~~[illegible] COAL FIELDS~~

BULKLEY COAL STUDY

G. OBKERT (B.P.)

INCLUDES PARTS OF
93M, 103 P, 103 I, 93 L

FILE 93 M ~~[illegible]~~ ?

JULY 1979 B

00806

# BULKLEY COAL STUDY AREA

## I. Introduction

Commencing on June 4, 1979 a geologic reconnaissance of an area within approximately 50 km of the railline from Smithers to Terrace, on west-central B.C., was undertaken by BP (for defined area see Vee Zay Smith Regional Location Map - Figure 1). The program was helicopter and truck based and operated out of Smithers for approximately half of the program duration and Terrace for the remaining portion. Work consisted of daily flying in search of coal occurrences, and in order to view stratigraphy and plot structural settings. Traverses were run in prospective areas in order to understand local stratigraphy and establish the presence or absence of coal. The program was staffed by G. Ockert (Project Geologist); R. Adamowicz and K. McCandlish (Senior Geologists); and S. Carr and D. Laing (Junior Geologists). The project was completed on July 19, 1979.

## 2. Background and Preparation

The southeastern portion of the study area was viewed in part by BP in 1978: the Morice River, Zymoetz, Telkwa (Bulkley Mine area), and Nanika Mountain area (see TR 20-C, Bulkley River Coalfields). It was therefore known, prior to the 1979 field project, that the stratigraphy of at least portions of the area was extremely complex and poorly understood (the bibliographic material suggests confusion).

The association of coal-bearing Jurassic-Cretaceous units with volcanic assemblages and post-Cretaceous intrusive activity leads to this complexity.

Northern portions of the study area (V.Zay Smith sheets 2 and 3) were at best only generally mapped by previous workers and in the case of parts of sheet 3, completely unmapped. The probability of coal occurrences in more favourable structural environments, than those of the southeastern portion of the study area, seemed likely from what meagre information was available on the area.

Prior to program commencement, a photo interpretation study was contracted to V.Zay Smith Associates Ltd. The geologic report and maps accompanying this report are the program results.

3. BP Fieldwork

A discussion of general geology of the area would be redundant in light of the summation by V.Zay Smith in the accompanying report and previous discussion (TR20-C). The coal-bearing units, Bowser Group and Skeena Group, are difficult to distinguish in photo-interpretation and at the field level (due to structural confusion, repetition of lithologies, and the general lack of fossil evidence). The Bowser Group concentrates in the western and northwestern portions of the area (sheets 3 and 4) while the Skeena Group is more centrally located.

Despite good exposure, particularly at higher elevations, few coal outcrops, other than those reported in published data, were discovered (see section 4 of this report). A number of carbonaceous mudstone and shale units were seen in Skeena Group strata as well as a few thin coal seams (outside of reported seams). Graphitic shale was seen within the Sheet 4 area (associated with nearby intrusives).

Locations of traverses, and the general area of investigation, are illustrated on 1:50,000 scale maps (too bulky to accompany this report).

4. Coal Occurrences

1) Goathorn Creek - The Bulkely Valley Colliery is located along the west bank of Goathorn Creek. The Gething family has optioned their holdings including the colliery to Cyprus Anvil Ltd. (see TR-20-C for stratigraphy).

2) Telkwa River - On the north bank of the river near the junction of Pine Creek old adit workings and outcrop indicate coal occurrences. A large exposure along the river evidences at least 3 coal zones, 2 of which are indicated on the accompanying lithology logs. There is some structural confusion at the outcrop site (normal faulting) and generally within downstream of the area (see accompanying figures).

   Canex Aerial Exploration Ltd. held ground to the north of the area (1969?), (B.C. Open File TK-69(1)A, 69(2)A, 69(3)A - all filed in Coal Library).

Canex drilled some 9 rotary holes, the results of which are indicated in the open file reports.

BP applied for licences in Lots 237, 230, and 221 (September 1979). The area was viewed briefly in July 1979, and outcrop location GO-3 requires a complete section description within the footwall of a large normal fault dissecting the exposure; a coal zone at the top of this section was not reached due to steep ground (a rope should be employed).

Outcrop GO-4, immediately downstream from GO-3 represents an old adit site. A 1.15 m seam was viewed and sampled. Exposure up a creek south of Lot 230 evidences some structural variation; only minor coal was seen. However, small normal faults, a small thrust and igneous dike invasions were viewed in the predominantly clastic strata (RA-44C, 44D).

RA-44E is a river level exposure downstream from GO-4. Coals to 1 m are interbedded with mudstone/shale units.

3) <u>Coal Creek (Zymoetz)</u>

This area is discussed in TR 20-C. No further area adjacent to the holdings of Shell Resources is worth acquisition; the coal-bearing area is quite clearly defined by their licences.

4) <u>Little Cedar River (north of Terrace - Sheet 4)</u>

About 0.6 km north of the bridge that crosses the Little Cedar River is approximately 1.5 m of close to vertically dipping graphite/highly carbonaceous shale. This occurrence is believed to be related to citings in early literature of anthracite coal in the immediate vicinity of Cedar River and Little Cedar River.

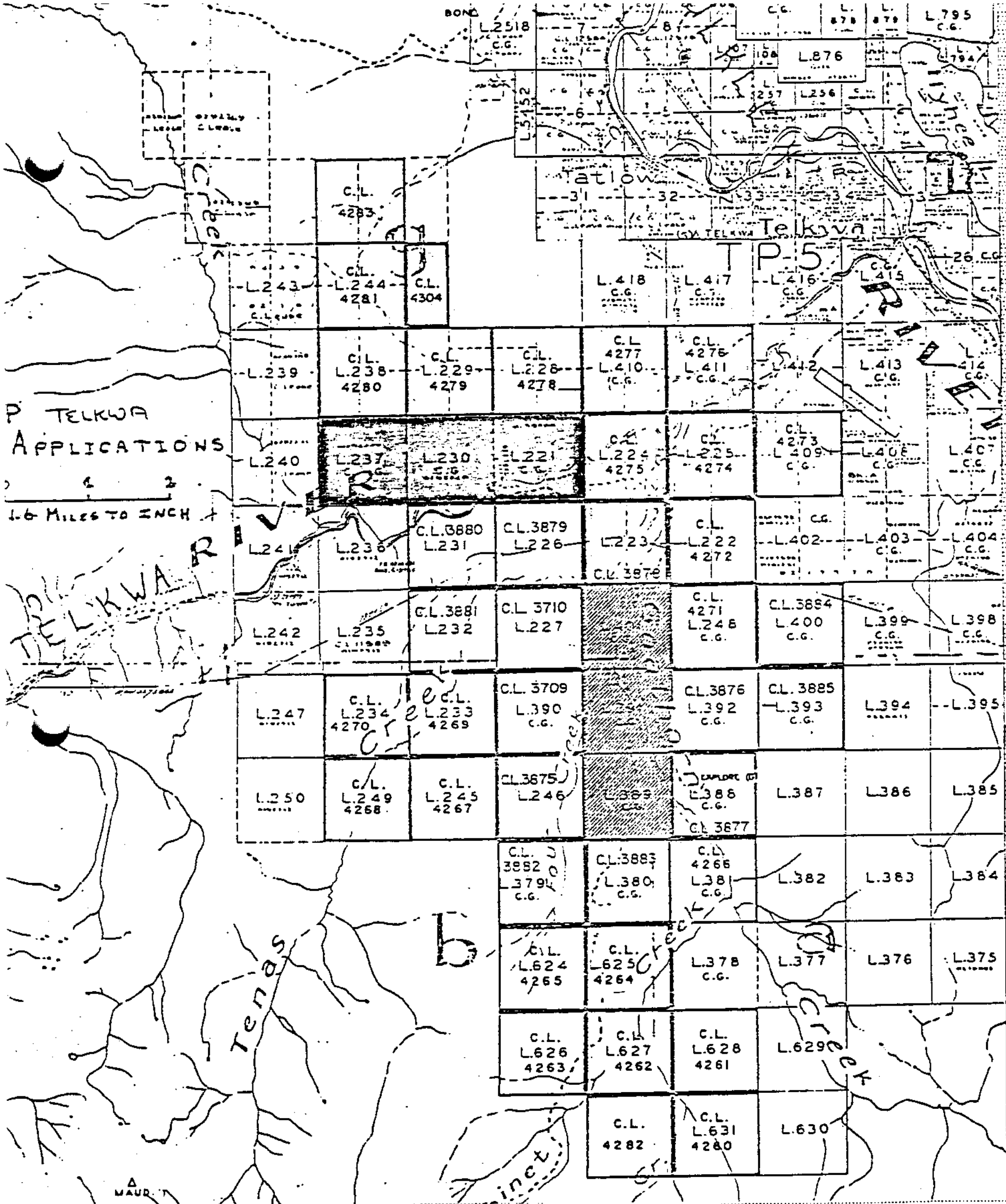
5) Skeena Crossing

Thin coals are observed in outcrop in the Skeena River and along the Highway at the east edge of the Kitsuguecla Reserve west of Hazelton. Strata is believed to be Skeena Group.

