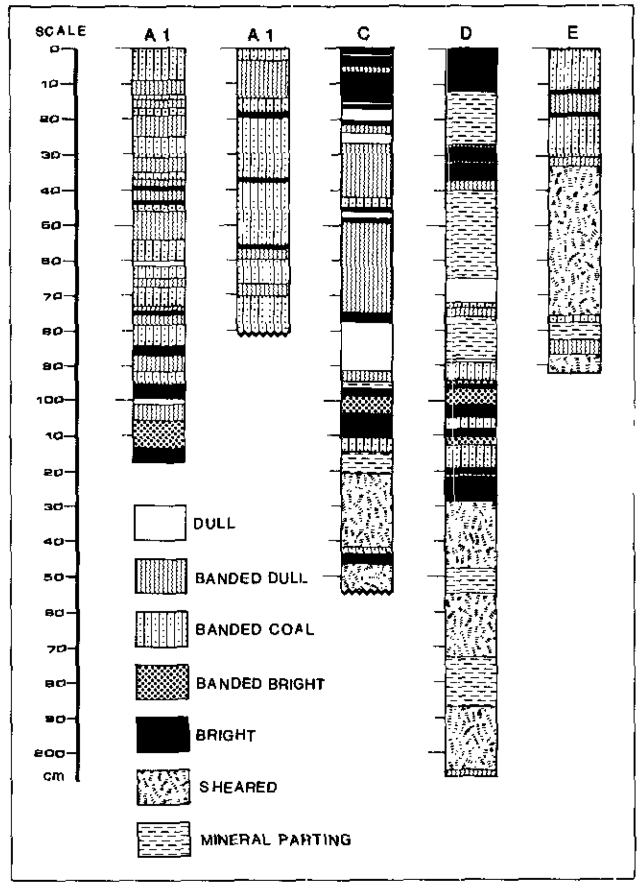

Figure 4-6-3. Lithotype columns for selected bench seam samples collected during 1988 from Bullmoose mine. Seam designation at top of column.

In order to properly evaluate compositional variation in terms of organic depositional environment, it will be necessary to collect additional bench samples. Future fieldwork will concentrate on obtaining at least two more bench samples of each of the coal seams at Bullmoose mine which are less tectonically deformed than those at Quintette.

Laboratory research will focus on characterizing the coal lithotypes in terms of maceral composition and major and trace element geochemistry. The variation in type and quantity of organic matter in the lithofacies associated with the coals will be investigated. The rock samples will be analyzed in terms of the same parameters as the coal samples and organic facies delineated. In order to further aid in understanding the depositional environments, fossil plant assemblages will be determined.

