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GEOLOGY AND SAMPLING OF POSSIBLE SORBENT SITES FOR HAT CREEK PRESSURIZED FLUIDIZED BED COMBUSTION STUDY

Report No.SE 8221

September 1982
Revised Sept. 1983

B.C. HYDRO

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GEOLOGY AND SAMPLING OF POSSIBLE SORBENT SITES FOR HAT CREEK PRESSURIZED FLUIDIZED BED COMBUSTION STUDY

SYSTEM ENGINEERING DIVISION
GENERATION PLANNING DEPARTMENT

September 1982

(updated September 1983)

FR11

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GEOLOGY AND SAMPLING OF POSSIBLE SORBENT SITES FOR HAT CREEK PRESSURIZED FLUIDIZED BED COMBUSTION STUDY

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FIGURES - (Cont'd)

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LIST OF ABBREVIATIONS USED ON GEOLOGIC MAPS

AB	abundant
AGGLOM	agglomerate
ANG	angular
APRROX	approximate
B	bedding
B.L.	base line
BLK	black
BRN	brown
BX	breccia
CALC	calcareous
C-G	coarse-grained
CL	cleavage
cm	centimeter
DK	dark
DOLO	dolomite
DOLO LST	dolomitic limestone
F-G	fine-grained
FL	float
FRACTS	fractures
FRAGS	fragments
GRN	green
GRNST	greenstone
GY	grey
HEM	hematite
IRREG	irregular
LST	limestone
LT	light
M	metre
MED	medium
M-G	medium-grained
METASED	metasedimentary
mm	millimetre
O.C.	outcrop
QTZITE	quartzite
RK	rock
SIL	siliceous
SL	slate
STR	strong
TH	thick
W/	with
WTE	white

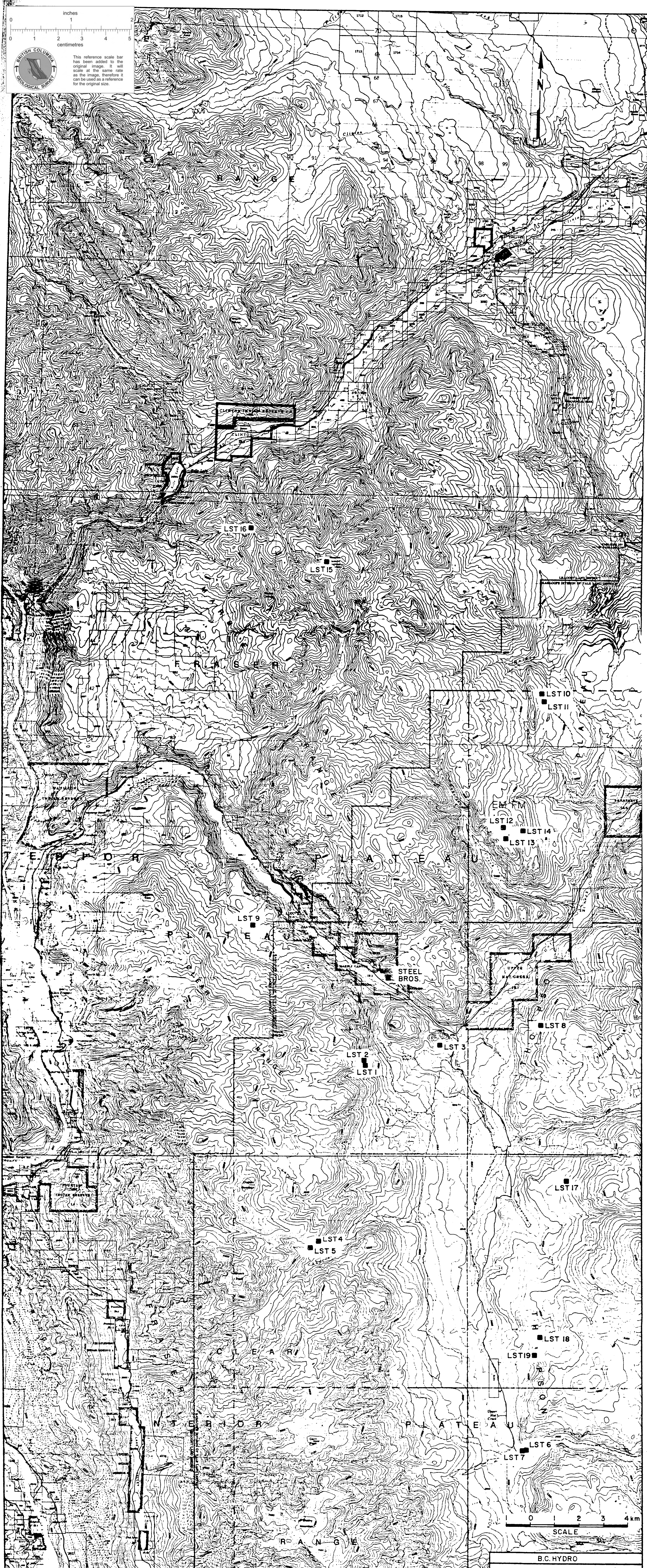
SECTION 1.0 - INTRODUCTION

In 1981 a preliminary evaluation of some possible sites for sulphur sorbents for pressurized fluidized bed combustion (PFBC) tests was completed (B.C. Hydro Report No. SE 8117)[1]. This report examined earlier, detailed work by Trettin (1979)[2] in the northern part of the Marble Range and applied this information to the region farther south. On this basis 16 samples were collected from the area. In addition, two samples from Domtar Chemicals Ltd. on Texada Island, B.C. and one sample from Impact Resources Inc. at Zeballos, B.C. were also analyzed. All of these samples plus one sample from Dolowhite Mines Ltd. at Rock Creek, B.C., one sample from International Marble and Stone Co. Ltd. at Crawford Bay, B.C. and one sample from Grandex Dolomite near Sechelt, B.C. were tested by the Westinghouse Research and Development Centre and the results are described in a Westinghouse report by Ulerich, N.H. et al (1982)[3] that was completed for B.C. Hydro. These results were somewhat disappointing. However, four sites near Hat Creek were selected because they offered the best opportunity for obtaining a sample for further testing. The sites are Anderson Creek (No. 4 and No. 5), Langley Lake (No. 6), Robertson Creek (No. 13 and No. 14) and Pavilion Mountain (No. 16) as illustrated in Fig. 1-1.

The criteria for selecting these four sites are based partly on the results of the testing at Westinghouse and are as follows:

1. These sites required the least quantity of sorbent (limestone or dolomite) for sulphur removal. The quantity ranged from 47.8 Mt from site No. 16 to 82.6 Mt from site No. 13 (for 2000 MW).

2. It is preferable that the deposit be close to Hat Creek. Sites No. 4 and No. 5 are 13.5 km from the proposed powerplant site, site



B.C. HYDRO

LOCATION MAP SHOWING POTENTIAL LIMESTONE AND DOLOMITE AREAS NEAR HAT CREEK

FIGURE 1-1

No. 6 is 16 km, sites No. 13 and No. 14 are 9.5 km and site No. 16 is 25.5 km.

3. The stone should have a high Mg content, a small grain size and/or numerous small impurities. The small grain size and the presence of impurities result in increased grain boundaries or surface area for reaction. These characteristics are summarized in Table 1-1 (from Ulerich, N.H., et al, 1982). The columns headed (% Mg), Average Grain Size, Surface Area and kg Sorbent/kg Sulphur Fed are particularly important.

Between 29 May and 8 June 1982 geological mapping was conducted and some additional samples were collected for analysis at some of site Nos. 4, 5, 6, 13, 14 and 16. As a result of this geological mapping a site for a bulk sample was selected at Anderson Creek (sites No. 4 and No. 5). The sample was collected by Bema Industries Ltd. between 11 and 15 August 1982 and subsequently sent to the United Kingdom for further testing.

TABLE 1-1

BRITISH COLUMBIA SORBENT SCREENING TEST SUMMARY
(from Ulerich et al, 1982)

Sorbent	Chemical Analysis		Physical Analysis of Raw Stone				PFBC Performance[A3]			AFBC Performance[A4]		
	(% Ca)	(% Mg)	Average Grain Size (μm)[A1]	Pore Volume (cc/g)[A2]	Surface Area (m^2/g)[A2]	Particle Density (g/cc)[A2]	Utilization (%)	Ca/S Molar Ratio	kg Sorbent/ kg Sulphur Fed	Utilization (%)	Ca/s Molar Ratio	kg Sorbent/ kg Sulphur Fed
Plum Run Dolomite	20.4	12.30	32	0.045	0.718	2.44	37.8 ± 4.6	2.4 ± 0.3	14.7 ± 1.8	29-31	2.9-3.1	18.4
Limestone No. 1	37.3	1.66		0.024	0.056	2.54	1.9	47	158	16.1	5.6	18.7
Limestone No. 2	39.1	0.54		0.023	0.124	2.51	0.8	113	361	13.4	6.7	21.5
Limestone No. 3	37.8	0.74		0.027	0.075	2.51	3.0	30	99	17.2	5.2	17.3
Limestone No. 4	37.7	0.94		0.033	0.122	2.47	5.6	16	53	23.3 ± 2.7	3.9 ± 0.5	12.9 ± 1.7
Limestone No. 5	38.3	0.88		0.031	0.185	2.46	5.1	18	59	24.4	3.7	12.0
Dolomite No. 6	25.0	9.52	27	0.034	0.473	2.51	9.0 ± 0.7	10.1 ± 0.7	51 ± 4	26.6	3.4	16.9
Limestone No. 8	34.0	1.13		0.023	0.0011	2.45	2.3	39	143	12.4	7.3	26.7
Limestone No. 9	36.9	1.13		0.017	0.0011	2.50	2.2	41	139	11.3 ± 0.6	8.0 ± 0.4	27.1 ± 1.4
Limestone No. 10	38.1	1.03		0.016	0.0011	2.49	1.0	90	295	7.9	12.6	41.3
Limestone No. 11	34.6	2.48		0.027	0.0011	2.49	3.2	28	101	8.2	11.0	39.7
Limestone No. 12	37.1	1.48		0.024	0.0012	2.50	2.1	43	145	13.2	6.8	23.0
Dolomite No. 13	24.4	9.91	35	0.028	0.190	2.57	7.2	12.5	64	23.8	3.8	19.4
Limestone No. 14	34.0	2.71		0.030	0.137	2.49	5.2	17	63	17.1	5.3	19.3
Limestone No. 15	38.7	0.66		0.029	0.098	2.48	3.3	27	87	14.4	6.3	20.2
Dolomite No. 16	24.1	10.20	120	0.042	0.279	2.55	11 ± 1.7	8.4 ± 1.3	44 ± 7	35.4	2.5	13.2
Marble Canyon Limestone	38.7	0.75		0.024	0.234	2.52	1.3	69	223	13.6	6.6	21.3
TEX CA Limestone	38.0	0.79		0.077	0.196	2.48	4.0	22.5	74	21.9 ± 1.5	4.1 ± 0.3	13.5 ± 1.0
TEX MG Limestone	33.2	4.55		0.045	0.240	2.52	2.0	45	169	18.1	5.0	18.7
Steel Bros. Limestone	38.4	1.46		0.022	0.0011	2.50	1.6	56	182	11.7	7.7	25.0
Zeballos Dolomite	26.2	9.83	180	0.023	0.047	2.64	2.9	31	148	17.4	5.2	24.7
Dolowhite Mines Dolomite	21.5	11.40	210	0.025	0.105	2.66	6.0	15	87	29.3	3.1	18.0
International Marble Dolomite	21.8	11.40	75	0.017	0.044	2.71	2.3	39	224	11.3	8.0	45.6
Grandex Dolomite	24.2	11.00	180	0.033	0.060	2.76	4.5	20	103	-	-	-

[A1] Determined by ASTM E112 Method
[A2] Determined by Mercury Penetration Porosimeter
[A3] Projection for 90 percent Sulfur Removal at 1600 kPa, 850°C, 8.7 percent CO_2, 3.3s Gas Residence Time, 1100 μm Particles from TG Data
[A4] Projection for 90 percent Sulfur Removal at Typical AFBC Conditions (840°C, 20 percent Excess Air, 0.5s Gas Residence Time, 1100 μm Particles) from TG Data

SECTION 2.0 - GEOLOGY OF THE MARBLE CANYON FORMATION IN THE HAT CREEK AREA

2.1 GENERAL GEOLOGY

The Marble Canyon Formation (Fig. 2-1) is part of the Cache Creek Group and it comprises a northwest trending belt approximately 10 km wide and 90 km long. It is Permian in age and consists mainly of ridge-forming, variably bedded limestones, with poorly exposed chert, .pelite and volcanic rocks. Dolostone beds are rather rare, but nevertheless exist in the western part of the northern study area. In addition, some limestone beds contain small amounts of dolomite.