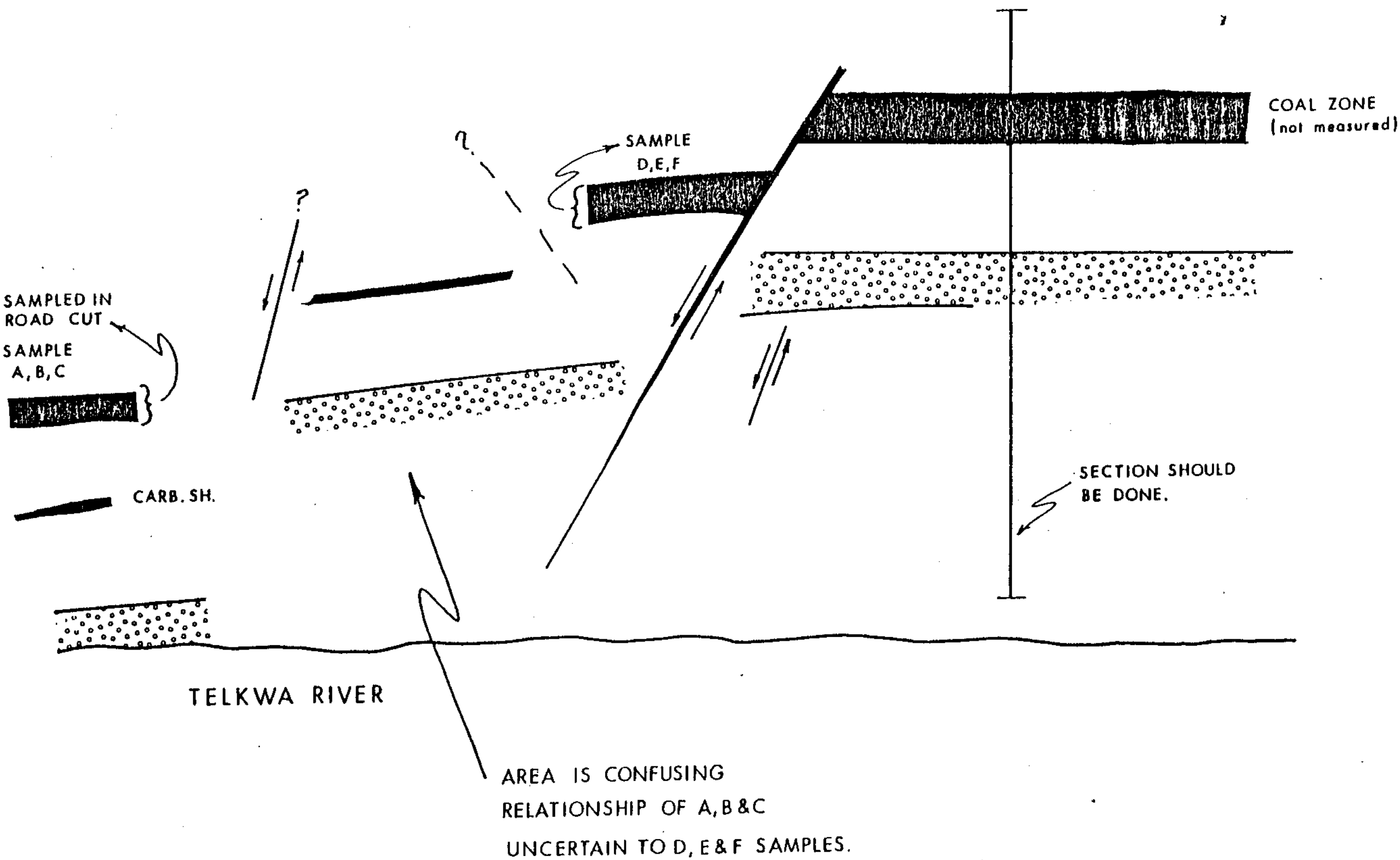
## Conclusions

The designated study area was completely investigated during the 1979 field season. The only coal of interest is found along the Telkwa River between the mouths of Goathorn Creek and Pine Creek. This area has licence application by BP (777 ha applied for in August 1979).

G. Ockert
September 17, 1979

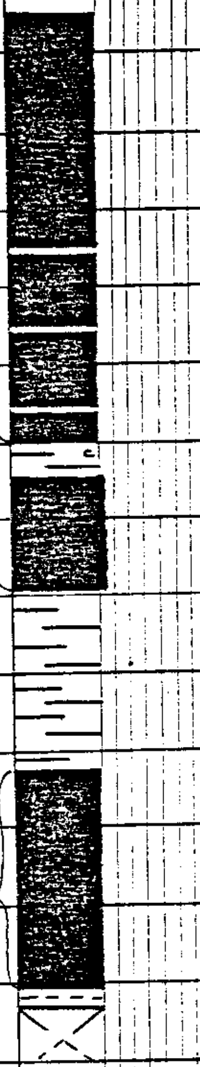

P TELKWA
APPLICATIONS
1.6 MILES TO INCH
Tatlow
Telkwa
TP 5
TELKWA R
Tenas
Creek
MAUD
L.2518
L.876
L.795
L.5152
C.L. 4283
L.243
C.L. L.244 4281
C.L. 4304
L.418 C.G.
L.417
L.416
C.L. 415
L.239
C.L. L.238 4280
C.L. L.229 4279
C.L. L.228 4278
C.L. 4277 L.410 C.G.
C.L. 4276 L.411 C.G.
L.412
L.413 C.G.
L.414
L.240
L.237
L.230
L.221
C.L. L.224 4275
C.L. L.225 4274
C.L. 4273 L.409 C.G.
L.408 C.G.
L.407 C.G.
L.241
L.236
C.L.3880 L.231
C.L.3879 L.226
L.223
C.L. 3878
C.L. L.222 4272
L.402
L.403 C.G.
L.404 C.G.
L.242
L.235
C.L.3881 L.232
C.L. 3710 L.227
C.L. 4271 L.248 C.G.
C.L.3884 L.400 C.G.
L.399 C.G.
L.398 C.G.
L.247
C.L. L.234 4270
C.L. L.233 4269
C.L. 3709 L.390 C.G.
C.L.3876 L.392 C.G.
C.L. 3885 L.393 C.G.
L.394
L.395
L.250
C.L. L.249 4268
C.L. L.245 4267
C.L.3875 L.246
L.389
L.388 C.G.
C.L. 3877
L.387
L.386
L.385
C.L. 3882 L.379 C.G.
C.L.3883 L.380 C.G.
C.L. 4266 L.381 C.G.
L.382
L.383
L.384
C.L. L.624 4265
C.L. L.625 4264
L.378 C.G.
L.377
L.376
L.375
C.L. L.626 4263
C.L. L.627 4262
C.L. L.628 4261
L.629
C.L. 4282
C.L. L.631 4260
L.630

OUTCROP
GO-3


SAMPLE
D,E,F
COAL ZONE
(not measured)
SAMPLED IN
ROAD CUT
SAMPLE
A, B, C
CARB. SH.
SECTION SHOULD
BE DONE.
TELKWA RIVER
AREA IS CONFUSING
RELATIONSHIP OF A, B & C
UNCERTAIN TO D, E & F SAMPLES.

# B.P. CANADA LTD. – COAL GROUP

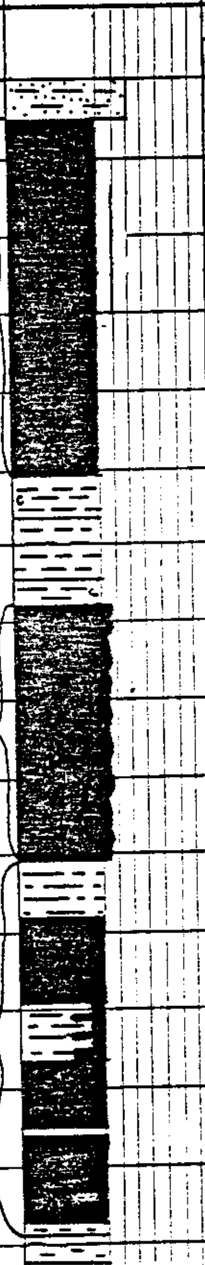
STRAT. COLUMN: GO-3 Telkwa  SCALE: 1:25
PROJECT: BULKLEY/BOWSER  DATE: July 9/79.
LOCATION: TELKWA RIVER  ELEVATION:
GEOLOGIST: G. OCKERT
COMMENTS: only coal segment, not entire section.



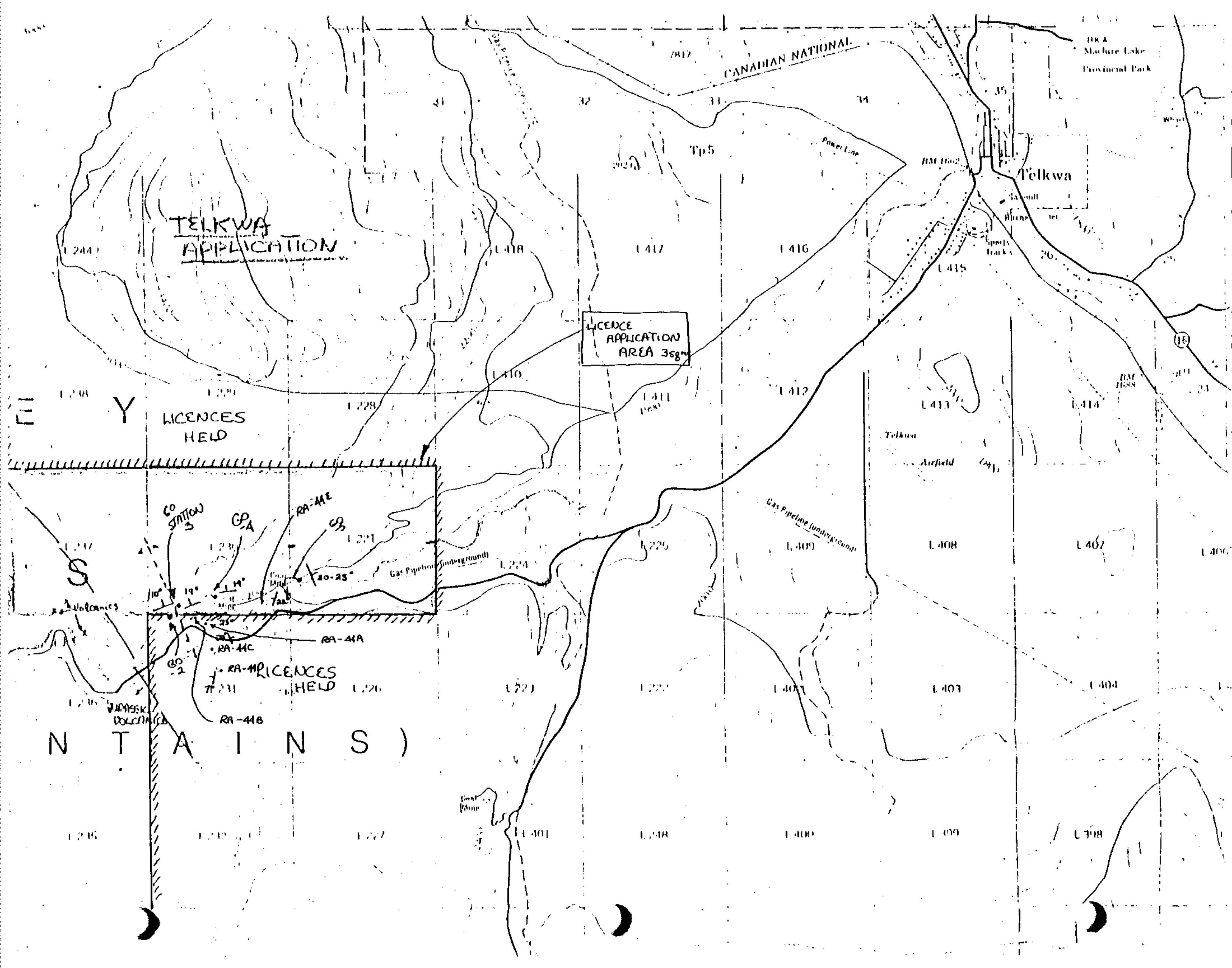
| MEMB./FORM | DEPTHS (METRES) | GRAPHIC (COARSER →) | ELEV. (METRES) | SED. SYMBOL | DESCRIPTION |
|---|---|---|---|---|---|
| | SAMPLE F (1.4m) | | | | coal, 3 thin (1-2cm) shale partings (Sample F) |
| | SAMPLE E (.44m) | | | carb. | shale, black, fissile, carbonaceous (Sample E) |
| | | | | | coal, good quality, v. resistant (Sample E) |
| | | | | | shale, dark grey |
| | SAMPLE D (.7m) | | | | coal, dull/bright, grades to carbonaceous shale at top (Sample D - may be contaminated by overlying shale |
| | | | | | clay |
| | | | | | covered |