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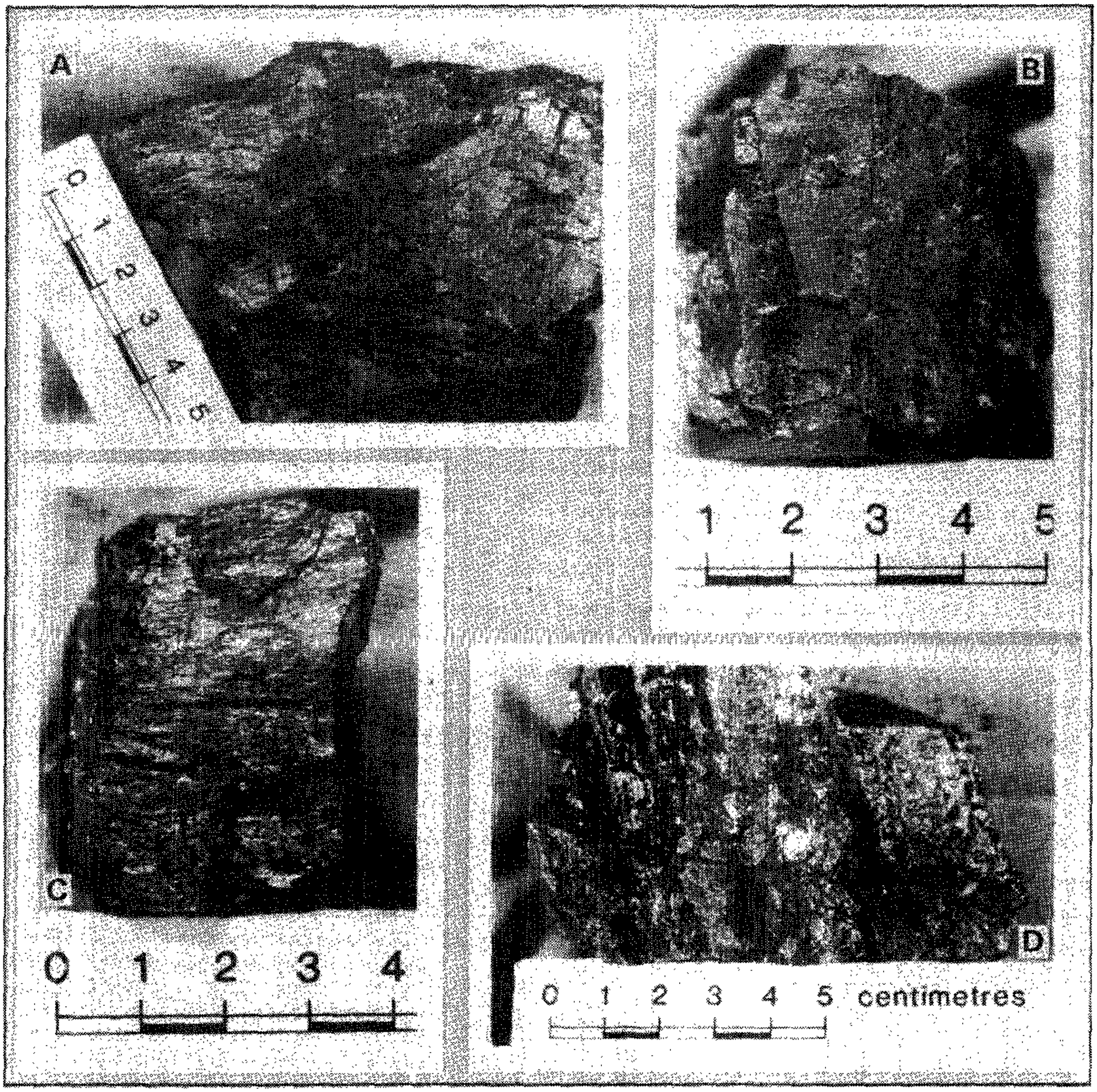