The Marble Range has undergone considerable deformation which makes interpretation of the stratigraphy very difficult. Similarly the geological environment of deposition is difficult to interpret.

The Marble Canyon Formation consists of five map-units (designated units 2 to 6 in Trettin, 1979)[2] that overlie the volcanic rocks of the Cache Creek Group. These units are outlined in Fig. 2-1.

Map-units 2 and 4 are mainly limestone with minor chert, marble, and dolostone in unit 2.[1] Units 2 and 4 could be lithofacies equivalents; unit 2 may have been deposited on the shelf between the deep sea detrital sediment (unit 6) to the west and the thick-bedded limestone (unit 4) to the east. The occurrence of dolostone in map-unit 2 may be associated with marginal shelf deposition of the unit, and evaporation of water, with the resulting concentration of brine on top of the shelf.

Map-units 3 and 5 are also thought to be lithofacies equivalents. The two units are very similar, consisting mainly of lithic arenite and siltstone, carbonate rocks, chert, and pelite. Unit 3 also has volcanic

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

SYMBOLS

- BOUNDARY OF AREA OF DETAILED MAPPING
- SMALL OUTCROP
- GEOLOGICAL BOUNDARY
- BEDDING, TOPS KNOWN (INCLINED, OVERTURNED)
- BEDDING, TOPS KNOWN, ESTIMATED DIP (MODERATE)
- BEDDING, TOPS KNOWN (DIP DETERMINED BY PHOTOGRAMMETRY)
- BEDDING, TOPS UNKNOWN (INCLINED, VERTICAL)
- BEDDING, TOPS UNKNOWN, ESTIMATED DIP (MODERATE, VERY STEEP)
- SLATY CLEAVAGE (INCLINED)
- FAULT (THRUST) (NORMAL OR STRIKE-SLIP)
- ANTICLINE
- ANTICLINE (OVERTURNED)
- SYNCLINE
- SYNCLINE (OVERTURNED)
- STRATIGRAPHIC SECTION (SHORT, LONGER, PHOTOGRAMMETRIC SECTION)
- FOSSIL LOCALITY
- POTENTIAL SITE FOR DOLOSTONE OR DOLOMITIC LIMESTONE
- SAMPLE LOCATION LST 1

E

CHERTIFIED IN THIS AREA

FORTYMILE CREEK ANTICLINORIUM

LESLIE CREEK ANTICLINE

N

LST 16
LST 15
LST 10
LST 11
LST 12
LST 14
LST 13
LST 9
STEEL BROS.
LST 8
LST 2
LST 1
LST 3
LST 5
LST 4
LST 17
LST 18
LST 19
LST 6
LST 7

F R A S E R P L A T E A U

T E R R I O R P L A T E A U

R I D G E

R A N G E

LEGEND

QUATERNARY

UNCONSOLIDATED SEDIMENTS
Q — UNDERLYING BEDROCK IS INDICATED BY THE APPROPRIATE SYMBOL.

TERTIARY — CENOZOIC

MIOCENE
VESICULAR BASALT, OLIVINE BASALT, BASALT, ANDESITE

EOCENE AND/OR MIOCENE
KAMLOOPS GROUP
BASALT, ANDESITE, RHYOLITE; ASSOCIATED TUFF AND BRECCIA; LAHAR(L); INCLUDES VOLCANIC ROCKS THAT UNDERLIE THE KAMLOOPS SEDIMENTARY ROCKS
SANDSTONE, CLAYSTONE, SILTSTONE, CONGLOMERATE AND COAL (INCLUDES COLDWATER BEDS PLUS HAT CREEK COAL AND MEDICINE CREEK FORMATIONS)
UNDIFFERENTIATED VOLCANICLASTICS
DETRITAL ROCKS CONSISTING OF MIXED VOLCANIC SANDSTONE, SILTSTONE, AND CONGLOMERATE

CRETACEOUS — MESOZOIC

SPENCES BRIDGE GROUP
ANDESITE, DACITE, BASALT AND RHYOLITE; TUFF, BRECCIA, AGGLOMERATE; CONGLOMERATE, SANDSTONE, GREYWACKE AND ARKOSE.

CRETACEOUS OR JURASSIC
GRANODIORITE AND QUARTZ DIORITE

TRIASSIC OR PERMIAN
PAVILION GROUP
ARGILLITE, PHYLLITE, CHERT, LIMESTONE, TUFF, GREYWACKE, GREENSTONE AND SCHIST

PERMIAN OR CARBONIFEROUS
CACHE CREEK GROUP
GREENSTONE, CHERT, ARGILLITE, GREENSCHIST, QUARTZITE AND LIMESTONE

WESTERN BELT

CARBONIFEROUS(?), PERMIAN AND (?) TRIASSIC
CACHE CREEK GROUP
6 — CHERT, PELITE, LIMESTONE, VOLCANIC ROCKS; 6v: VOLCANIC ROCKS; 6cb: LIMESTONE

PERMIAN
CENTRAL BELT
MARBLE CANYON FORMATION
LIMESTONE: (CONTAINS UNITS 1-6 WHICH HAVE NOT BEEN MAPPED IN DETAIL; WHERE THE GEOLOGY OF THE LIMESTONES HAS BEEN MAPPED IN DETAIL, THE DETAILED UNITS ARE INDICATED

UPPER PERMIAN (GUADALUPIAN)
MARBLE CANYON FORMATION
5 — LITHIC ARENITE, CHERT, PELITE, CARBONATE ROCKS (PROBABLY EQUIVALENT OF MAP UNIT 3 REPEATED BY THRUST FAULTING); 5or: LITHIC ARENITE; 5cb: CARBONATE ROCKS, 5ch: CHERT, PELITE
4 — MASSIVE LIMESTONE (PROBABLY FACIES EQUIVALENT OF MAP UNIT 2, SUPERIMPOSED ON 3 BY THRUST FAULT)
3 — LITHIC ARENITE AND SILTSTONE, VOLCANIC ROCKS, CARBONATE ROCKS, CHERT, PELITE; 3cb: CARBONATE ROCKS
2 — WELL-BEDDED LIMESTONE WITH STRINGERS OF CHERT, MINOR MARBLE, DOLOSTONE

UPPER AND/OR LOWER PERMIAN (GUADALUPIAN AND/OR LEONARDIAN)
CACHE CREEK GROUP
1 — BASALT, CHERT, PELITE, CARBONATE ROCKS, 1cb: CARBONATE ROCKS; 1ch: CHERT, PELITE; 1v: VOLCANIC ROCKS; MINOR LIMESTONE, CHERT.
INFERRED GEOLOGY
MARBLE CANYON FORMATION
2(?) — WELL BEDDED LIMESTONE WITH STRINGERS OF CHERT; MINOR MARBLE, DOLOSTONE. THIS UNIT INFERRED FROM NORTHERN DETAILED GEOLOGICAL MAPPING
POSSIBLE DOLOMITIZATION ON LIMESTONE/INTRUSIVE CONTACT

PALEOZOIC AND (?) MESOZOIC

SCALE 0 1 2 3 4 KM

B.C. HYDRO

GEOLOGICAL MAP SHOWING POTENTIAL LIMESTONE AND DOLOMITE AREAS NEAR HAT CREEK

FIGURE 2-1

rocks which are not found in unit 5. For map-units 2 and 4, and map-units 3 and 5 to be lithofacies equivalents, there must be a low angle thrust fault between units 3 and 4. If this is the case, map units 4 and 5 constitute a thrust sheet that overlies and repeats map-units 2 and 3.

Map-unit 6 comprises the western belt, and is Carboniferous (?), Permian (?) and Triassic in age. It consists of chert, pelite, limestone, and volcanic rocks. Unit 6 was probably deposited at the same time as units 2 and 3. Locally, dolomite comprises a few percent of the rock and occurs as rhombohedra that are very fine to finely crystalline in size. The rock is brecciated and traversed by stylolites. The preponderance of interstratified radioloarian chert and pelite in this unit suggests a deeper water environment. If so, the limestones must be submarine slide deposits, but this has not been established.[1] The description given by H.P. Trettin suggests that unit 6 forms the western edge of the map-unit 2 marginal shelf deposits. The existence of dolomite in the unit 6 sediments lends support to the theory that evaporative reflux has occurred in a unit 2 shelf margin setting above and adjacent to map-unit 6.

2.2 METASOMATIC DOLOMITIZATION

Volcanic rocks of the Cache Creek Group which underlie the limestone units are thought to predate them. Basalt and diorite intrusions occur in the limestone strata near Hat Creek. These intrusions postdate the limestones; the basaltic unit is Eocene and (?) Oligocene in age and part of the Skull Hill Formation. It consists of dacite, trachyte, basalt, andesite, rhyolite, and associated breccias. The granodiorite and quartz diorite intrusions (further south than the basalts, and nearer Hat Creek) are Cretaceous and Jurassic in age. The extent of localized dolomitization on intrusive-limestone contacts has been partly investigated and found to be insignificant.

SECTION 3.0 - SITES EXAMINED FOR DOLOMITE OR DOLOMITIC LIMESTONE

3.1 INTRODUCTION

Four areas of dolomitic rocks were examined for this report. These sites are Anderson Creek (No. 4 and No. 5), Langley Lake (No. 6), Robertson Creek (No. 13 and No. 14) and Pavilion Mountain (No. 16). Refer to Fig. 1-1 for locations.

3.2 ANDERSON CREEK (No. 4 and No. 5)

The locations that were examined on Anderson Creek are approximately 13.5 km from the proposed powerplant site near Harry Lake. The outcrops are on a steep hillside on the north side of Anderson Creek between El. 1660 and 1910. Access is by way of a logging road and cattle trail to El. 1580, directly below the outcrops. The limestone and dolomitic limestone (carbonate) comprise a remnant on the southern end of the Mount Martley stock (Fig. 2-1). The stock is Jurassic and Cretaceous in age, but it has not had a significant effect on the chemistry or grain size of the limestone where it was examined. The carbonates consist of fine-grained and rarely medium-grained or coarse-grained limestone. The colour is mostly dark grey, but parts of some outcrops are black, white, grey, or black and white streaked (Fig. 3-1). The beds strike approximately 135° and dip mostly 35° to 75° SW. In the central part of the area the dips are more erratic; lower dip angles are common and the dips are even northeast at 51° and 57° at two locations.

The samples that were analyzed by Westinghouse were taken near L4-0 m and L4-650 m. The subsequent samples and analyses are listed in Table 3-1 and they were taken at L3-25 m (Fig. 3-2), L3-150 m (Fig. 3-3)

SITE 1 SITE 2

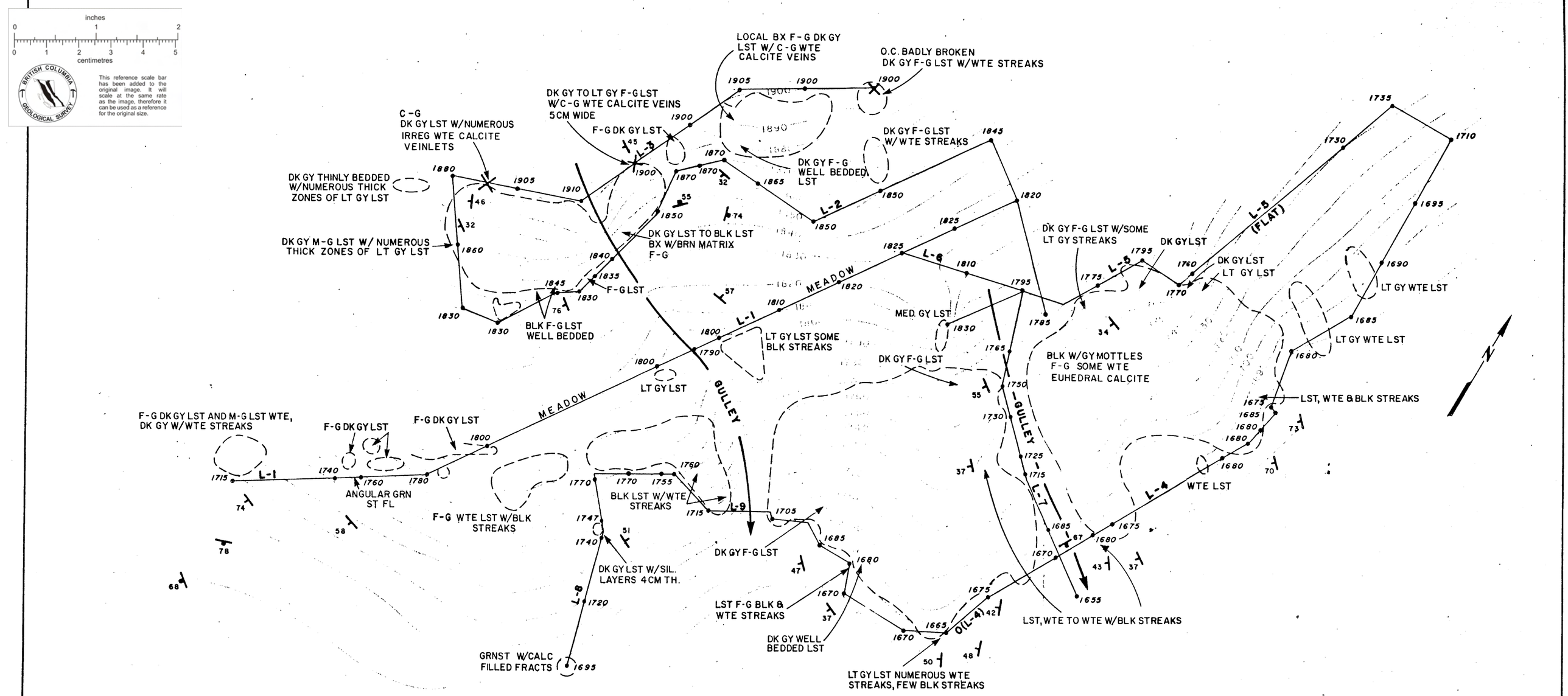


FIG. 3-1

GEOLOGY
ANDERSON CREEK #4 & #5
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