# B.P. CANADA LTD. - COAL GROUP

STRAT. COLUMN: GO.-2 SCALE: 1:25
PROJECT: BULKLEY/BOWSER DATE: JULY 9/1979.
LOCATION: TELKWA RIVER ELEVATION:
GEOLOGIST: G. OCKERT
COMMENTS: on licence application
coal exposure on strike face - 10m above river
see slide S. Cam sampling.



| MEMB./FORM | DEPTHS (METRES) | GRAPHIC (COARSER →) | ELEV. (METRES) | SED. SYMBOL | DESCRIPTION |
|---|---|---|---|---|---|
| | | | | | Structure: Dip direction 340° I/10° |
| | | | | ~~~? | Dip 10° estimated - maybe part of a fault block (doubtful) |
| | SAMPLE A (1.19m) | | | | Roof of seam appears to be sandy clay (drift?) |
| | | | | | Coal, very wthd, near vertical cleat, v. minor clay wisps, poor at top, 5cm. bright band at base (SM. A) |
| | | | | carb. | clay/shale, dk brwn, carbonaceous |
| | | | | | clay, wthd wh-gy, non-silty |
| | | | | carb | ✓clay, blk, v. carb., laterally disappears |
| | SAMPLE B (.82m) | | | | coal, resistant, forms bench dull/br to bright (SM. B) |
| | SAMPLE C (1.14m) | | | carb | shale, blk, carb., rust wthing |
| | | | | | coal, dull to dull/bright, minor vitrinite bands, poorer than above coal. |
| | | | | carb | shale, v. carb, grades laterally to coal |
| | | | | | coal, dull bright - bright, 22cm from top 2cm clay |
| | | | | carb. | clay, dk brwn, carb |
| | | | | | mudstone, gy-brwn, non-silty |
| | | | | | SECTION IS 3.57m. thick |



TELKWA
APPLICATION
LICENCE
APPLICATION
AREA 358ha
LICENCES
HELD
LICENCES
HELD
CANADIAN NATIONAL
Telkwa
Tp 5
Power Line
Provincial Park
Telkwa
Airfield
Gas Pipeline (underground)
CO
STATION
3
CO A
CO 3
RA-44E
RA-44A
RA-44C
RA-44B
Volcanics
Y
S
N T A I N S )
L 418
L 417
L 416
L 415
L 410
L 411
L 412
L 413
L 414
L 228
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L 224
L 225
L 409
L 408
L 407
L 404
L 403
L 401
L 400
L 399
L 398
31
32
33
34
35

Telkwa River - Station GO-2 (July 9, 1979)

Coal exposure on a strike face approximately 10 m above the river on the north side. Exposure is indicated on an accompanying stratigraphic column.

Dip $10^{\circ}$ (estimated) at $340^{\circ} \pm 10^{\circ}$

Roof of the seam appears to be a sandy clay (may be drift?) Description from top to base.

| | |
|---|---|
| 1.14 m | coal, badly weathered, near vertical cleat @ $300^{\circ}$ orientation, very minor clay intercalations, dull to bright, appears poorer at the top, 5 cm bright band at the base (Sample A). |
| .14 m | clay/shale, dark brown, carbonaceous, weathers light-brown. |
| .21 m | clay, crumbly, grey, weathers white-grey, non-silty. |
| .07 m | clay, black, very carbonaceous, marks the top of the lower seam, laterally grades to above clay. |
| .82 m | coal, dull/bright to bright, resistant-stands in relief (Sample B). |
| .17 m | shale, fissile, black, carbonaceous, weathers rust to black (Sample C). |
| .27 m | coal, minor thin vitrinite bands, infrequent dull to bright, appears poorer quality to Sample B. (Sample C) |
| .18 m | shale, very carbonaceous, minor vitrinite bands. May laterally grade to a poor quality coal (Sample C). |
| .52 m | coal, dull/bright to bright, 2 cm clay band at 22 cm from top (Sample C). |
| .05 m | clay, dark brown. |

At the base a mudstone, grey-brown, weathers rusty brown, non-silty.

This outcrop is upstream from Station GO-3 (50 m?).

G. Ockert
September 19/79

Telkwa River Station GO-3 (July 9, 1979)

This is a large cliff exposure with 1 large normal fault (possibly 2 more) and a couple of smaller faults visible (see Diagram 1). It is difficult to get a complete section where the cliff is accessible due to the confusion of faulting. A steep portion of the cliff on the footwall of the large fault can only be reached using ropes and was therefore not done in this exercise (Diagram 2).

The structure at the base of the footwall block is $19^{o}$ @ $342^{o}$ east of north into the cliff face.

The notes describing the entire section are not included here but the general structure and coal geology is as follows:

The coal exposure at the uppermost reach of the hanging wall block of the large normal fault is described below (from base to top - see Diagram 3).

| | |
|---|---|
| .70 m | coal, dull/bright, resistant, grading upwards to carbonaceous shale (Sample D - may have shale contamination from above). |
| .55 m | shale, dark grey |
| .34 m | coal, very resistant, good quality (sample E). |
| .10 m | shale, dark grey, very fissile, carbonaceous (sample E). |
| 1.4 m | coal, 3 thin (1-2 cm) shale partings near base (Sample F). |

Roof difficult to see due to slump flow.

The coal outcrop in the footwall does not appear to be that similiar to the above described section and should be described (utilizing ropes to get to it).

G. Ockert
September 19/79

Telkwa River Station RA-44e (July 17, 1979)

This is a river level exposure located between GO-4 and GO-5. Structure: $25^\circ$ @ $280^\circ$.

Description from top to base:

| | |
|---|---|
| 1 m | coal (est.) |
| 1 m | mudstone (est.) |
| .4 m | coal |
| 2 m | mudstone, carbonaceous |
| .8 m | coal and interbedded carbonaceous shale |
| .7 m | mudstone, friable |
| .54 m | coal, and concretionary claystone horizon |
| .94 m | mudstone |
| .26 m | coal |
| .2 m | shale, carbonaceous; 2 cm stringers of coal - shale laterally pinches out |
| .4 m | mudstone, friable |
| .3 m | coal |
| .5 m | mudstone |
| .4 m | coal (at water level) |

Total coal = 4.1 m approx. 10 m

G. Ockert
September 19/79

Telkwa River  Station GO-4 (July 9, 1979)

An old adit/mine site indicated on topographic maps was discovered downstream from GO-3.

1.15 m coal, very weathered exposed near old workings (sample G).

clay/mudstone floor

Structure = Dip of $14^{\circ}$ @ $350^{\circ}$ east of north

Coal outcrop is about 14 m above the river.

Telkwa River Station GO-5 (July 9, 1979)

0.4 m coal, $20\text{-}25^{\circ}$ dip at $60\text{-}70^{\circ}$ east of north

The outcrop is at river level immediately downstream from the old bridge and access road.

G. Ockert
September 19/79

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD.

# INVOICE

| | |
|---|---|
| Invoice No. | 1255 |
| Date | September 28, 1979 |
| P.O. No. | 62002 |
| Job No. | BC-170 |

BP Exploration Canada Ltd.
333 - 5 Avenue SW
Calgary, Alberta
T2P 3B6

Attention: Mr. G. Ockert

| | |
|---|---|
| Test work on TELKWA samples: | |
| Reports dated September 21, and 24, 1979: | |
| a) 7 head raw analyses for Prox., S., BTU, S.G. plus sample preparation @ $40.00/set. | $ 280.0C |
| b) 5 float-sinks @ 6 separations @ $15.00 each - 30 separations | 450.0C |
| c) 35 ash determinations @ $4.50 each. | 157.5C |
| d) 5 ultimate analyses @ $70.00 each. | 350.0C |
| e) 5 ash fusions (oxidizing and reducing) @ $45.00 ea. | 225.0C |
| TOTAL | $1,462.5( |

TERMS: net 30 days.