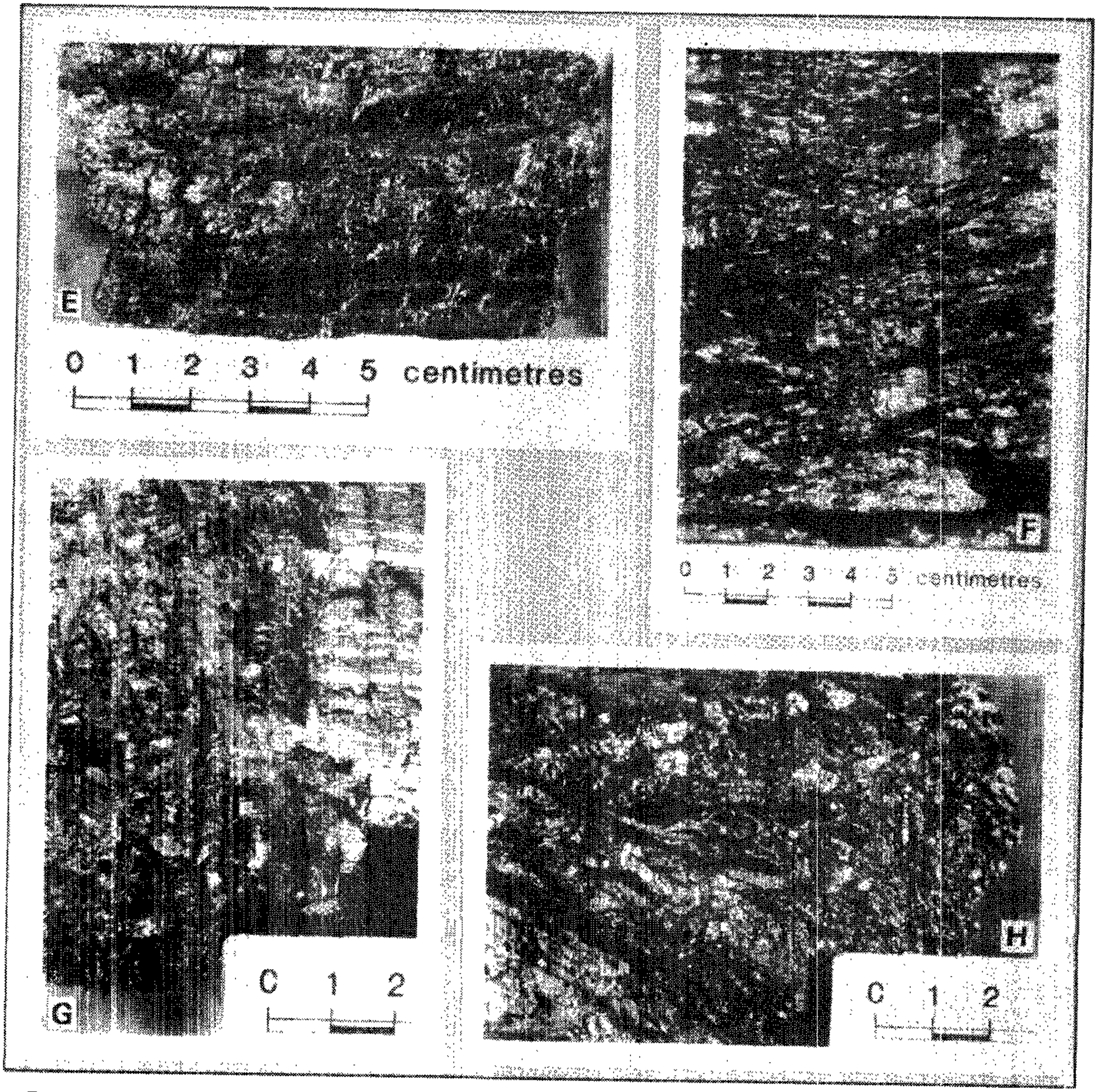
Plate 4-6-1. Examples of coal lithotypes.

A. FIBROUS COAL — bedding plane surface. Note charcoal-like appearance. Friable, sooty to touch. E seam, Shikano pit, Quintette mine.

B. DULL COAL — <10% bright coal. Note dull, grey, matte appearance. Bright streak in photograph is <1 cm thick. E seam, Shikano pit, Quintette mine.

C. BANDED DULL — 10-40% bright coal. Bright material appears as black streaks in coal. Grey background material with waxy lustre is dull coal matrix. D seam, Bullmoose mine.

D. BANDED COAL — approximately 50% dull, 50% bright layers. Bright coal appears black with glassy lustre, conchoidal fracture. D seam, Bullmoose mine.



E. BRIGHT COAL — 10-40% dull coal. Thick bright layers with thin streaks of dull coal. E seam, Shikano Pit, Quintette mine.

F. BRIGHT COAL — <10% dull coal. Note glassy lustre, black color, conchoidal fracture. Material is quite brittle. D seam, Bullmoose mine.

G,H. SHEARED COAL — Two examples of sheared coal. Note random orientation of layers, slickenside surfaces. Material is quite friable, falls apart easily to touch. D seam, Bullmoose mine.

tion and access to areas within the mines. Mr. Murray Gant and Mr. John Whittles provided excellent assistance in the field and are gratefully acknowledged. Support for this project was in part provided by the British Columbia Ministry of Energy, Mines and Petroleum Resources.

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