3-1

TABLE 3-1

LIMESTONE-DOLOMITE ASSAYS
(%)

Sample	I.D.	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MgO	CaO	Na_2O	k_2O	P_2O_5	LOI	Total	Dolomite[*1]
LST	1	1.23	0.75	0.17	0.02	4.57	50.47	0.02	0.07	0.02	43.49	100.81	20.91
LST	2	1.11	0.55	0.13	0.02	2.19	53.17	0.02	0.02	0.02	43.05	100.28	10.02
LST	3	1.15	0.59	0.14	0.02	2.06	53.29	0.02	0.02	0.02	43.19	100.50	9.42
LST	4	1.14	0.52	0.17	0.02	2.07	53.27	0.02	0.02	0.02	43.22	100.40	9.47
LST	5	0.64	0.57	0.24	0.02	2.13	53.35	0.02	0.02	0.02	43.40	100.49	9.74
LST	6	5.83	0.50	0.18	0.02	17.47	33.83	0.02	0.02	0.06	43.03	100.96	79.93
LST	7	67.00	0.30	0.60	0.02	1.42	17.22	0.02	0.02	0.11	14.24	100.95	6.50
LST	8	11.50	0.66	0.21	0.02	2.86	47.81	0.02	0.02	0.02	38.69	101.83	13.08
LST	9	4.94	0.53	0.14	0.02	3.24	50.94	0.02	0.02	0.02	41.25	101.13	14.82
LST	10	0.46	0.50	0.11	0.02	2.45	53.90	0.02	0.02	0.02	43.49	101.08	11.21
LST	11	2.78	0.85	0.17	0.02	4.69	49.76	0.02	0.20	0.20	42.29	100.81	21.46
LST	12	1.71	0.52	0.11	0.02	4.47	51.16	0.02	0.02	0.02	43.26	101.36	20.45
LST	13	1.63	0.56	0.13	0.02	17.09	36.56	0.02	0.02	0.02	45.50	101.63	78.19
LST	14	1.57	0.56	0.12	0.02	6.04	49.57	0.02	0.02	0.02	43.53	101.49	27.63
LST	15	0.57	0.61	0.16	0.02	2.09	54.23	0.02	0.02	0.02	43.49	101.24	9.56
LST	16	0.73	0.70	0.26	0.05	20.44	33.22	0.02	0.02	0.03	46.13	101.60	93.51
Tex	Ca	0.63	0.58	0.17	0.02	2.15	54.52	0.02	0.02	0.02	43.47	101.60	9.84
Tex	Mg	1.70	0.76	0.39	0.03	10.22	44.32	0.02	0.02	0.02	43.99	101.50	46.76
Steel Bros[*2]		0.4	-	0.03[*3]	-	0.2	54.60	-	-	-	44.20	99.70	0.92
Dolowhite Mines[*4]		6.74	0.37	0.15	-	18.07	30.76	-	-	-	43.87	99.96	82.67
International Marble[*4]		1.78	0.04	0.40	-	20.51	30.88	-	-	-	46.61	100.22	93.83
A.C. L2-600		1.22	0.58	0.22	0.02	0.43	53.26	0.51	0.02	0.02	42.95	99.01	1.97
A.C. L3-150		0.52	0.56	0.25	0.02	0.43	53.88	0.02	0.02	0.02	43.16	98.88	1.97
A.C. L3-350		0.57	0.56	0.18	0.02	0.47	54.12	0.02	0.02	0.02	42.28	98.26	2.15
L.L. L1-124		7.33	0.47	0.20	0.02	4.13	46.25	0.02	0.02	0.02	40.20	98.74	18.89
L.L. L1-1100		0.80	0.51	0.21	0.02	17.86	33.52	0.02	0.02	0.04	45.49	98.49	81.71
L.L. L2-460		7.21	0.52	0.17	0.02	3.93	46.04	0.02	0.02	0.02	40.25	98.20	17.98
L.L. L2-870		4.69	0.55	0.25	0.02	17.81	32.16	0.02	0.02	0.07	44.06	99.65	81.48
L.L. L2-1419		11.95	0.52	0.17	0.02	4.41	43.43	0.02	0.02	0.02	38.46	99.02	20.18
L.L. L3-525		4.26	0.68	0.32	0.02	0.54	51.49	0.08	0.02	0.02	41.48	98.91	2.47
Quarry (0 - 5.2 m)		12.21	0.58	0.29	0.02	14.53	31.93	0.02	0.02	0.11	40.16	99.87	66.47
Quarry (5.2 - 7.6 m)		9.95	0.39	0.21	0.02	13.46	33.65	0.02	0.02	0.07	40.75	98.54	61.58
Quarry (7.6 - 17.4 m)		10.39	0.55	0.29	0.02	1.65	47.59	0.02	0.02	0.02	38.61	99.16	7.55
Quarry (17.4 - 22.0 m)		13.02	0.60	0.24	0.03	0.46	47.78	0.03	0.03	0.03	37.46	99.68	2.10
Quarry (22.0 - 37.2 m)		15.67	0.57	0.27	0.03	1.31	45.07	0.03	0.03	0.03	36.34	99.35	5.99
A.C.-1-1		1.42	0.58	0.28	0.20	0.50	54.61	0.14	0.02	0.02	42.42	100.19	2.29
A.C.-1-2		6.91	0.49	0.25	0.20	0.57	52.31	0.17	0.02	0.02	40.31	101.25	2.61
A.C.-1-3		12.60	0.55	0.30	0.30	0.64	48.65	0.34	0.03	0.03	37.43	100.87	2.93
A.C.-2-1		0.40	0.54	0.25	0.20	0.65	55.81	0.17	0.02	0.02	43.06	101.12	2.97
A.C.-2-2		0.24	0.50	0.24	0.20	0.72	55.83	0.27	0.02	0.02	43.03	101.07	3.29
A.C.-2-3		0.13	0.55	0.29	0.20	0.72	55.47	0.54	0.02	0.02	43.00	100.94	3.29
A.C.-3-1		0.90	0.58	0.19	0.20	0.71	55.32	0.34	0.02	0.02	41.74	100.02	3.25
A.C.-3-2		1.25	0.77	0.21	0.20	1.08	54.99	0.49	0.02	0.02	41.99	101.02	4.94
A.C.-3-3		0.14	0.52	0.19	0.20	0.79	55.33	0.12	0.02	0.02	42.09	99.42	3.61
LST 17		41.93	0.44	0.30	0.30	0.36	32.11	0.29	0.03	0.21	24.74	100.71	1.65
LST 18		0.39	0.43	0.15	0.20	0.91	55.47	0.13	0.02	0.02	43.00	100.72	4.16
LST 19		0.26	0.58	0.18	0.20	0.81	55.50	0.02	0.02	0.02	42.49	100.08	3.71

Texada

Anderson Cr.

Langley Lake

on road @S. end of H.C. Valley

Anderson Cr.

[*1] Stochiometric calcite has 56.03 percent CaO and 43.97 percent CO_2, whereas dolomite has 30.41 percent CaO, 21.86 percent MgO and 43.73 percent CO_2. Ideally, the percentage dolomite may be obtained by multiplying the MgO content by 4.575.

[*2] Typical sample from Steel Brothers quarry, assayed in 1970.

[*3] Combined Fe_2O_3 and Al_2O_3.

[*4] Analysis obtained from the company.

Fig. 3-2 View of L3-25 m: Anderson Creek Site 1

Fig. 3-3 View of L3-150 m: Anderson Creek Site 2

SITE 3

and L3-350 m (Fig. 3-4). These sites were selected because they offered the best opportunities for collecting a bulk sample on this steep hillside which is illustrated in Fig. 3-5.

The three samples have similar chemical compositions to samples tested by Westinghouse except that MgO was markedly lower in these latter samples. For this reason the MgO content was re-analyzed and the MgO values increased. The latest analyses are listed in Table 3-1. The analyses indicate that the samples are actually limestones with a very low magnesian content, much lower than samples collected at L4-0 m and L4-650 m.

The quantity of limestone required for a 2000 MW PFBC powerplant is 76 Mt on the basis of the Westinghouse testing; this assumes that the sorbency is equivalent to 59 kg sorbent per kg of sulphur removed (Table 1-1). Sufficient material is probably available from this site if the quality is consistent over the area; however, the lower MgO in the samples that were analyzed more recently indicates that the composition is variable.

3.3 LANGLEY LAKE (No. 6)

The Langley Lake site is near the south end of the Upper Hat Creek Valley, 16.0 km south of the proposed Harry Lake powerplant site (Fig. 1-1). The limestone, dolomitic limestone and dolomite comprise an elongate block bounded by faults (horst), in the Cornwall Hills, on the edge of the Hat Creek Valley (Fig. 2-1). The fault block is 9.5 km long and 1.7 km wide and it has a series of cliffs on its west side. The Ministry of Transportation and Highways has a little-used quarry for road aggregate at the junction of the Oregon Jack Creek road and the main entrance to the Reynolds Ranch. The quarry and much of the surrounding area that is underlain by limestone lies on property held by Ridge Investments Ltd. (Reynolds Ranch).

Fig. 3-4 View of L3-350 m: Anderson Creek Site 3

Fig. 3-5 Steep Hillside in Limestone Near Hat Creek (L2-400 m)

The carbonates consist of grey, rarely white or black, fine-grained or medium-grained, rarely coarse-grained limestone, dolomitic limestone and dolomite that are interbedded and impractical to separate (Fig. 3-6). There are rare beds of quartzite, shale and sedimentary breccia; the latter have black chert clasts in a calcareous matrix. Some of the limestones are markedly siliceous. The beds strike 010° to 055°, but they commonly strike 025° and dip 22° to 86° NW. They rarely dip at a high angle to the southeast. Although bedding attitudes are variable, they are commonly steeper in the western part of the Langley Lake area. One concentric fold was mapped; the axial plane strikes 090° and dips 25° N, the axis plunges 335° at 20°. The fold is in well-bedded, fissile limestone that looks shaly.

The samples (LST 6 and LST 7) that were analyzed during the previous study (Report No. SE 8117, September 1981)[1] were taken from the Ministry of Transportation and Highways' quarry. Sample LST 6 proved to be the second best of the samples tested at Westinghouse Research, whereas Sample LST 7, a sedimentary breccia with a calcareous matrix, is so siliceous that it was not tested.

In 1982 samples were taken from the rock quarry as well as along the chained lines. Samples from the quarry (Fig. 3-7) are all siliceous with silica (SiO_2) contents ranging from 9.95 percent to 15.67 percent (Table 3-1). The two most easterly samples are siliceous dolomites. Dolomites were sampled at 1100 m along Line 1 and at 870 m along Line 2 (Table 3-1). The former is fine-grained and dark grey, the latter is light grey-brown, fine-grained and siliceous. Samples from Line 1 at 124 m, Line 2 at 460 m and Line 2 at 1419 m are siliceous, medium grey to black, dolomitic limestones. The sample from Line 3 at 525 m is dark grey to white, coarse-grained, siliceous limestone.