Please Remit To:

505 - 50th Avenue S.E.,
P.O. Box 5488, Station "A",
Calgary, Alberta T2H 1X9
Telephone (403) 253-8273

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

| HEAD RAW ANALYSIS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | ULTIMATE ANALYSIS | | | | | | |
| | H2O% | C% | H% | N% | S% | ASH% | O% by diff. |
| 3361 COMPOSITE SAMPLES E & F | 1.14 | 71.11 | 4.71 | | 0.80 | 14.76 | |

| 3361 COMPOSITE SAMPLES E & F | ASH FUSION TEMPS (°F) | | | |
|---|---|---|---|---|
| ATMOSPHERE | I.D.T. | S.T. | H.T. | F.T. |
| OXIDIZING | 2800+ | | | |
| REDUCING | 2700 | 2800+ | | |

| LAB. NO.: 3361, COMPOSITE SAMPLES E & F | | | | |
|---|---|---|---|---|
| SINK-FLOAT ANALYSIS, a.d.b.: 1/8" x 0 | | | | |
| | | | CUMULATIVE | |
| S.G. FRACTION | WT.% | ASH% | WT.% | ASH% |
| -1.30 | 13.0 | 2.2 | 13.0 | 2.2 |
| 1.30-1.40 | 51.3 | 8.4 | 64.3 | 7.1 |
| 1.40-1.50 | 12.4 | 17.2 | 76.7 | 8.8 |
| 1.50-1.60 | 11.7 | 26.0 | 88.4 | 11.1 |
| 1.60-1.70 | 6.7 | 34.9 | 95.1 | 12.7 |
| 1.70-1.80 | 3.0 | 49.4 | 98.1 | 13.9 |
| +1.80 | 1.9 | 63.2 | 100.0 | 14.8 |

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

| HEAD RAW ANALYSIS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | ULTIMATE ANALYSIS | | | | | | |
| | H2O% | C% | H% | N% | S% | ASH% | O% by diff. |
| 3360 COMPOSITE SAMPLES B & C | 2.85 | 50.62 | 3.46 | | 0.52 | 29.53 | |

| 3360 COMPOSITE SAMPLES B & C | ASH FUSION TEMPS(°F) | | | | |
|---|---|---|---|---|---|
| | ATMOSPHERE | I.D.T. | S.T. | H.T. | F.T. |
| | OXIDIZING | 2800+ | | | |
| | REDUCING | 2800+ | | | |

| LAB. NO.: 3360, COMPOSITE SAMPLES B & C | | | | |
|---|---|---|---|---|
| SINK-FLOAT ANALYSIS, a.d.b.: 1/8" x 0 | | | | |
| | | | CUMULATIVE | |
| S.G. FRACTION | WT.% | ASH% | WT.% | ASH% |
| -1.30 | 0.4 | 3.9 | 0.4 | 3.9 |
| 1.30-1.40 | 21.1 | 7.5 | 21.5 | 7.4 |
| 1.40-1.50 | 13.9 | 12.0 | 35.4 | 9.2 |
| 1.50-1.60 | 23.7 | 19.2 | 59.1 | 13.2 |
| 1.60-1.70 | 11.6 | 29.6 | 70.7 | 15.9 |
| 1.70-1.80 | 11.1 | 50.2 | 81.8 | 20.6 |
| +1.80 | 18.2 | 68.9 | 100.0 | 29.4 |

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

| | ADM% | MOIST% | ASH% | VM.% | FC.% | S% | BTU/LB | S.G. | |
|---|---|---|---|---|---|---|---|---|---|
| 3316 SAMPLE G (GO-4G) | 15.4 | 5.0 | 21.3 | 27.3 | 46.4 | 0.61 | 9221 | 1.56 | a.d.b. |
| | | 19.6 | 18.0 | 23.1 | 39.3 | 0.52 | 7801 | -- | a.r.b. |
| | | | 22.4 | 28.7 | 48.9 | 0.64 | 9706 | -- | db |

HEAD RAW ANALYSIS (above)

ULTIMATE ANALYSIS

| H2O% | C% | H% | N% | S% | ASH% | O% by diff. |
|---|---|---|---|---|---|---|
| 5.01 | 56.46 | 3.11 | | 0.61 | 21.28 | |

ASH FUSION TEMPS. (°F)

| ATMOSPHERE | I.D.T. | S.T. | H.T. | F.T. |
|---|---|---|---|---|
| OXIDIZING | 2400 | 2460 | 2530 | 2570 |
| REDUCING | 2350 | 2430 | 2460 | 2540 |

LAB. NO. 3316: SAMPLE G (GO-4G) SINK-FLOAT ANALYSIS, a.d.b.: 1/8" x 0

| S.G. FRACTION | WT.% | ASH% | CUMULATIVE WT.% | CUMULATIVE ASH% |
|---|---|---|---|---|
| -1.30 | nil | -- | -- | -- |
| 1.30-1.40 | 15.5 | 10.6 | 15.5 | 10.6 |
| 1.40-1.50 | 17.5 | 13.5 | 33.0 | 12.1 |
| 1.50-1.60 | 33.7 | 19.1 | 66.7 | 15.7 |
| 1.60-1.70 | 23.5 | 25.3 | 90.2 | 18.2 |
| 1.70-1.80 | 7.4 | 36.8 | 97.6 | 19.6 |
| +1.80 | 2.4 | 57.9 | 100.0 | 20.5 |

Birtley Coal
& Minerals Testing

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

HEAD RAW ANALYSIS

| | ADM% | MOIST% | ASH% | VM.% | FC.% | S% | BTU/LB | S.G. | |
|---|---|---|---|---|---|---|---|---|---|
| 3314 | 1.4 | 1.1 | 17.0 | 28.8 | 53.1 | 0.92 | 11923 | 1.43 | adb |
| SAMPLE E | | 2.5 | 16.8 | 28.4 | 52.3 | 0.91 | 11756 | -- | arb |
| (GO-3E) | | | 17.2 | 29.1 | 53.7 | 0.93 | 12056 | -- | db |
| 3315 | 1.0 | 1.1 | 14.3 | 29.2 | 55.4 | 0.76 | 12365 | 1.42 | adb |
| SAMPLE F | | 2.1 | 14.2 | 28.9 | 54.8 | 0.75 | 12241 | -- | arb |
| (GO-3F) | | | 14.5 | 29.5 | 56.0 | 0.77 | 12503 | -- | db |

Birtley Coal
& Minerals Testing

CLIENT; BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

| HEAD RAW ANALYSIS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ADM% | MOIST. | ASH% | VM.% | FC.% | S% | BTU/LB | S.G. | |
| 3313 | 4.5 | 1.3 | 24.8 | 26.1 | 47.8 | 0.55 | 10564 | 1.50 | a.d.b. |
| SAMPLE D | | 5.7 | 23.7 | 24.9 | 45.7 | 0.53 | 10089 | -- | a.r.b. |
| (GO-3D) | | | 25.1 | 26.4 | 48.5 | 0.56 | 10703 | --- | d.b. |

| ULTIMATE ANALYSIS | | | | | | |
|---|---|---|---|---|---|---|
| H20% | C% | H% | N% | S% | ASH% | 0% by diff. |
| 1.31 | 61.65 | 4.05 | | 0.55 | 24.84 | |

| ASH FUSION TEMPS. (°F) | | | | |
|---|---|---|---|---|
| ATMOSPHERE | I.D.T. | S.T. | H.T. | F.T. |
| OXIDIZING | 2800 + | | | |
| REDUCING | 2800 + | | | |

LAB. NO. 3313: SAMPLE D (GO-3D) SINK-FLOAT ANALYSIS, a.d.b.: 1/8" x 0

| S.G. FRACTION | WT.% | ASH% | CUMULATIVE WT.% | CUMULATIVE ASH% |
|---|---|---|---|---|
| -1.30 | 9.0 | 1.3 | 9.0 | 1.3 |
| 1.30-1.40 | 20.8 | 8.6 | 29.8 | 6.4 |
| 1.40-1.50 | 24.3 | 19.2 | 54.1 | 12.1 |
| 1.50-1.60 | 18.9 | 26.6 | 73.0 | 15.9 |
| 1.60-1.70 | 11.9 | 34.7 | 84.9 | 18.5 |
| 1.70-1.80 | 6.1 | 44.9 | 91.0 | 20.3 |
| +1.80 | 9.0 | 65.1 | 100.0 | 24.3 |

Birtley Coal
& Minerals Testing

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

HEAD RAW ANALYSIS

| | ADM% | MOIST. | ASH% | VM.% | FC.% | S% | BTU/LB | S.G. | |
|---|---|---|---|---|---|---|---|---|---|
| 3311 | 12.3 | 9.8 | 14.3 | 22.0 | 53.9 | 0.53 | 9998 | 1.51 | adb |
| SAMPLE B | | 20.9 | 12.5 | 19.3 | 47.3 | 0.46 | 8768 | -- | arb |
| (GO-2B) | | | 15.9 | 24.4 | 59.7 | 0.59 | 11084 | -- | db |
| 3312 | 3.7 | 1.9 | 40.1 | 21.9 | 36.1 | 0.51 | 7588 | 1.70 | adb |
| SAMPLE C | | 5.5 | 38.6 | 21.1 | 34.8 | 0.49 | 7307 | -- | arb |
| (GO-2C) | | | 40.9 | 22.3 | 36.8 | 0.52 | 7735 | -- | db |

Birtley Coal
& Minerals Testing

CLIENT: BP EXPLORATION CANADA LTD. September 19, 1979

SAMPLE: TELKWA CORE SAMPLES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HEAD RAW ANALYSIS | | | | | | | | | |
| | ADM% | MOIST. | ASH% | VM.% | FC.% | S% | BTU/LB | S.G. | |
| 3310 | 7.9 | 3.6 | 22.7 | 26.5 | 47.2 | 0.43 | 9262 | 1.58 | a.d.b. |
| SAMPLE A | | 11.2 | 20.9 | 24.4 | 43.5 | 0.40 | 8530 | --- | a.r.b. |
| (GO-2A) | | | 23.5 | 27.5 | 49.0 | 0.45 | 9608 | --- | d.b. |

| | | | | | | |
|---|---|---|---|---|---|---|
| ULTIMATE ANALYSIS | | | | | | |
| H2O% | C% | H% | N% | S% | ASH% | O% by diff. |
| 3.56 | 57.70 | 3.15 | | 0.43 | 22.71 | |

| | | | | |
|---|---|---|---|---|
| ASH FUSION TEMPS. (°F) | | | | |
| ATMOSPHERE | I.D.T. | S.T. | H.T. | F.T. |
| OXIDIZING | 2410 | 2600 | 2640 | 2740 |
| REDUCING | 2340 | 2420 | 2620 | 2680 |

LAB. NO. 3310: SAMPLE A (GO-2A) SINK-FLOAT ANALYSIS, a.d.b.: 1/8" x 0

| S.G. FRACTION | WT.% | ASH% | CUMULATIVE WT.% | CUMULATIVE ASH% |
|---|---|---|---|---|
| -1.30 | nil | -- | -- | -- |
| 1.30-1.40 | 13.9 | 6.4 | 13.9 | 6.4 |
| 1.40-1.50 | 18.9 | 10.7 | 32.8 | 8.9 |
| 1.50-1.60 | 26.8 | 18.1 | 59.6 | 13.0 |
| 1.60-1.70 | 20.6 | 27.1 | 80.2 | 16.6 |
| 1.70-1.80 | 10.6 | 40.2 | 90.8 | 19.4 |
| +1.80 | 9.2 | 52.6 | 100.0 | 22.4 |

Birtley Coal
& Minerals Testing

# V. ZAY SMITH ASSOCIATES LTD.

**#200, 1147 - 17th Ave. S.W.**
**Calgary, Alberta T2T 0B7**

20-7-79

To: B P Canada Limited
15th Floor 333 - 5th Ave.S.W.
Calgary, Alta.

Date: July 25, 1979
Project No. 209-6

Attention: Dr. J. K. Stobernack, Coal Division

Material Transmitted:

Geologic report on Areal Geology and Structural Interpretation of the Telkwa Area, British Columbia.

This completes delivery of this project. We have appreciated the opportunity to be of service.

NOTE: Please acknowledge receipt of this material by signing and returning the enclosed copy of this form.

Received: ..............................

Dated: ..............................

V. ZAY SMITH ASSOCIATES LTD.
F. Kent Wallace
F. Kent Wallace,
Chief Geologist

GEOLOGIC REPORT

on

AREAL GEOLOGY AND STRUCTURAL INTERPRETATION

of the

TELKWA AREA, BRITISH COLUMBIA

Prepared By
V. ZAY SMITH ASSOCIATES LTD.
and
VEEZAY GEODATA LTD.
Calgary, Alberta
1979

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# AREAL GEOLOGY AND STRUCTURAL INTERPRETATION

of the

# TELKWA AREA, BRITISH COLUMBIA

## *INTRODUCTION*

The Telkwa area lies within the Interior Plateau and mountainous regions of the Cordilleran of north-central British Columbia. It occupies about 6,900 square miles and includes parts of major geologic basins centered around Hazelton and Smithers.

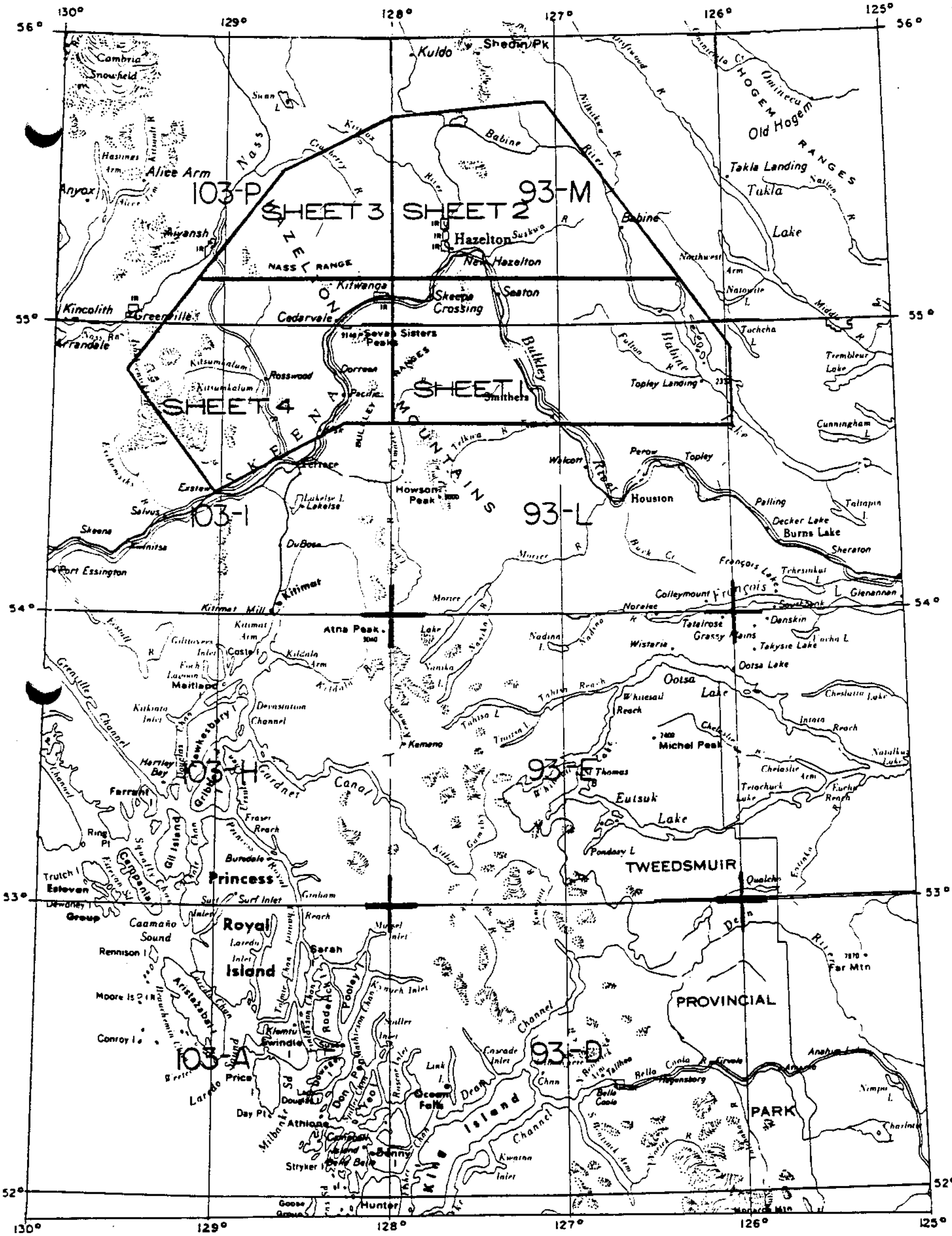
The objective of the study was to provide a series of areal geology and structural interpretation maps from a study of vertical air photographs. This was done to outline the general disposition and configuration of bedrock to assist field parties exploring in the area.

Bedrock throughout the area consists of Mesozoic clastics and volcanic rocks as well as scattered igneous intrusions. The outline of the area is shown on Figure 1. Physiographically it lies within the Cordilleran region which in this area is made up of the Hazelton Mountains on the west and the Skeena Mountains on the east. A portion of the Interior Plateau extends from the south as far north as Smithers and occupies a small portion of the southeastern part of the project around Babine Lake. The Hazelton Mountains comprise a group of ranges which are traversed by the Skeena River. They are underlain by folded sedimentary and volcanic rocks and isolated intrusions of igneous rocks. To the west the almost wholly granitic terrain of the Coast Mountains is present in contrast to the dominantly sedimentary makeup of the Hazelton and Skeena Mountains. The highest peaks range in elevations between 8,200 and 9,200 feet in the map area. The terrain is heavily forest covered over much of it, and alluvial deposits mantle stream valleys in places.

The Hazelton Mountains are made up of the Bulkley Ranges and to the northwest, the Kispiox Range. Major tributaries to the Skeena River, which transect the area, are the Bulkley River, which flows from the south to join the Skeena at the town of Hazelton and the Kispiox River which drains the Skeena Mountains north of the project area.

The study resulted in a photogeological interpretation of the area which was posted to overlays on mosaics. Prints of these overlays and mosaics are included with this report.

FIGURE 2




INDEX TO MOSAICS

## PROCEDURES and METHODS

Air photography necessary for the compilation of the illustrations accompanying this report was obtained mainly from the British Columbia Government. These photos are at the approximate scale of 1:60,000 and were flown in 1975. With the exception of the extreme northern part of the map area, they provide complete coverage. In this area it was necessary to obtain Federal Government photography at the scale 1:40,000 to completely infill the area.

Uncontrolled mosaics at the scale 1 inch = 2 miles were prepared from this photography. It was necessary to cover the area with four mosaics at this scale, and the area of coverage of each mosaic is shown on Figure 2. Photographic enlargement of topographic maps provided the background on which the photos were layed to provide overall scale accuracy. It should be recognized however that the mosaics are uncontrolled and that distortion and overlap especially in areas of high relief do occur.

Following this phase, the air photographs were studied photogeologically and annotated in various colored pencils. Ground control in the form of published information was followed where it was available. The significant references used in the preparation of the interpretation are listed in the Selected Bibliography at the end of this report. In places identification of bedrock was uncertain due to lack of published information and poor expression of bedrock on the air photographs. Where this occurs, it is qualified on the interpretation. Special attention was devoted to outlining areas of possible and probable exposures on the air photographs. As well, attitudes of bedrock, structures such as anticlines and synclines as well as distinctive alignments, lineaments and faults were mapped. In addition, identifiable key beds and stratigraphic breaks as well as formational contacts were delineated. Special attention was given in areas where published references to coal deposits were made.

The photogeological interpretation was accurately posted to a clear film overlay on each of the mosaics. The mosaics were tied stereoscopically. Blueline prints of the overlays were obtained, and these were pencil colored to provide the final interpretation.