The quantity of dolomite required for a 2000 MW PFBC powerplant operating for 35 years is 61 Mt; this assumes that the sorbency is equivalent to 47 kg/kg sulphur, the quantity required for the test on

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

N

GULLEY
EDGE OF TREES
WTE LST
LT GY TO WTE LST
LT GY LST
WTE LST
MED GY DOLO LST
MED GY LST
MED GY DOLO LST
MED GY LST
MED GY LST, MINOR WTE LST, GY DOLO LST (SAMPLE)
MED GY DOLO BX W/BLK DOLO FRAGS
MED GY DOLO FRAGMENTAL LST
DK GY LST
DK GY DOLO
DK GY DOLO LST
MED GY DOLO & DOLO LST
DK GY DOLO
LT GY LST
DK GY LST
LST BX W/AB SILICA
DOLO LST
LT GY LST, LOCALLY DOLOMITIC
LT BRN GY LST
BRN LST & MED GY DOLO
MED GY LST
MED GY LST
LT GY LST W/HEM STAIN ON FRACTS
DOLO LST MED GY TO LT GY
GY LST
DOLO BX W/BLK FRAGS SOME LT GY LST MINOR SIL ZONES
LT GY M-G LST
F-G WTE LST
DK GY LST
DK GY LST
DK GY LST
LT GY TO DK GY LST PODS OF DK GY DOLO
GY LST
GY DOLO
LT GY BRN SIL DOLO (SAMPLE)
L-2
GY QTZITE
DK GY CALC DOLO
F-G BLK & GY LST
DK GY F-G LST
DK GY DOLO LST
DK GY DOLO LST
MED GY LST
F-G BLK CALC DOLO
DK GY F-G DOLO LST AND F-G BLK CALC DOLO
BLK CALC DOLO
DK GY DOLO LST FL
L-1
LST, MINOR DOLO
MED GY LST
MED GY LST
DK GY DOLO LST
LST
DK GY DOLO LST W/NUMEROUS WTE CALCITE VEINLETS
DK GY DOLO LST
DOLO LST
DK GY DOLO LST, MINOR WTE DOLO (SAMPLE)
GY LST
LT GY SIL DOLO
LT GY SIL DOLO
LT GY SIL DOLO
LT GY SIL DOLO
MED GY CALC DOLO
LT GY LST
MED GY LST
DK GY LST W/ WTE MOTTLES
MED GY M-G DOLO
GY LST
MED GY DOLO LST
SED BX ANGULAR BLK CHERT FRAGS IN LST MATRIX
GY DOLO W/ CALCITE PODS, PARTLY SIL GY LST
BLK DOLO W/GY LST SST 0.3m TH W/ANGULAR TO SUBROUNDED CLASTS TO 0.5cm. (SAMPLE).
BLK LST
F-G BLK LST
GY (SAMPLES)
GY F-G LST
MED GY LST
TO REYNOLDS RANCH
ANGULAR FL GY DOLO
LT GRN CALC DOLO
F-G TO M-G MED GY LST
DK GY CALC DOLO
LT GY DOLO
GRN BRN SH BLK DOLO LST
ROAD & CATTLE TRAIL
GULLEY
L-3
DK GY MASSIVE AND FISSILE LST
DK GY SL
CONCENTRIC FOLD
DK GY TO WTE C-G LST, SAMPLE NOT FRESH, BEDS CONTORTED, LOCALLY, WELL-BEDDED (SAMPLE).
LT GY SIL DOLO
DK GY DOLO W/MINOR CHALCEDONY ALONG FRACTS (SAMPLE).
BRN GY C-G LST
MED GY F-G LST
DK GY LST
DK GY LST W/LENSES OF GY GRN SIL DOLO
M-G TO C-G DK GY LST
FISSILE LST OVERLIES LT GY M-G MASSIVE LST
DK GY LST
FISSILE LST UNDERLIES MASSIVE LST
MASSIVE LT GY TO WTE LST OVERLYING FISSILE LST, BEDS OF COBBLY LST W/CLASTS OF LST TO 15CM, BEDS ARE 1M THICK CALCAREOUS CEMENT
MASSIVE LST
MED GY FISSILE LST 3M+ THICK
MASSIVE DK GY TO MED BRN LST
STREAKED WTE AND BLK LST
M-G FISSILE LST

SEE INSET

0 50 100 150
SCALE IN METRES

LEGEND

L1	LINE NUMBER
1825	ELEVATION (METRES)
1825	LINE DISTANCE (METRES)
	BEDDING ATTITUDE
	JOINT ATTITUDE
	OUTCROP MARGINS

INSET

GULLEY
DK GY M-G TO OF-G LST
DK GY M-G LST

FIG. 3-6

GEOLOGY
LANGLEY LAKE #6
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

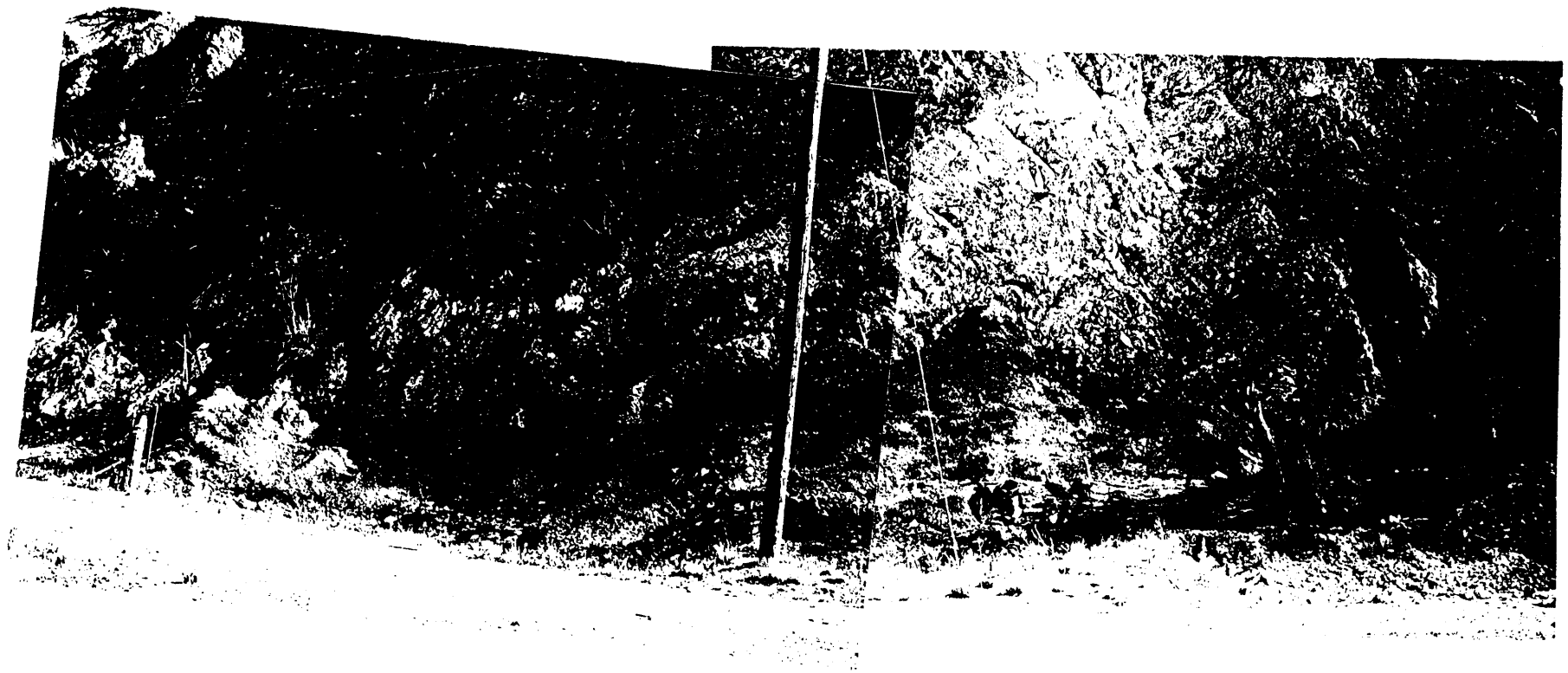


Fig. 3-7 Sampling Location Langley Lake Rock Quarry

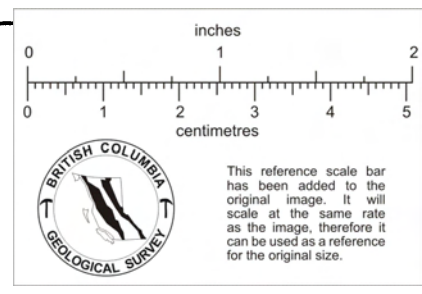
Langley Lake siliceous dolomite that was conducted by Westinghouse (Table 1-1). Sufficient material of a poorer sorbency is available at this site, but much of the material would have to be discarded because of its high silica content. In addition, the Ministry of Lands, Parks and Housing is reluctant to give approval to work on this site because of its proximity to a recreation area at Langley Lake.

3.4 ROBERTSON CREEK (No. 13 and No. 14)

The limestone, dolomitic limestone and dolomite at the Robertson Creek sites LST 13 and LST 14 lie along low ridges east of Robertson Creek (Fig. 1-1). The sites are approximately 9.5 km from the proposed powerplant site near Harry Lake and they are accessible from an old logging road that joins Highway 12 on Bonaparte Indian Reserve No. 2.

The ridges lie in a faulted zone near the southern end of the Marble Range (Fig. 2-1). Traverses were conducted at site No. 13 and site No. 14 and a line was extended to join the two main traverse lines. A 50 m base line with cross lines at 5 m intervals was established in order to conduct detailed mapping at site No. 13. Bedding attitudes at site No. 13 strike 108° to 152° and dip 30° SW to 90° (Fig. 3-8). Bedding that has gentler dips, strikes approximately 131° and dips 33° SW. Bedding attitudes with steep dips are scattered, but they still dip southwest.

The outcrops are mostly light grey, fine-grained limestone that is commonly massive, but it is locally thin-bedded (Fig. 3-9). A few irregular zones of light grey, fine-grained to medium-grained dolomite and dolomitic-limestone are as much as 7 m thick and overlie fine-grained, thin-bedded limestone strata. These strata are illustrated in Fig. 3-10.



LEGEND

LI LINE NUMBER

1825 ELEVATION (METRES)

1825 LINE DISTANCE (METRES)

BEDDING ATTITUDE

JOINT ATTITUDE

OUTCROP MARGINS

N

0 *1470*
LT GY LST
1475 50
MED GY LST
L-1
1490 100
MED GY, F-G LST
1505
MED GY, F-G LST
150 *1495*
MED GY, F-G LST
GULLEY
BL-0 *1500*
LST
33
LST
DOLO
LST AND DOLO
BL-50
250 *1495*
END OF AREA OF LT GY DOLO FL.
ANG DOLO FL
M-G, GY BRN LST
1480
DOLO
1465
L-2
300 *1490*
1475
M-G, MED GY LST
ANG. FL. LT. GY DOLO AND DOLO LST
GULLEY
1470
MED GY LST
350 *1480*
1500 400
BRN-GY LST
450 *1500*
L-1
1515 500
LT GY LST
LST W/SOME LT GY F-G DOLO LST
LT GY F-G THIN BEDDED LST
550 *1510*
76
1500 600
1495
MED GY LST
650
80
THIN BEDDED LT GY LST
LT GRN GY DOLO
1500 700
MOSTLY LT GY LST MINOR DOLO
1485 750
GULLEY
1480 800
MOSTLY LST MINOR DOLO LST LOCALLY THIN BEDDED
79
850 *1490*
LT GY LST
900 *1495*
950
1000 *1480*
MOSTLY F-G LT GY LST SOME C-G LST MINOR GY GRN F-G DOLO THAT WEATHERS BEIGE
1050 *1465*
MED GY LST
50 *1450*
L-3
100 *1430*
150 *1420*
200 *1425*
LT GY-WTE LST MINOR ARGILL ROCKS
250 *1425*
1415