In places, forest cover is widespread and that combined with alluvial deposits in major stream valleys tends to mask the expression of underlying bedrock. Where this occurred, an attempt was made to analyze landforms to provide a geomorphic interpretation of underlying bedrock. Details of major structural features are also obscure in places. Alignment of streams and other topographic features assisted in providing an interpretation of major alignments which may have structural significance.

In the northwestern part of the map area it was difficult to differentiate between Jurassic Bowser Lake Group rocks and Cretaceous Skeena Group strata because of the similar lithology of these units as well as their erosional expression and other like characteristics. Where this occurred, an arbitrary nomenclature line has been portrayed on the mosaic.

## STRATIGRAPHY

Bedrock within the project area is made up mainly of sedimentary rocks which are in places intruded by igneous rocks. The sediments have been folded and dislocated by faults and are well exposed where present in mountainous areas especially above the tree line. The sedimentary rocks contain volcaniclastic material which attest to intermittent but fairly widespread volcanism during sedimentary cycles.

Bedrock is made up mainly of Mesozoic rocks. The Mesozoic strata can be divided into five groups as follows: the Upper Triassic Takla made up mainly of basic volcanics and sediments; the Lower to Middle Jurassic Hazelton Group made up mainly of sediments; the Middle and Upper Jurassic Bowser Lake Group; the overlying Lower Cretaceous Skeena Group which contain a variety of sediments and volcanics; and an upper nonmarine late Cretaceous to early Tertiary Sustut Group. The composite thicknesses of these strata is over 20,000 feet and because no complete sections are exposed at any one locality, they are in places imperfectly known.

These mainly sedimentary Mesozoic and Cenozoic rocks represent eugeosynclinal island-arc volcanic and sedimentary assemblages which were deposited within major depositional troughs in irregular basins bounded on the east by the Omineca crystalline belt on the west by the Coast plutonic complex, and on the south by the Skeena Arch. Thus, the provenance for sediments making up this thick assemblage was from a variety of sources associated with surrounding uplifted terrains. These stratified rocks located in the intermontane belt are in the same relative position in which they formed (Tipper & Richards, 1976). Thus, although block-faulting and intrusion are common there is no evidence for major dislocation along transcurrent faults, no regional high-grade metamorphism and only relatively minor thrust faulting.

Each major Mesozoic group shows a depositional and tectonic environment distinct from surrounding units. The late Triassic volcanism was followed by sediments and dominantly rhyolite volcanics of the early Jurassic Hazelton group. Development of the Bowser Basin and deposition of dominantly deltaic clastic rocks of the Bowser Lake Group occurred in later Jurassic time. These strata are separated from overlying Cretaceous and Tertiary Skeena and Sustut Groups by a major hiatus. These latter strata were deposited on folded and faulted terrains of the Bowser Lake Group and older rocks.

## SEDIMENTARY and VOLCANIC ROCKS

### PERMIAN and CARBONIFEROUS

Rocks of these ages are exposed in several small areas adjacent to intrusive contacts in the western part of the map area. Contained fossils indicate that these rocks are older than Triassic. Their main area of exposure is in the southwestern part of the map area along the Skeena River.

Rocks of these ages consist of two thick limestone members underlain by structureless greenstones. The lower limestone is a grey-black argillaceous unit which is interbedded with limy shales. The upper limestone member is a bluish white, massive, pure limestone. The greenstone complex is highly altered, but despite this the rock is believed to have been originally a sedimentary sequence. The upper limestone member is about 1,000 feet thick and contains fossiliferous, calcareous shales which record slump structures. In addition, intraformational conglomerates are found throughout. The upper limestone member rests unconformably on the lower argillaceous limestone. In places it is massively bedded and contains partings up to 2 inches thick made up of angular pebbles of andesitic composition. The overall thickness of the Permian and Carboniferous rocks immediately southwest of the map area may approach 5,000 feet. No complete sections are known to be present within the project area.

### TRIASSIC

#### Takla Group

Rocks of the Takla Group are exposed in the eastern part of the project area near Babine Lake and extensively throughout the southwestern part of the area in the environs of the Skeena and Kitsumkalum Rivers. In the eastern part of the project these rocks are reported as consisting of two distinct facies of Upper Karnian and Lower Norian age.

East of the Ingenika Fault to the northeast of the map area, the Takla Group consists of augite porphyry, tuff breccia and sub-volcanic intrusive bodies. Interbedded with these lithologies are shale, siltstone, and well bedded, laminated limestone. Dacite and rhyolite tuff and breccia are conspicuous locally. These rocks have been metamorphosed to greenschist facies. The base of the group is marked by well bedded argillite, siltstone and minor sandstone above which are a wide suite of volcanic rocks. These volcanic rocks include flows, tuffs, breccia and pillow basalt. Most of this assemblage is of marine depositional origin and weathers a reddish color.

In the southwestern map area rocks assigned to the Triassic are separated from overlying Hazelton Group strata only with difficulty. They are separated from underlying Paleozoic rocks by an erosional unconformity marked by a limestone-boulder conglomerate. This conglomerate is up to several hundred feet thick and contains pebbles and cobbles of unsorted fragments of limestone, andesite, chert and argillite. Lying conformably above this conglomerate is a series of greywackes, banded volcanic sandstone, siltstone, chert and fine volcanic breccia. This sequence is up to 1,000 feet thick and appears in beds 5 to 15 feet thick. Fragments which appear in the greywackes reach a diameter up to 3 inches and are made up of rock types that provided the material for the sequence. Above the coarse greywackes and partially interbedded with them is a sequence of red, purple and green banded volcanic sandstones, water-lain tuffs and chert. Individual graded beds are up to a foot in thickness and mud cracks have been developed. These in combination with intraformational conglomerates prove a shallow-water origin for these rocks. Near the top of the group, massive beds of coarse greywacke occur similar to those situated stratigraphically lower, and these are overlain by andesite breccia which grades upward into coarse volcanic breccias of the overlying Hazelton Group.

## JURASSIC

### Hazelton Group

The Hazelton Group is a thick widespread assemblage of basaltic to rhyolitic volcanic rocks, sedimentary rocks and minor limestones that were deposited in early and mid-Jurassic time. Over a period of time, this name has been a catchall for Jurassic rocks in north-central British Columbia and as a result recognition of the boundaries of the group as well as its rock constituents have been confused. Relationships with surrounding strata have been ill-defined and in addition, strata within the group undergo major facies changes at different geographic localities. The term was originally proposed for rocks near the town of Hazelton which are no longer part of the group. However, the term Hazelton Group is synonymous with sequences of vari-colored Jurassic and volcanic sedimentary rocks specified by the original definition and to avoid confusion, this term has been retained.

These strata are a sequence of volcanic and sedimentary rocks deposited within the Hazelton trough. At different localities within the map area the Hazelton Group can be subdivided into various units or formations. Because of the wide variance of these subdivisions and for reasons mentioned earlier, it was impossible to differentiate or subdivide the Hazelton Group on the air photographs. Stratigraphic breaks and key beds have been mapped on distinctive units within this assemblage, where feasible.

In the northeastern part of the map area the Hazelton Group has been subdivided by Richards (1974) into four units of variable thickness. These have been identified from the eastern and northeastern part of the map area in the vicinity of Babine Lake. They consist of mid-Lower Jurassic continental and marine volcanics and upper Lower Jurassic continental and marine volcanics. Combined thicknesses of these sediments. and volcanics approach 15,000 feet.

The lower part of this series consists of clastics and fine-grained pyroclastic rocks which are interbedded with and overlie volcanic rocks. They display numerous facies variations and contain shallow-water marine greywackes and tuffs. Minor constituents consist of argillite, limestone, minor grits and interbedded volcanics. Near Mount Netalzul south of the Suskwa River this facies is about 50 feet thick while to the east, in the Takla Lake area east of the project boundary, this map unit is represented by 3,000 feet of sandstones, mudstones, pyroclastics and conglomerates.

The overlying unit consists of sandstone, greywacke and argillite which is feldspathic in nature. These strata are interbedded with red tuffs and are up to 1,500 feet thick. Overlying this unit is a sequence of up to 3,000 feet of well bedded, well indurated, silty greywacke, grit and minor conglomerate. Shallow-water marine sandstones and siltstones grade upwards into nonmarine sandstone, mudstone and conglomerate with minor coaly horizons. The uppermost distinctive map unit in the Hazelton Group within this part of the map area is described as being made up of 1,000 feet of volcanics which are green and maroon in color and contain breccia and flows conformable and interbedded with the underlying unit. Interbedded conglomerate, coaly mudstone and sandstone occur locally.

Immediately north of the map area Richards (1976) has divided the Hazelton Group into two major units. These are a lower nonmarine volcanic and volcaniclastic unit and an upper marine volcanic and sedimentary unit. The lower unit consists of older volcaniclastics with subordinate volcanics including an extensive volcanic unit. It is over 3,000 feet thick. The volcanic flows are red in color, nonmarine and are composed of basalt to rhyolite calc-alkaline volcanic composition. Conformably overlying the lower unit are marine volcanic and sedimentary rocks. The transition between the two units in this area represents a major facies change typical of the Hazelton Group in other localities. The upper unit consists of well bedded greywacke siltstone, argillite, acidic tuff, limy argillite, and minor basaltic breccia. The thickness of this unit is highly variable but probably is over 1,500 feet.

In the western part of the map area, Duffell and Souther (1964) have described Hazelton strata. These rocks are variably exposed and have been subdivided into a lower division made up of about 3,000 feet of sedimentary and fragmental volcanic rocks that is at least 4,000 feet thick. The lower division consists of massive bedded, coarse breccia, minor andesitic flows, and intercalated clastic material representing argillaceous sedimentation. The upper division is made up of a series of massive volcanic rocks of mainly andesitic composition locally including basaltic, dacitic and rhyolitic flows as well as some andesitic breccia. These rocks are commonly bright colored hues of greens, reds, purples and white. They are extensively exposed around Mount Sir Robert in the Bulkley Range and elsewhere in this area.

Tipper & Richards (1976) have studied Hazelton Group strata within north-central British Columbia. They have subdivided the group into three formations: a lower Telkwa Formation made up of five distinctive facies belts, a middle Nilkitkwa Formation composed of three separate members and an upper Smithers Formation divisible into two members.