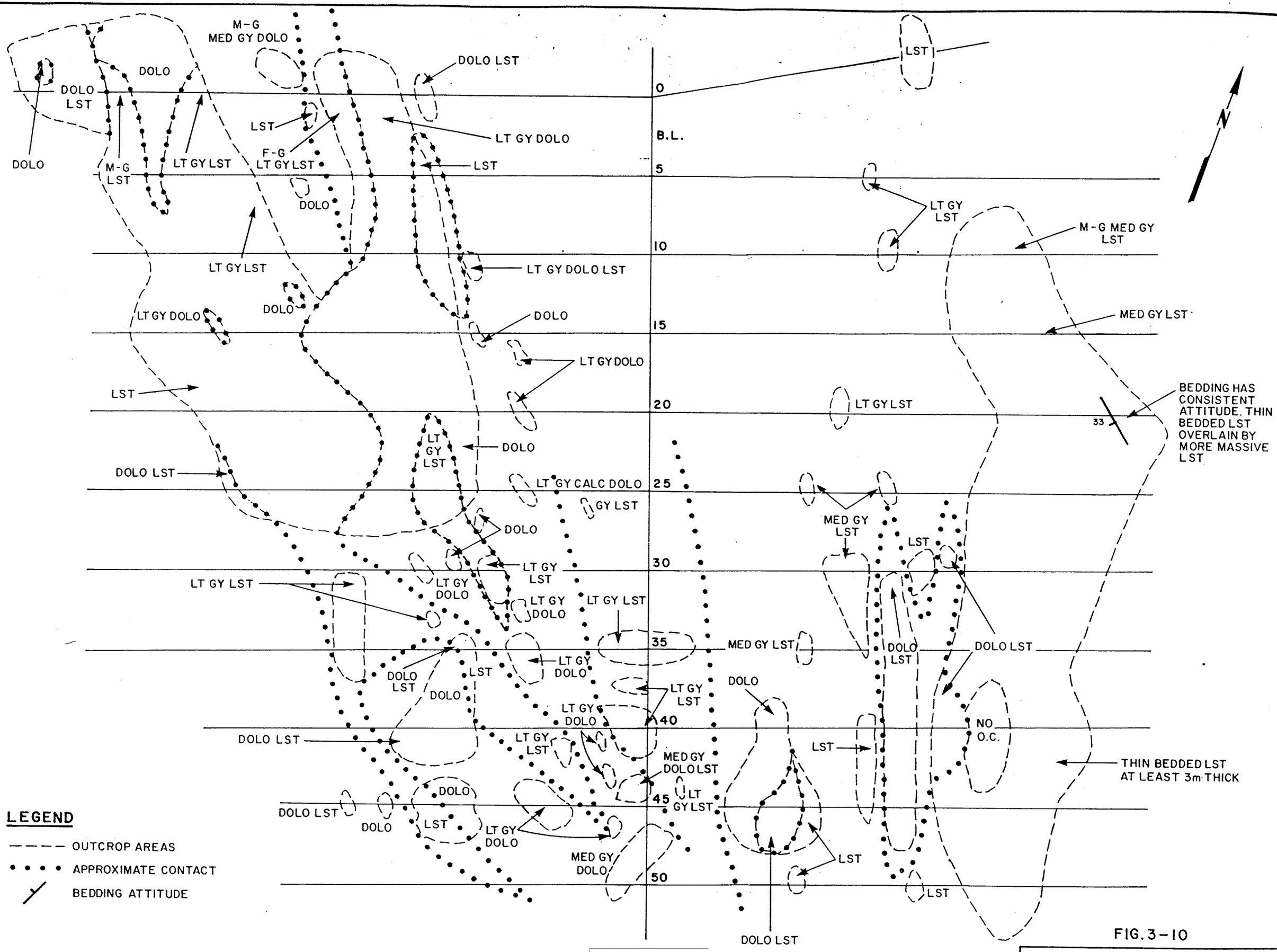
800 *1455*
LT GY TO MED GY LST
750 *1445*
LT GY LST
700 *1445*
DK GY LST
MED GY LST
650 *1440*
600 *1440*
550 *1435*
LST FL
500 *1435*
1440 450
1440 400
1435 350
1440 300
1440 250
42
1435 200
THINLY BEDDED LST AND MED GY, M-G, BUFF WEATHERING DOLO.
150 *1430*
1430 100
1440 50

0 50 100 150
SCALE IN METRES

FIG. 3-8

GEOLOGY
ROBERTSON CREEK #13
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

Fig. 3-9 Overview of Part of Robertson Creek No. 13 Limestone-Dolomite Showings



LEGEND

- OUTCROP AREAS
- APPROXIMATE CONTACT
- BEDDING ATTITUDE

0 5 10 15

SCALE IN METRES

inches
0 1
0 1 2
centimetres

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

FIG. 3-10

GEOLOGY
DOLOMITE SHOWINGS
ROBERTSON CREEK #13
NEAR HAT CREEK

siliceous dolomite. The dolomites are commonly associated with thin-bedded limestone and they do not appear to be extensive.

No additional samples from sites No. 13 and No. 14 were analyzed. The samples collected in 1981 contain 4.47 percent and 17.09 percent MgO (Table 3-1). The carbonates from both sites are fine-grained. These samples have a moderately favourable sorbency at 64 kg and 63 kg sorbent/kg sulphur fed (Table 1-1). The quantity required for a 2000 MW thermal plant operating for 35 years is 83 Mt. There is insufficient dolomite of the type found at site No. 13; however there may well be enough material of the type found at site No. 14 to supply a thermal plant. This site is close to the Hat Creek powerplant site provided that a road could be constructed from Robertson Creek.

3.5 PAVILION MOUNTAIN (No. 16)

The dolomite at site LST 16 lies along the access road to the B.C. Hydro and B.C. Telephone microwave stations (Fig. 1-1). The site is at a sharp bend in the road 4.55 km from the B.C. Hydro microwave station. The sample site is 25.5 km northwest of the proposed Harry Lake powerplant site and it is accessible by good gravel and dirt road from Kelly Lake or Pavilion. Two traverses were conducted one beginning at the sample site and the other beginning beside the road 1.7 km east-southeast of the sample site. Detailed mapping was also conducted at the sample site.

between agglomerate and limestone; the contact strikes 173° and dips 65° NE. Slaty cleavage strikes 168° and dips 89° NE, indicating that the folds are plunging southerly in the western part of the map area that is near the sample site. The dolomite is fine-grained and light grey, whereas the dolomite breccia in the roadcut is dark grey with angular, black clasts as much as 2 mm across. The greenstone is dark green and massive; it is associated with some sandy shales and other metasedimentary rocks.

Outcrops at the sample site are extensively broken (Fig. 3-13). The carbonate unit, consisting of approximately half limestone and limestone breccia and half dolomite breccia, is approximately 21 m wide in outcrop (Fig. 3-14). Some of the limestone breccia contains dolomite clasts. The bedding attitude could not be determined, but the foliation was measured at two places where it strikes 136° and 160° and dips 69° SW and 43° SW respectively. The foliation is in sandy to pebbly slate with 25 percent rounded to angular clasts which are as much as 6.3 cm long, but the clasts are usually much smaller. The foliation was also collected in light grey, sandy phyllite. Clasts in both the slate and the phyllite are elongated parallel to the slaty cleavage.

3.5

The second traverse was conducted on a ridge approximately 1 km east of the ridge that was traversed first (Fig. 1-1). The first outcrop that was encountered consists of light grey andesite. Subsequent outcrops are limestone and limestone breccia with minor greenstone, quartzite and slate (Fig. 3-15). The limestone is light grey to dark grey, rarely black, and usually fine-grained to medium-grained. Limestone breccia is

TRUCK ELEVATION - 1310 METRES

LEGEND

- L1 LINE NUMBER
- *1825* ELEVATION (METRES)
- 1825 LINE DISTANCE (METRES)
- BEDDING ATTITUDE
- JOINT ATTITUDE
- OUTCROP MARGINS

0 50 100 150
SCALE IN METRES

MED GY LST
W/WTE CALCITE VEINS
SAMPLE-ROBERTSON CR. #14
0 *1355*
50 *1350*
100 *1345*
MED GY LST
LT BRN GY SIL DOLO FL
150 *1345*
LT GY F-G LST
W/MOD CALCITE
VEINING, MINOR
LOCAL DOLO
63
1350
200
SIL DOLO FL
LT GY LST
LT GY F-G LST
THIN BEDDED LST
76
250
MED GY LST
1340
300
L1
1350
350
MED GY LST
MED GY LST
MED GY LST
1340
MED GY LST
450
DK GY LST
DK GY LST
500
DK GY LST
1325
550
DK GY LST
DK GY LST
DK GY LST
W/LOCALLY
ABUND. CALCITE
600 VEINS
1330
MED GY LST
MED GY LST
650
1325
MED GY TO
DK GY LST
700
1325
750
1330
800
1335
650
1330
MED GY TO
LT GY ALMOST
WTE LST
LT GY F-G LST
900
1325
LT GY DOLO FL
950
1330
MED GY LST
LT GY LST
1000
1320
DK GY LST
50
1315
GY LST
MED GY DOLO LST AND DOLO
100
1295
LT GY DOLO
GULLEY
L-2
150
1265
200
1275
250
1290
300
1320
1340
M-G LT GY LST
THINLY BEDDED
LT GY LST
1420
650
F-G MED GY LST
1440
1410
600
R #13
L4-50
R #14
L3-685
F-G LT BRN LST
1410
550
WTE LST
1400
500
MED GY LST
1385
450
LT GY LST
MOSTLY LT GY LST
MINOR LT BRN CALC DOLO
1370
400
LT GY LST
LT GY LST
1365
350
F-G LT GY LST
WTE LST
300
1360
M-G WTE LST
250
1350
LT GY LST
L-3
WTE TO LT GY LST
200
1345
WTE LST
1340
150
LT GY LST
SOME THIN BEDDED LST
MINOR LT GRN M-G DOLO
M-G LT GY LST
1350
100
F-G LT GY LST
1345
50
62
F-G LT GY LST

FIG. 3-11

GEOLOGY
ROBERTSON CREEK #14
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

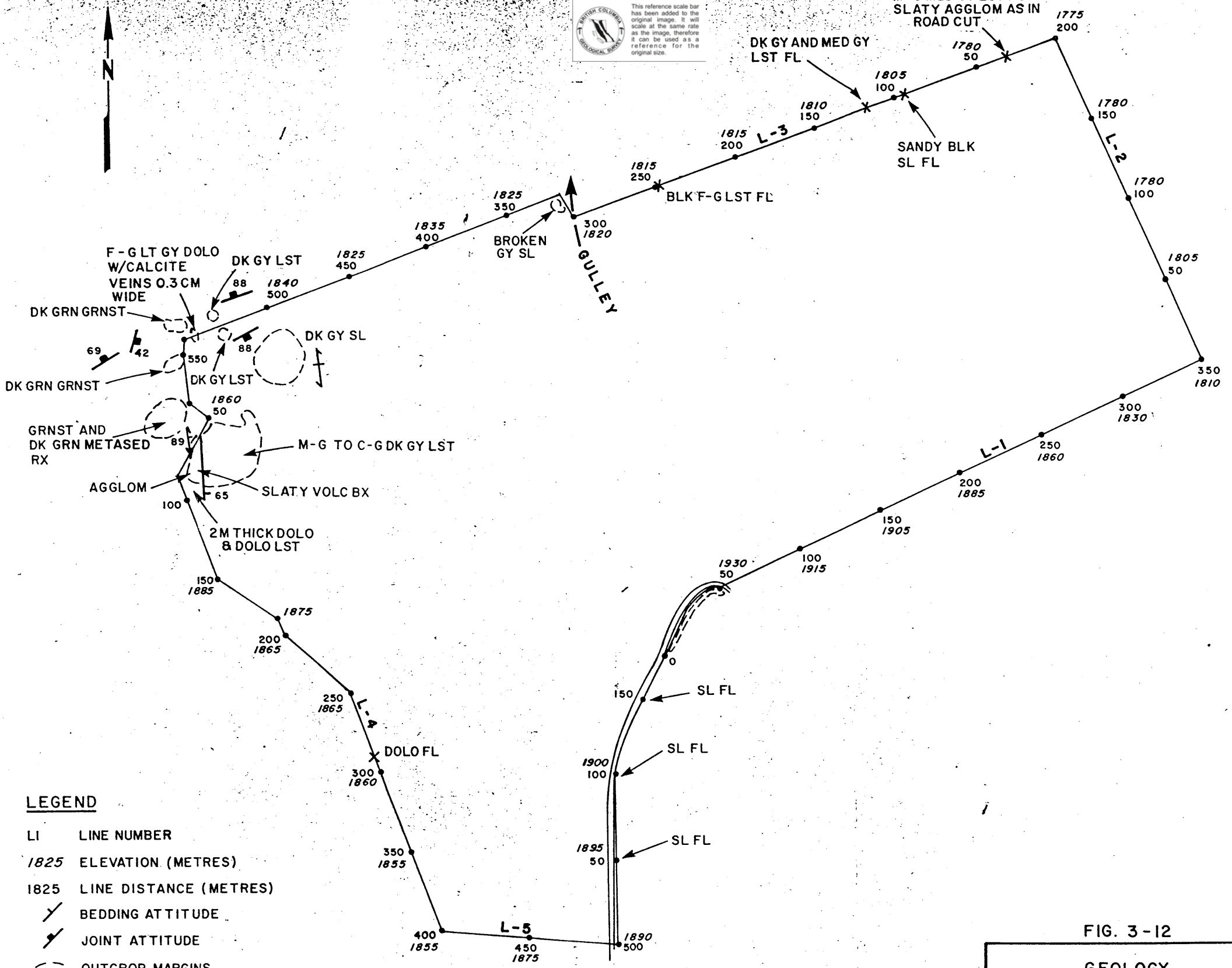


FIG. 3-12

GEOLOGY
PAVILION MOUNTAIN #16
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