The Telkwa Formation consists of a varied assemblage of marine and nonmarine volcanics at the base (Sikanni Facies). These rocks are up to 3,000 feet thick and also have minor amounts of conglomerate, sandstone and mudstone. About 6,000 feet of basalt to rhyolite flows, breccia and tuff overlie this sequence (Bear Lake facies). This is followed by a variable sequence up to over 4,000 feet thick of sub-aqueous basalt and rhyolite flows, breccia, tuff with minor amounts of limestone, greywacke siltstone and shale (Kotsine facies). The next youngest subdivision of the Telkwa Formation is similar to underlying rocks but does not contain pillow breccia. It is up to 3,000 feet thick although complete sequences are rarely exposed (Babine facies). The upper facies of the Telkwa Formation consists of calc-alkaline basalt to rhyolite flows with minor breccia, tuff and intravolcanic sediments (Howson facies).

The middle portion of the Hazelton Group is occupied by the Nilkitkwa Formation which is subdivisible into four members. The lower Red Tuff member is up to 1,000 feet thick and consists of various tuffs as well as rhyolite basalt, flow breccia and minor subaqueous volcanics. Overlying this basal member are alkali olivine basalts containing minor sandstones and limestones of the Ankwell Member which are up to 3,000 feet thick. A distinctive, thin (150 feet) pillow basalt containing minor breccia and limestones intervenes between the Ankwell Member and the upper unit. This is the Carruthers Member. The uppermost unit of this median formation consists of shale, siltstone, limestone breccia and basalt. It is up to 3,500 feet thick.

The uppermost Smithers Formation of the Hazelton Group has been subdivided by these authors into two members. The lower Yuen Member is composed of siltstone, tuffaceous siltstone, reddish tuff and greywacke. It is about 2,000 feet thick. It is in turn overlain by argillites, siltstones, limestones, tuffs and tuffaceous sediments of the Bait Member. This upper unit is up to 1,500 feet thick.

The diverse assemblage of rocks present within the Hazelton Group suggests that this period of geologic time was one of intrusive, tectonic and volcanic activity which was accompanied by rapid accumulations of clastic sediments and volcanic flows in large parts of the inter-connected depositional basins in north-central British Columbia. Marine and continental clastic deposition occurred contemporaneously within separate parts of the basins as did the accumulation of volcanic deposits. Lack of diagnostic fossils combined with intermittent exposures and, in places, monotonous and similar lithologies make recognition of individual subdivisions of the Hazelton Group over large areas difficult.

<u>Bowser Lake Group</u>

The Bowser Lake Group is a thick assemblage of marine and nonmarine sediments which occupies large parts of the project area. These strata consist of shale, siltstone, sandstone and conglomerate with minor interbedded volcanic assemblages. They are of Middle and Late Jurassic age and represent deposition in near-shore, deltaic, alluvial and locally turbidite environments. Locally coal seams, some of significant thickness, are interbedded. The Groundhog region to the north contains coal measures in these rocks.

These mainly sedimentary rocks were deposited in the Bowser Basin which was bounded on the south by the Skeena Arch, a northeasterly trending structural feature which bounds the project area on the south. A major hiatus is recognized between Cretaceous and Jurassic rocks and in fact the Cretaceous depositional basin is not coincident with the Jurassic Bowser Basin. However, over the central part of the project area it was impossible to differentiate between Bowser Lake Group rocks and overlying Cretaceous sediments. This results from their similar outcrop expression as well as general lack of outcrop. Where this occurs, a nomenclature change has been indicated on the photogeological interpretation.

The Bowser Lake Group has been subdivided into several facies within the project area. It was not possible using photogeological techniques to outline these various facies due to lack of expression of correlatable key beds and stratigraphic breaks. Within the Hazelton West map area, Richards & Jeletzky (1975) have subdivided these strata into a lower Trout Creek facies and an upper Bowser assemblage. The lower unit consists of a basal sandstone which is winnowed, cross bedded and ripple-marked and locally conglomeratic. These grade up into fine-grained siltstone and sandstone and further upsection into more sandstones and siltstones which contain belemnite and pelecypod coquinas. Local cross bedded greywacke tuffs and siliceous limestone and volcanic cobbles and conglomerate overlie the shell-bearing beds. The upper portion of the lower Trout Creek facies is a black shale sequence up to 1,000 feet thick. It contains silty argillite zones and carbonate nodules as well as minor grey limestone lenses and bands. Fossils collected from this interval indicate an Upper Oxfordian to Lower Kimmeridgian age.

The upper part of the Bowser Lake Group in this area has tentatively been subdivided into six major facies. To the south, the sequence consists of stream deposits showing overbank and channel facies. To the north, a change in depositional environment is indicated which shifts gradually from coastal environments to a sandy shoreline facies. Farther north yet the section is entirely marine and is marked by a delta front and a pro-delta facies. The alluvial-deltaic sequence appears to be pro-grading northward. The basal part of this subdivision is dominated by conglomerate lenses about 30 feet thick which contain clasts from the underlying Hazelton Group. Overlying sediments consist of fine clastics which show mud cracks, burrow structures and well preserved clams. Rare coal seams up to one and one-half feet thick are reported from this interval. The transition from alluvial to marine sedimentation is marked by a relatively narrow belt of channel and overbank, coastal swamp, tidal channel and sandbar deposits which are 5 to 10 miles wide. This zone is located 15 to 20 miles north of Hazelton and trends in a general east-west direction. Numerous depositional indicators are conspicuous and mark gradual environmental changes. Paleocurrent directions suggest a southwesterly directed flow. The delta facies is recognized in the Sidina Mountain area and consists of rusty weathering tabular beds of greywacke to subgreywacke and laminated fine sandstones and siltstones. Ripple marks are common as are rare pelecypod fragments.

Thus, in the northeastern part of the map area widespread Bowser Lake Group strata occupy large regions, with the lower Bowser having the greatest areal extent, as northerly prograding deltaic assemblage have a gentle northwest dipping paleoslope. The upper Bowser Lake Group occupies many of the major valley bottoms. It is a shallow-marine lagoonal alluvial suite which is in contrast to the uppermost overlying unit which is generally finer grained and contains a greater amount of carbonaceous material, and is generally much less indurated.

Further work ty Tipper & Richards (1976) has subdivided these strata into two formations - the lower Ashman Formation and a younger assemblage which is of late Oxfordian to early Kimmeridgian age. The Ashman Formation is described as composed of dark grey to black shale, feldspathic to quartzose sandstone, greywacke, chert-pebble conglomerate and greywacke conglomerate. Minor limestone bands and lenses are found locally. In the southern part of the map area thin beds of tuff or tuffaceous shale occur. At the type section on Ashman Ridge about 25 miles west of Smithers, the formation is about 2,300 feet thick. At this locality, because of its proximity to the basin margin, it has a higher proportion of coarse clastic sediments than would be expected in the center of the basin. Only partial sections of the Ashman Formation are present throughout the area and although only limited exposures are available, these strata represent nearshore facies of a northwestern regressing sea (Tipper & Richards, 1976). Fossils indicate that the age of the formation ranges from late Bajocian to the top of the early Oxfordian.

The younger facies of the Bowser Lake Group has been described earlier. They are present in the northern part of the map area, and represent a further marine regression as well as local volcanism along the margins of the basin of deposition. Sandstone, conglomerate, siltstone and minor coal were deposited above the Ashman Formation. These strata reflect a transition from marine and nonmarine environments and this is traceable from the Bait Range northeast of the map area to Netalzul Mountain. To the north, the facies becomes dominantly marine and the contact with the underlying Ashman Formation is gradational. Volcanic rocks which are mainly breccias and tuffs but include thick bedded flows and intravolcanic sandstones overlie and in part are interbedded with this upper facies.

The youngest strata of the Bowser Lake Group in the northeastern part of the map area occur in the environs of Blunt Mountain and Mount Thomlinson. In this area these deposits interfinger with shoreline coquina facies. These rocks probably are as young as earliest Kimmeridgian.

In the western part of the map area Duffell & Souther (1964) describe strata from the Bowser Lake Group. Within this part of the map area they are widespread, but due to lack of continuous outcrop no definite thickness has been measured. It is believed however that their thickness may be as much as 8,000 feet in this area. They are represented by a well bedded series of marine and fresh water clastic rocks composed of detrital material from the erosion of volcanic terrain. They contain fine pebble conglomerates and locally coarse boulder conglomerates as well as light and dark-grey argillites and slates. Beds of carbonaceous material and some coaly material is reported in scattered outcrops throughout this region. In the Seven Sisters Peaks region porphyritic volcanic rocks derived from underlying Hazelton Group strata are common. In the southwestern part of the map area greywackes are the most abundant rock type in the group. They are commonly shades of grey but may be black in color and consist of feldspar, quartz and fragments from older volcanic rocks. Contained fossils in these mainly clastic rocks indicate an age similar with other Bowser Lake Group strata to the east. In places it is believed that these rocks may, however, extend into the Lower Cretaceous. As is the case to the east, difficulty is encountered in separating these strata from overlying Cretaceous Skeena Group strata. When this occurs a nomenclature change is employed on the interpretation.

## CRETACEOUS

### Skeena Group

Skeena Group strata are present at scattered localities throughout the project area. They commonly occur in topographically low areas and are generally poorly exposed especially where associated with or intruded by Tertiary granitic rocks. This group contains the main coal-bearing rocks of the Telkwa map area and includes interbedded marine and nonmarine sedimentary and volcanic strata. Major sediments consist of greywacke, sandstone, shale and conglomerate. At various stratigraphic positions minor or major coal seams are present. The volcanic rocks which constitute a minor proportion of this unit consist of grey to green or varicolored basaltic to rhyolitic breccias, tuffs and flows. Although the proportion of volcanics is generally less than the sediments, this varies from place to place.