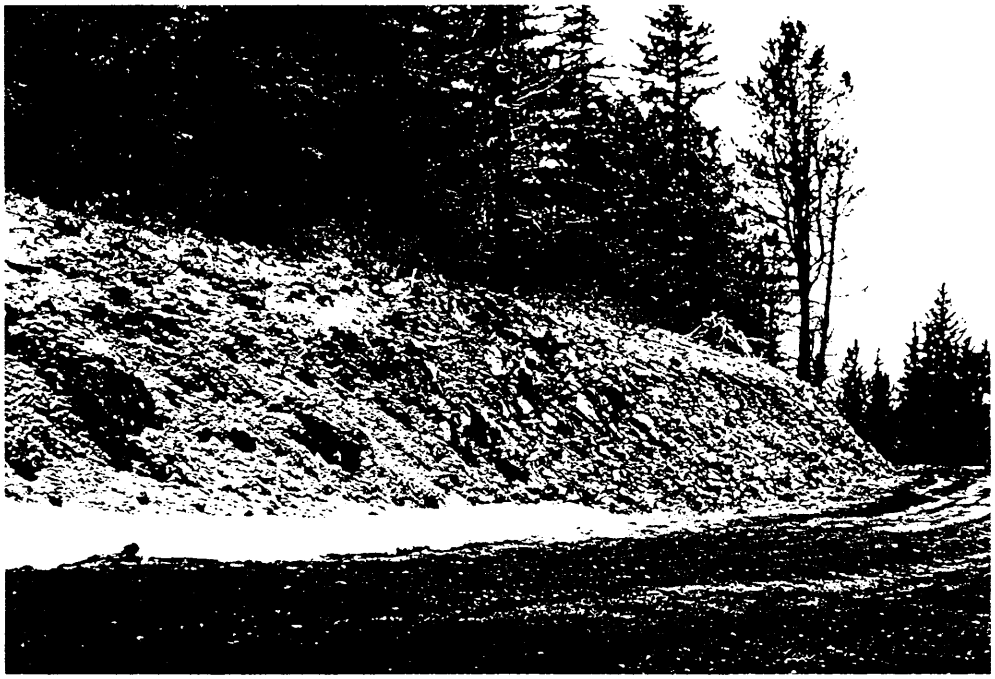


Fig. 3-13 Roadcut at Pavilion Mountain No. 16. Limestone-Dolomite Showings Which Consist of Broken Rock

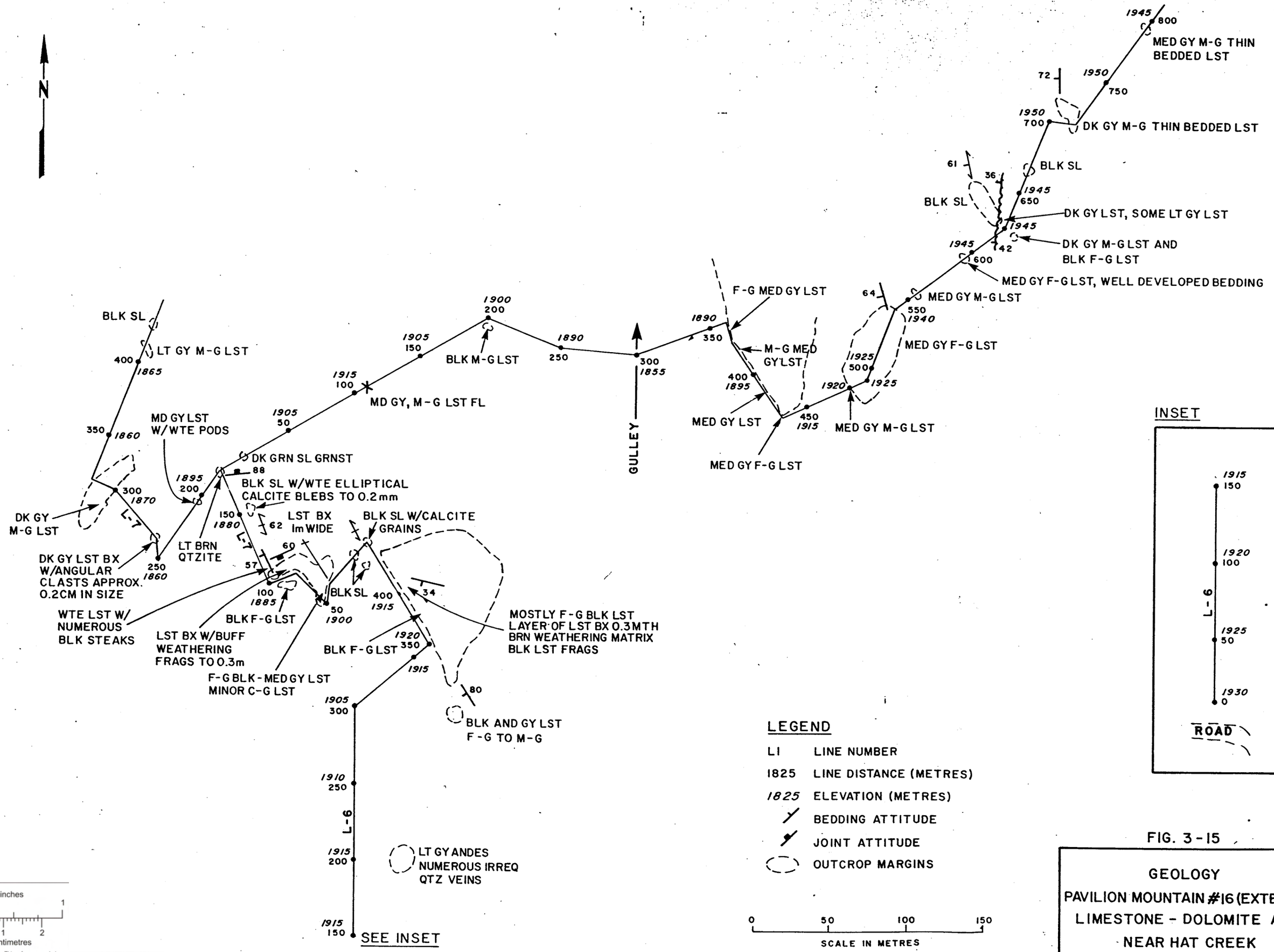


FIG. 3-15

GEOLOGY
PAVILION MOUNTAIN #16 (EXTENSION)
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

FIG 3-14

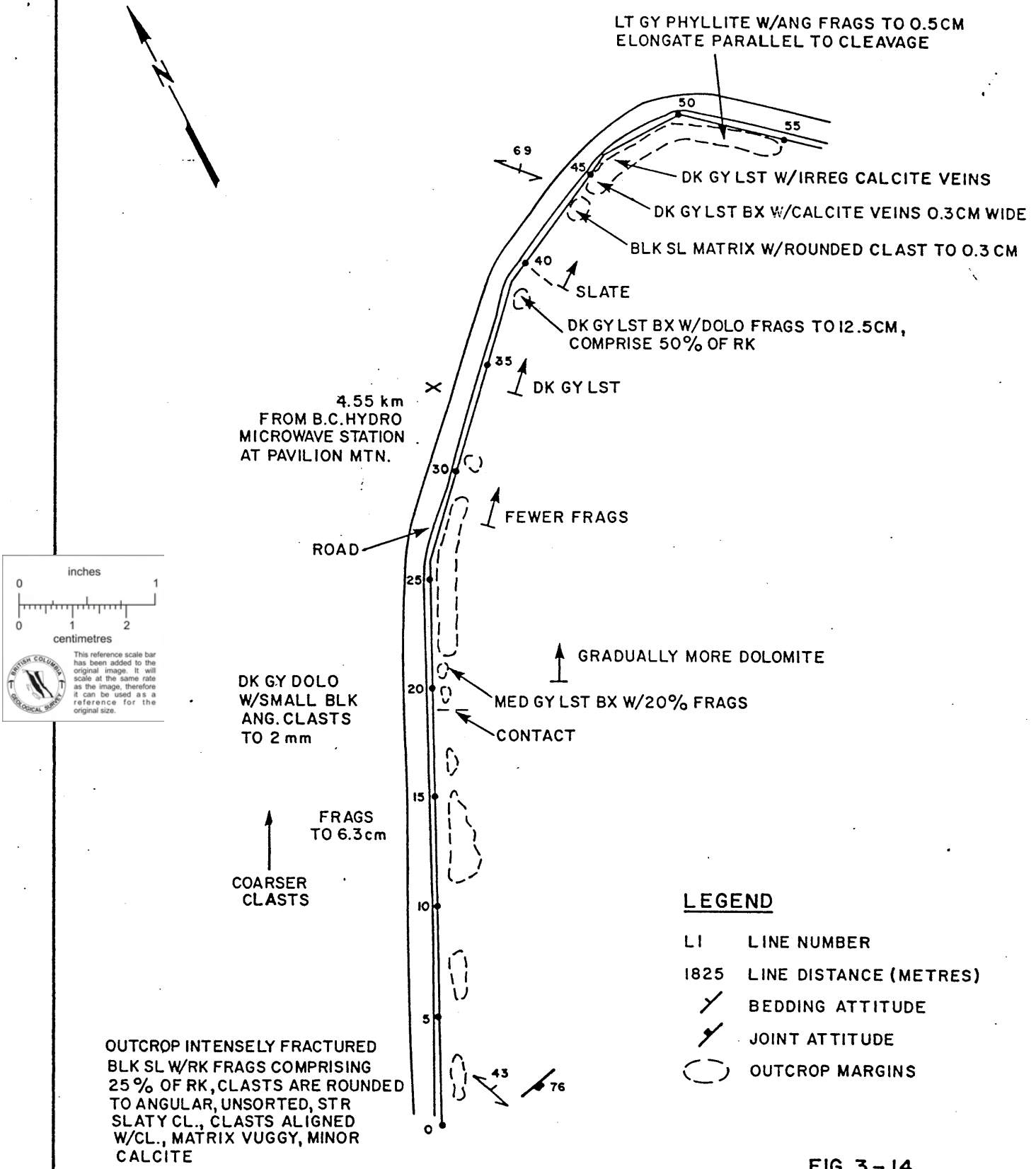


FIG. 3-14

GEOLOGY
DOLOMITE SHOWINGS
PAVILION MOUNTAIN #16
NEAR HAT CREEK

common in the southern part of the area. The maximum size of clasts ranges from 0.2 cm to 30 cm depending on the outcrop.

The bedding commonly strikes approximately 157° and dips 76° SW. The bedding is particularly thin along the northeast part of the traversed line.

No additional samples were taken from these sites in 1982. Sample LST 16 is fine-grained, with numerous small inclusions and it contains 20.44 percent MgO and 0.73 percent SiO_2. The sample has the best sorbency of any of the B.C. samples (Table 1-1). It was estimated by Westinghouse that 37 kg of sorbent would be required for each kilogram of sulphur fed.

The quantity required for a 2000 MW thermal plant over 35 years is 48 Mt. The dolomite at Pavilion Mountain is present in only small quantities. A limestone sample LST 15 was taken near the B.C. Hydro microwave station on Pavilion Mountain and it proved to be a poor sorbent (Table 1-1). An additional detraction of this site is its long distance from the proposed Hat Creek powerplant. Therefore, no further work is recommended for this site.

SECTION 4.0 - COLLECTION OF SORBENT

4.1 INTRODUCTION

Application was made to the Ministry of Land, Parks and Housing for a "Letter of Consent" in order to excavate limestone and/or dolomite from one or all of the four selected sites. This process began 27 May 1982. It was emphasized that Anderson Creek and Langley Lake are the preferred sites.