The sediments of the Skeena Group are in places difficult to distinguish from underlying Hazelton or Bowser Lake sediments. It is reported by Tipper & Richards (1976) that the distinguishing element is the presence of fine flakes of detrital muscovite in the Skeena Group which are lacking in older sediments. Contained fossils indicate that the age of the Skeena Group is early Cretaceous to earliest late Cretaceous.

These sediments of marine origin were deposited by a transgressive sea in an area of low relief which spread across the Skeena Arch and inundated most of central British Columbia. Thus, the basin of deposition differs from that of older Jurassic strata.

In places on the photogeological interpretation difficulty is encountered in differentiating these strata from underlying older rocks. It is reported that only subtle lithological and sedimentalogical differences combined with palynological criteria allow definition of ages for these sediments. Initially, the Skeena Group was subdivided into the Brian Boru and Red Rose Formations. These have not been differentiated on the accompanying interpretation but it is acknowledged that the Brian Boru volcanics are included with this map unit (Ks), at the top.

Exposures of the Skeena Group occur along the Bulkley Valley east of Smithers, in the vicinity of the Telkwa coal field and west of Smithers. In addition, scattered exposures of these rocks are present along the Skeena River.

It is reported by Richards (1974) that most of the sediments of the Skeena Group are continental in the northern part of the map area. They are described as well-winnowed, well-bedded, chert-feldspar-lithic-quartz arenites. Chert pebble conglomerates are common and the material making up these conglomerates is derived from older Jurassic volcanics. In the northern part of the map area, volcanic rocks of the Skeena Group consist of vari-colored massive, feldspathic, augitic porphyritic breccias and flows. It is reported that four centers of volcanism are recognized.

Ootsa Lake Group

Volcanics of the Ootsa Lake Group are confined to small areas in the eastern part of the map area near Babine Lake. These volcanic rocks are mainly rhyolites with subordinate basic and intermediate volcanics which outcrop as small intrusive-extrusive centers. They underlie the Sustut Group in this area and are believed to be Lower Tertiary to late Cretaceous in age. They consist dominantly of rhyolites but include dacitic breccias, flows and tuffs.

TERTIARY

Sustut Group

Strata belonging to this group occur at scattered localities throughout the project area. They consist of a relatively thick assemblage of conspicuously bedded and banded continental strata. They contain conglomerate, sandstone, shale and locally bands of tuff. To the north the formation is widespread and has been subdivided into formations which have individual members. This subdivision cannot be carried into the Telkwa map area because of lack of outcrop.

These rocks are believed to be Eocene to Paleocene in age and occupy parts of broad valleys such as the Babine, Bulkley and to the northeast, the Takla. Chert-pebble conglomerates which contain broad leaf flora are conspicuous in the northeastern part of the map area and probably represent the lower part of the Sustut Group.

These loosely indurated continental clastics contain minor coal clasts which are derived from older rock. It is probable that some of the coal areas indicated on the interpretation and described by Armstrong (1944, 1944a) occur in the Sustut Group. The photogeologic interpretation map shows some of these areas situated near or in Quaternary deposits which mantle broad valley floors. It is impossible to differentiate between the loosely consolidated Paleocene deposits and Quaternary gravels and alluvium, on the air photos.

Endako Group

The Endako Group consists mainly of volcanic rocks. Their surface distribution within the map area is confined to the region near Babine Lake where they are of local extent.

They consist of basaltic breccia, basalt and locally water-lain sediments which are interbedded near the upper part of the unit. These various lithologies overlie aphanitic andesite and dacite flows, and breccia as well as minor basalts and locally sediments. Tipper (1976) has subdivided these strata in the Smithers map area into an upper sequence of Oligocene (?) and Lower Miocene age which overlie Eocene and (?) Oligocene rocks.

## QUATERNARY

Quaternary deposits are widespread throughout the map area. They consist mainly of alluvium, hillwash, terrace and glacial deposits. Their distribution has been kept to a minimum and they have been mapped only where they mask all expression of underlying bedrock. This occurs mainly along major stream valleys and in areas adjacent to large lakes.

The area has been glaciated and glacial erosional and depositional effects are prominent. These are especially noticeable in the central and northwestern part of the map area where these deposits obscure underlying bedrock. It is probable that the trend of the distinctive glacial lineations in this area is controlled by underlying bedrock structure.

Small areas of Quaternary basalts have been mapped in the western part of the area around Lava Lake. These alkali basalt flows are one of the youngest volcanic features in British Columbia. They are about 230 years old and issued from a vent which is readily apparent on the air photomosaic. This flow caused the damming up of a river nearby and the formation of a lake. Further information on this lava flow is provided by A. Sutherland Brown in the Canadian Journal of Earth Sciences, v. 6, 1969, p. 1460.

## INTRUSIVE ROCKS

Intrusive rocks range in age from Jurassic to Eocene and are widely scattered throughout the project area. In the western part of the project area, Cretaceous intrusive rocks of the Coast Batholith (Ki) occupy large areas and form the boundary for the western part of the project. Elsewhere, early Jurassic, Cretaceous and younger intrusives rocks of varying composition are present.

The Topley Intrusives are calc-alkaline stocks and batholiths of early Jurassic age and are present in a series of irregular bodies along the general southern extent of the project - the former site of the Skeena Arch. These intrusive bodies are thought to be contemporaneous with and intruded into the Telkwa Formation, the oldest member of the Hazelton Group.

The Bulkley Intrusives are present at scattered localities north and east of the town of Hazelton. Age datings indicate a range from 70 to 84 million years. They form stocks, small plugs and dikes which are of limited areal extent but are widely scattered in the vicinity of the town of Hazelton. They consist of granodiorite, tonalite and diorite and form resistant mountains such as Blunt and Thomlinson. They are encircled by hornsfeld sediments in zones which are up to 2,000 feet in width.

Younger gabbros, diabases, granodiorites and rhyolite which have been dated as from Eocene to late Cretaceous in age are indicated by the map symbol TKi on the geologic interpretation. Minor constituents of this map unit also include breccia, porphyry and tonalite.

The Babine Intrusives are restricted to the general region of Babine Lake and consist of porphyritic granodiorite and quartz diorite. They also form part of the coast range complex and in this region in the western part of the map area consist of diorites,granodiorites, as well as pegmatitic gneisses.

## STRUCTURE

Faults dominate the structural style of the project area and subdivide it into distinctive geologic and geomorphologic belts. Major longitudinal faults trend generally northerly although east-west cross faults and a vast array of other trending minor faults also are present. Most of these faults are probably high angle normal faults. Thrust faulting is prevalent in the south-central part of the map area and results from northerly directed compressional forces. These generally low angle thrust faults have been offset by the younger.higher angle normal faults.

The age of the faulting has been documented from juxtapositioning of the beds and has been dated as occurring continuously or in stages from late Paleozoic to post-Eocene times. Movement in earliest Jurassic times has been evidenced by foliation around the Hogem Batholith located north of the map area. Strata of the Hazelton Group have been broken into elongate, graben-like structures in which thick conglomeratic deposits occur. Regional faulting occurred prior to the mid-to early Late Cretaceous as volcanic beds of the Sustut Group, especially in the south-eastern part of the project area, are affected. Throw on these faults is estimated to be up to 2,000 feet. In Eocene times a myriad of small scale, imbricate thrust faults and high angle normal faults offset Tertiary and Mesozoic rocks.

Folds are prevalent throughout the region and are related in some instances to dominant faults. They also are common in incompetent sediments partially as a response to faulting.

The combination of folding and faulting has resulted in extremely complex structures in parts of the map area. In places axes of folds average up to three or four per mile except locally where broad open folds predominate. Structures may be isoclinal and recumbent and valleys and saddles are characterized by tight complex folding. Broader massifs of competent rock are commonly gently contorted and acted as a resistant force to deformative stresses. This could also be related to major longitudinal faults which lie along valleys. Many of the fold axes plunge gently and are defined by moderate to steep dips. Several major stream valleys such as the Skeena River are believed to be structurally controlled. Other major drainages which owe their existence and direction of flow to underlying structure are indicated on the geology maps.

In places within the map area numerous minor tight folds are present, but because of their small size and complexity, all individual structures could not be traced with certainty on the air photographs. Where this occurs, notes to this effect appear on the mosaic overlay. Numerous published dips appear on the interpretation and attest to the intensely folded nature of the bedrock.

## CONCLUSIONS

Stereoscopic examination of vertical air photographs from the Telkwa area has lead to the preparation of a series of photogeological maps. These maps display the surface distribution of bedrock and are based on published ground control where available.

This analysis has shown that the area is underlain by various assemblages of sedimentary and volcanic rocks which have been subjected to complex structural deformation.

The project is regarded as an aid and supplement to field investigations in the area, and to this end the photogeologic interpretations and illustrations should assist in exploring for commercial coal deposits.

Several areas which have reported occurrences of coal have been noted on the geologic interpretation maps on Sheets 1 and 2. These have been mentioned mainly in Armstrong (1944, 1944a). In the Kispiox and Seaton coal fields, this author reports seams up to 5 feet thick which commonly include shale bands and which are crushed and discontinuous. Analysis of the coal in this area showed that it contains 10 to 20% volatile matter, 40 to 70% fixed carbon and 20 to 30% ash. In the Telkwa area and Lake Kathlyn region numerous coal seams are reported. The Telkwa collieries have mined up to 200 tons a day of low grade anthracite from seams which are from six inches to four feet in width. All these coal occurrences are in the Tertiary Sustut Group, the Cretaceous Skeena Group or the Jurassic Bowser Lake Group.

To the north in the Groundhog area, several seams of coal occur in what has been mapped as Bowser Lake Group strata. These are reported as of bituminous to anthracite rank (Geological Survey of Canada, 1957). It is further reported that within this area exceedingly complex structure makes finding of commercial scale, economical deposits remote.

Pending results of the field work, it is recommended that should specific areas which are regarded as having potential be localized, large scale photogeologic mapping using recent color photography could be employed to trace and outline such potential economical deposits. Using this approach, it would then be readily determined if detailed mapping of such deposits could be accomplished in this terrane employing this technique.

Respectfully submitted,
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