Two companies were asked for estimates for sampling at the two sites; the companies were Pashco (H. Sharp) of Kamloops and Bema (M. Beley) of Langley. The Bema proposal was less expensive for excavating either one or two sites. The cost estimate for two sites was $15,008.49. A subsequent estimate for a single Anderson Creek site was received on 6 August 1982 and it totalled $8,753.30. An estimate of $3,060 for site work under the supervision of Mr. W.C. Fothergill was prepared on 4 August 1982 in consultation with him.

On 19 July 1982, a "Notice of Opening-Rock, Shale and Limestone Quarries" was submitted to Mr. E. Sadar, Ministry of Energy, Mines and Petroleum Resources, Kamloops, B.C., in compliance with the Mines Regulation Act. The reclamation programme outlined in the form included revegetation of the site.

Verbal approval to proceed with the excavation on the Anderson Creek, Pavilion Mountain and/or Robertson Creek site was received from the Ministry of Lands, Parks and Housing on 3 August 1982. The Langley Lake site is on land owned by Ridge Investments Limited. They gave verbal approval to excavate a sample from the site provided a royalty was paid; the amount would have to be negotiated. The land owned by Ridge

Investments Limited was not sufficient for a full-scale mining operation, so that some Crown land would be required. Mr. H. Hess of the Ministry of Lands, Parks and Housing maintained his earlier position established 16 January 1982, in which he would not approve the use of provincial land in that area for mining, because it is too close to the Langley Lake Recreation Area (this recreation area is not indicated on government claim maps, so its status is undetermined).

On 6 August 1982, E. Lehman and Pavilion Lake Co. Ltd. cleared a helicopter staging area on Anderson Creek and hauled 40 drums to this site.

On 9 August 1982, P.T. McCullough and K. Chow of B.C. Hydro left for Hat Creek. Messrs. W. Struck, and R. Horth of Bema prepared tools and equipment for mobilization to Hat Creek. On 10 August 1982, P.T. McCullough and K. Chow went to the Anderson Creek site where three locations had been selected over 350 m of the ridge. These locations were selected along the ridge because of the steepness of alternate terrain as illustrated in Fig. 4-1. A number of trees were cut at sites 1 and 2 in order to clear a landing area for a helicopter. Messrs. M. Beley, project manager, W. Struck, field supervisor, A. McIsaac, senior field technician, R. Horth, field technician and I. Sturrock, field technician for Bema Industries Limited arrived on 10 August 1982.

On 11 August 1982, an additional 10 drums were hauled to the Anderson Creek site by Pavilion Lake Co. Ltd. The helicopter arrived at 8:30 a.m. and began hauling equipment up the hill. A laborer working for E. Lehman was required to cut down and buck-up three larger trees at site 2 on Anderson Creek in order to develop more operating space for the helicopter. Some difficulty was encountered in obtaining a powder magazine from Kamloops and the powder could not be brought from Kamloops and transported up the hill until approximately 1:30 p.m.

Fig. 4-1 View Along Ridge of Limestone North of Anderson Creek (Site 1 is the Outcrop Above the centre of the photograph)

Fig. 4-2 Drilling Fresh Rock at Site 1

4.2 EXCAVATION OF THE SAMPLES

Drilling at site 1 on Anderson Creek began at approximately 1:00 p.m. on 11 August 1982. Between 50 and 65 holes were drilled for each round at each site. The spacings and patterns of holes varied with the terrain and with the purpose of the blast. Late on 11 August, site 1 was blasted to a depth of 0.5 m.

On 12 August 1982, site 1 was mucked out and the weathered rock was removed. This site was redrilled to a depth of 0.7 m (Fig. 4-2) and blasted; the fresh rock was loaded into 45-gal drums. It was estimated that each drum should be filled to approximately 1/2-full in order that the drum plus sample would weigh between 180 kg and 205 kg. In this way the helicoper (Bell 206B) would be lifting its maximum capacity of 410 kg (two drums) for that elevation under average temperature and wind conditions. In the meantime the second site was drilled to a depth of 0.5 m.

On the morning of 13 August 1982, M. Beley left the site for another job. The second site was prepared for blasting (Fig. 4-3), blasted, mucked out, redrilled to a depth of 0.7 m, blasted once again and the broken rock was loaded into drums. The third site was drilled and blasted (Fig. 4-4) in order to remove weathered rock to a depth of 0.5 m.

On 14 August 1982, the third site was mucked out, redrilled to a depth of 0.7 m and blasted. The drums at the third site were loaded (Fig. 4-5). The sites were cleaned up and equipment and materials were prepared for helicopter pick-up. Surplus, opened powder, fuse, and blasting caps were destroyed.

On 15 August 1982, the helicopter from Highland Helicopters Ltd. arrived at 8:30 a.m. and began slinging drums and equipment off the mountain (Fig. 4-6). Sites 1, 2 and 3 at Anderson Creek were reclaimed.

Fig. 4-3 Preparing Fuse and Powder for Blasting at Site 2

Fig. 4-4 Blast at Site 3

Fig. 4-5 Hand Loading 45-gallon Drums at Site 3

Fig. 4-6 Slinging Drums from the Mountain

The areas of disturbance are as follows:

1. Site 1 - An area of fly rock of approximately 158 m^2 and containing a trench covering 12 m^2 with a highwall 1.2 m high (Fig. 4-7).

2. Site 2 - An area of fly rock of approximately 75 m^2 and containing a trench covering 13 m^2 with a highwall 1.0 m high (Fig. 4-8).

3. Site 3 - An area of fly rock of approximately 87 m^2 and containing a trench covering 16 m^2 with a 0.8 m highwall (Fig. 4-9).

These areas were reseeded with a mix of alfalfa (Anik) at 6 percent by weight, sainfoin (Melrose) at 73 percent, creeping red fescue (Boreal) at 2 percent, smooth broom grass (Manchar) at 11 percent and stream bank wheat grass (Sodar) at 8 percent as recommended by F.G. Hathorn of B.C. Hydro. The mix was applied by hand at a rate of 156 kg/ha. A fertilizer mix of 13-16-10 was applied at a rate of approximately 50 kg/ha. The area was then raked and the seed was tamped into the ground. The transportation and reclamation were completed by 12 noon.

An attempt was made to return the explosives; however, because it was Sunday the person in charge of the powder magazine in Kamloops was not at home or at his office. The surplus explosives could not be returned.

On 16 August 1982, the Bema crew returned the powder magazine and surplus powder to Kamloops, B.C. and returned to their office at Langley, B.C. Mr. E. Lehman and four others working for Pavilion Lake Contracting took the drums from the helcopter staging area to the crusher site near the Hat Creek camp (Fig. 4-10). The samples from site 1 were put through the crusher, crushed to minus 3 1/2 inches (8.9 cm) and loaded into 45-gal drums (Fig. 4-11); each drum was filled

Fig. 4-7 Anderson Creek Site 1 After Work was Completed

Fig. 4-8 Anderson Creek Site 2 After Work was Completed

Fig. 4-9 Anderson Creek Site 3 After Work was Completed

Fig. 4-10 Loading Drums at the Anderson Creek Staging Area

Fig. 4-11 Receiving Crusher Product for Loading into Drums

to a gross weight of approximately 330 kg (the empty drums weigh approximately 18 kg).

On 17 August 1982, the remaining samples were put through the crusher and placed in drums labelled AC 1, AC 2 and AC 3 for Anderson Creek sites 1, 2 and 3; a total of 23 drums were filled.

On 18 August 1982, 16 of the drums were shipped to Vancouver via Signal Trucking Limited. One third of the drums came from each of the sites. The remaining seven drums are to be kept at the Hat Creek site in case additional sample(s) are required.

4.3. COST OF COLLECTION OF SORBENT

The costs for the collection of the limestone sorbent are as follows:

E. Lehman:

prepare helicopter site	$ 387
load and haul full drums	402
Subtotal	$ 789

Pavilion Lake:

labour-site preparation	$ 120
crushing	520
crushing and loading truck	800
Subtotal	$1,440

Domco:

camp accommodation (38 man-days)	$ 950

Bema:

labour	$ 5,907.50
powder	1,212.25
vehicle rental	882.34
miscellaneous disbursements and expenses	578.16
equipment rental	500.00
Subtotal	$ 9,080.25

Highland Helicopters:

mobilization of equipment and supplies	$ 1,249.43
demobilization of equipment and sample	1,519.85
Subtotal	$ 2,769.28

Signal Trucking:

trucking cost	$ 399.09

Chemex Laboratories:

whole rock analysis - Anderson Creek	$ 292.50
Others	97.50
Subtotal	$ 390.00
Total	$15,817.62

SECTION 5.0 - ADDITIONAL EXPLORATION

5.1 INTRODUCTION

Additional exploration along the ridge north of Anderson Creek and in two areas on the east side of the Hat Creek Valley were conducted during the Anderson Creek limestone sampling programme. The areas on the east side of the Hat Creek Valley are near Ambusten Creek (17) and White Rock Creek (18,19) as indicated in Figs. 1-1 and 2-1.

5.2 RIDGE NORTH OF ANDERSON CREEK

On 10 August 1982, a traverse was conducted along the ridge northwest of Anderson Creek L3-0 (Figs. 3-1 and 5-1). The traverse was of a reconnaissance nature. The rocks are commonly limestones with some thin-bedded, black, fine-grained, shaley limestones toward the northwest. One outcrop is calcareous shale which is overlain by limestone. The bedding attitudes range from strikes of 080° to 135° and dips of 85° SE to 67° SW; some beds dip northeast. The beds most commonly strike 134° and dip 50° SW to 70° SW. There are no dolomite or dolomitic limestones along the ridge. The limestones appear to be similar to those sampled previously on Anderson Creek; therefore no new samples were taken.

5.3 AMBUSTEN CREEK (LST 17)

On 13 August 1982, a traverse was conducted over the meadows north of Ambusten Creek. The outcrops are on the slope of a bench at El. 1340 m and 1.5 km from the creek (Figs. 1-1, 2-1 and 5-2). The limestones are medium grey and fine-grained with white calcite veinlets scattered

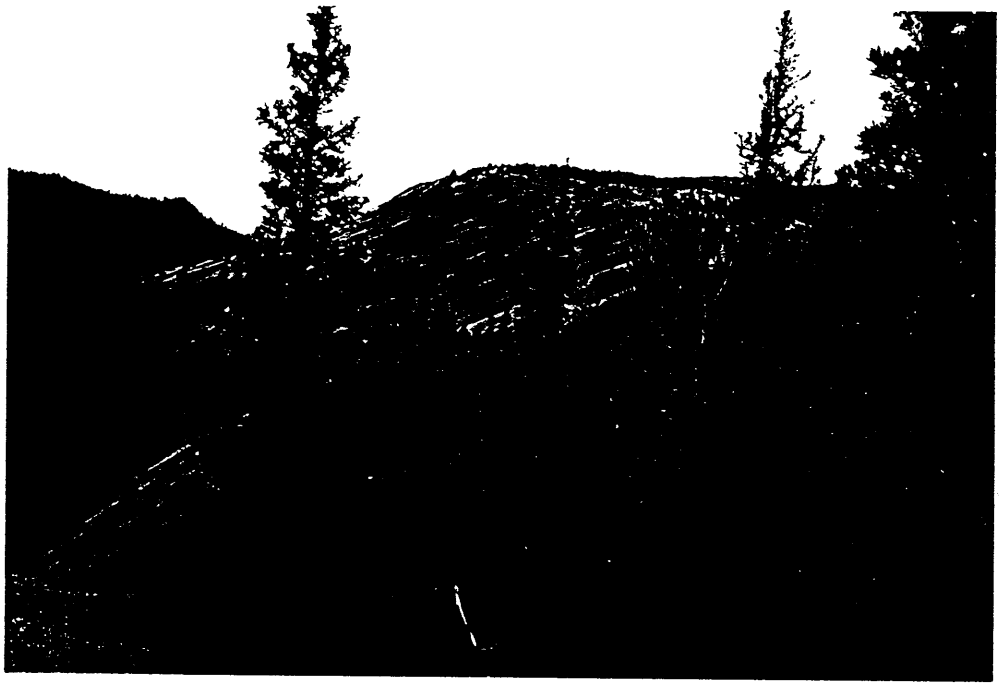


Fig. 5 - 1 Ridge North from Anderson Creek and L3-0

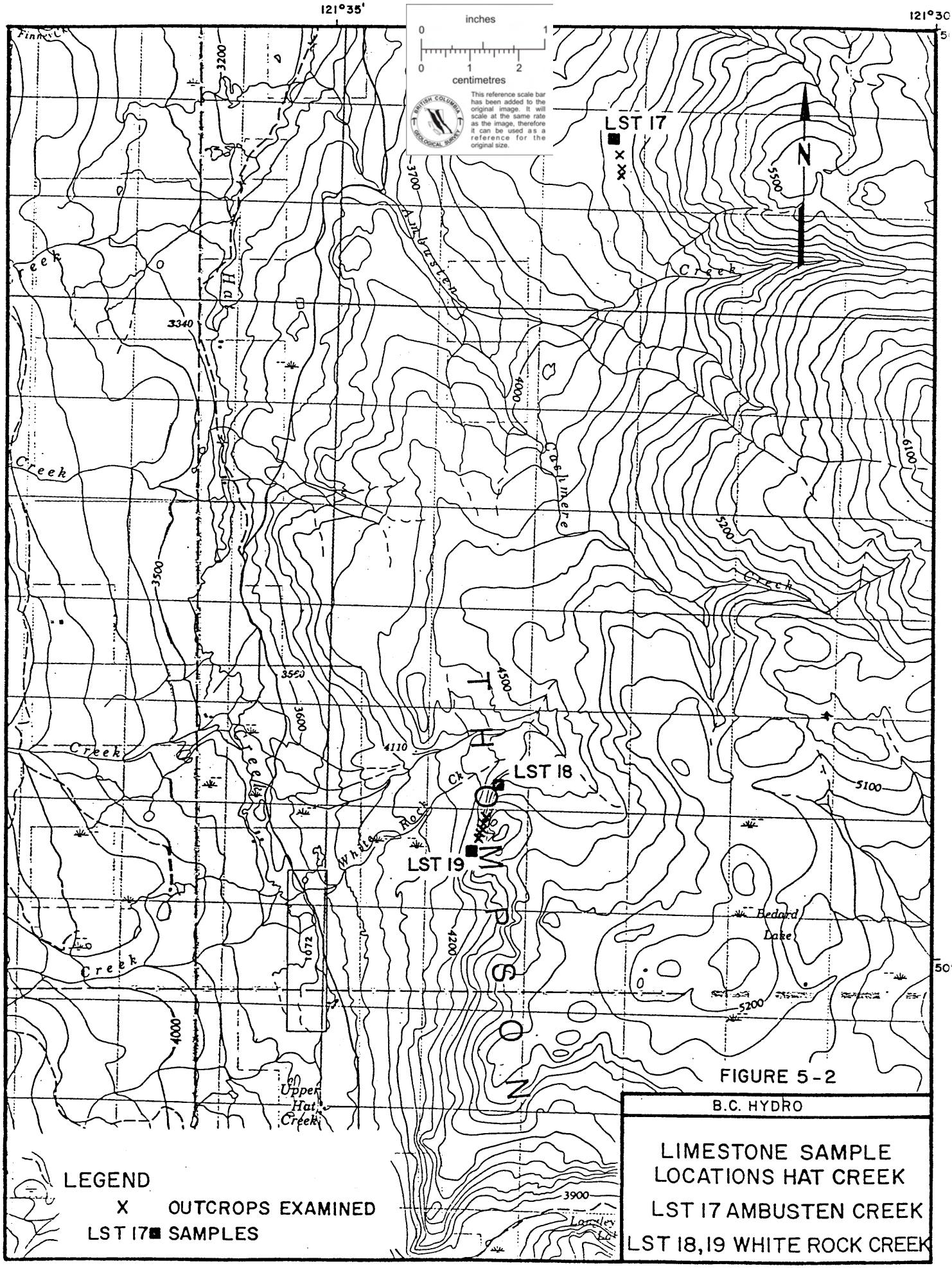


FIGURE 5-2

B.C. HYDRO

LIMESTONE SAMPLE LOCATIONS HAT CREEK

LST 17 AMBUSTEN CREEK

LST 18,19 WHITE ROCK CREEK

LEGEND

X OUTCROPS EXAMINED

LST 17■ SAMPLES

irregularly and along bedding planes. A sample was taken from the northernmost of the four outcrops examined (Fig. 5-3). An analysis of this limestone is summarized in Table 3-1. The rock is very siliceous and the area is of no further interest for sorbent.

5.4 WHITE ROCK CREEK (LST 18, LST 19)

On 16 August 1982, outcrops that form cliffs south of White Rock Creek were examined (Figs. 1-1 and 5-2). The base of the outcrops are at El. 1305 m to 1390 m and extend over 0.6 km. The outcrops are mostly light grey, fine-grained limestone, but some outcrops are dark grey and medium grey (Fig. 2-1). Two samples were taken. Sample LST 18 consists of light grey to medium grey, fine-grained, slightly magnesic limestone with a few, irregular calcite veinlets. Sample LST 19 consists of dark grey, fine-grained, slightly magnesic limestone which also has a few, irregular calcite veinlets. The analyses of these limestones are summarized in Table 3-1. It would be difficult to obtain a small bulk sample from these sites; however, mining costs and access for a large sample could be acceptable.

5.5 DISCUSSION

The ridge north of Anderson Creek is an extension of the limestone areas where the bulk sampling was undertaken. The limestone is continuous along the ridge for more than 2.0 km. No dolomite or dolomitic limestone was found. The area could provide ample limestone sorbent.

The bench north of Ambusten Creek is underlain by siliceous limestone. The area is of no further interest for sorbent.

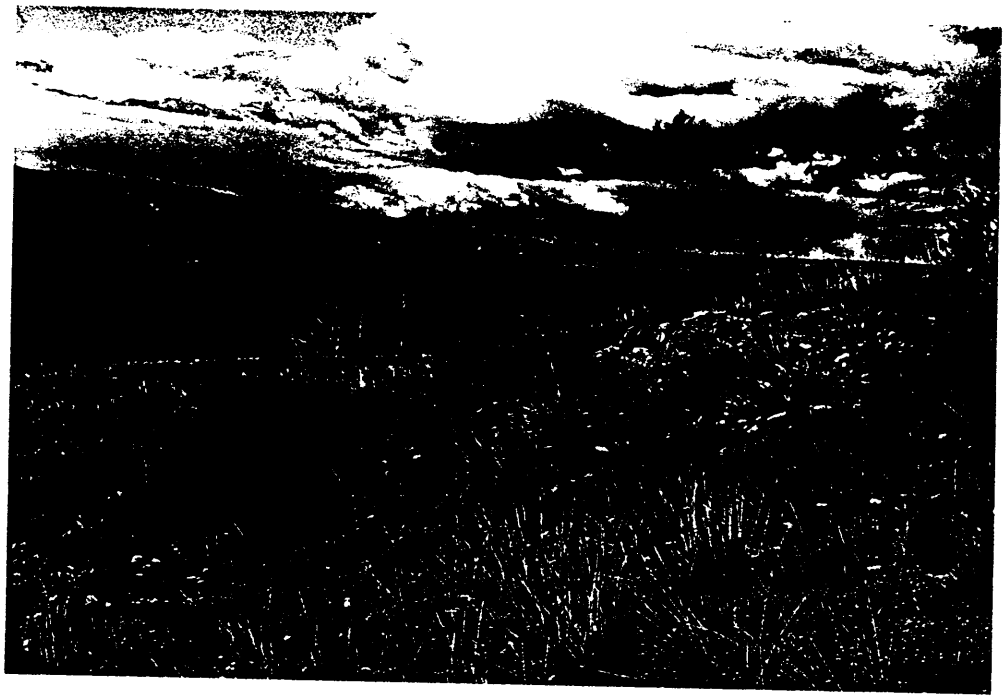


Fig. 5-3 Outcrop North of Ambusten Creek

The outcrops south of White Rock Creek consist of slightly magnesic limestone. These cliffs are close to the proposed Hat Creek powerplant site and they comprise a potential source of sorbent.

SECTION 6.0 - CONCLUSIONS

Five sites in the Hat Creek area could provide sorbent to a thermal plant using pressurized fluidized bed technology. The best site is at Langley Lake (No. 6), where interbedded limestone, dolomitic limestone and dolomite are exposed along a ridge extending north from the Oregon Jack Creek Road. Unfortunately, this site is not available because the Ministry of Lands, Parks and Housing will not permit mining activity on land in this area that is under its jurisdiction. This land is crucial to a large mining operation.

The second site is north of Anderson Creek (No. 4 and No. 5). This site consists of a long, gently undulating ridge bordered on the south by steep cliffs. The samples from 1981 were taken from the base of these cliffs and consist of slightly dolomitic limestones. The bulk sample, excavated in 1982, came from the top of these cliffs. This was necessary because of the problems of working on the steep hillside and of transporting the samples from the site by helicopter. These latter samples are less magnesic. The limestones are probably typical of the ridge as a whole and the ridge could provide sufficient limestone.

The bulk sampling conducted at Anderson Creek was completed quickly and efficiently. Therefore, the overall sampling and transportation was completed under budget.

The third site is at Robertson Creek (No. 14). The limestone is exposed on a narrow ridge. This limestone performed well in the tests at Westinghouse (Table 1-1), but there may be insufficient tonnage near this site. However, the limestones at Robertson Creek (No. 13) may perform as well as the dolomitic sample from that site and similar to those at Robertson Creek (No. 14). Therefore, there may be sufficient limestone similar to Robertson Creek (No. 14) to supply a thermal plant.

The fourth site is at Pavilion Mountain. The quantity of dolomite at this site is too small to be of interest. The associated limestone may be a suitable sorbent, but the site is too far from Hat Creek to be economically attractive.

The fifth site is south of White Rock Creek (No. 18 and No. 19). The limestones are fine-grained, but mostly light grey. It is not known how these limestones would perform under pressurized conditions, but it is expected that they may not perform well.

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1. B.C. Hydro. 1981. Dolomitization in the Marble Range Limestones near the Hat Creek Project. Preliminary Evaluation of Possible Sites for a Source of Magnesian Limestone. B.C. Hydro Report No. SE 8117.

2. Trettin, H.P. 1979. Permian Rocks of the Cache Creek Group in the Marble Range, Clinton Area, British Columbia; Geological Survey Canada Paper 79-17.

3. Ulerich, N.H., D.L. Keairns and W.G. Vaux. 1982. Sulphur Sorbent Testing. Prepared for B.C. Hydro by Westinghouse Research and Development Centre.

ADDENDUM - 1

ADDENDUM - GEOLOGY AND SAMPLING OF POSSIBLE SORBENT SITES FOR HAT CREEK PRESSURIZED FLUIDIZED BED COMBUSTION STUDY - 26 JULY 1983

Between 5 July and 11 July 1983, A. Penner and P.T. McCullough explored for sorbent in and near the Hat Creek Valley. Sixteen 20 kg samples were collected as well as three hand specimens. The location of each of the sample sites is illustrated in Figs. A-1 and A-2. The locations of the sample sites at Robertson Creek are illustrated more accurately in Figs. A-3 and A-4. Similarly, the locations of sample sites at Langley Lake are illustrated more accurately in Fig. A-5.

The following paragraphs contain a summary description of each of the samples. Each sample is from an outcrop area which commonly consists of more than one rock type; therefore, each sample was divided into groups, the proportion of each group was estimated and each group was described.

SAMPLE LST-20

Group 1 - 45 percent
Whitish grey to light grey, medium to fine grained, generally massive, strongly calcareous lst., with some calcite stringers.

Group 2 - 35 percent
Grey to dark grey, fine grained, massive, strongly calcareous lst., with many calcite stringers.

Group 3 - 20 percent
Dark grey to black, fine grained, massive, strongly calcareous lst., some minute calcite fracture coatings.

SAMPLE LST-21

Group 1 - 70 percent
Medium grey, fine grained lst., weathers light to medium brown.

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

LEGEND

LI LINE NUMBER

1825 ELEVATION (METRES)

1825 LINE DISTANCE (METRES)

BEDDING ATTITUDE

JOINT ATTITUDE

OUTCROP MARGINS

N

0 1470 LT GY LST

1475 50 MED GY LST

L-1

1490 100

SAMPLE LST 22 — 1505 — MED GY, F-G LST

MED GY, F-G LST

150 1495 MED GY, F-G LST

GULLEY

BL-0 1500 LST

SAMPLE LST 23

LST — 33

LST

DOLO

LST AND DOLO

BL-50

250 1495

END OF AREA OF LT GY DOLO FL.

ANG DOLO FL

M-G, GY BRN LST 1465

L-2

1480 DOLO

300 1490

1475

M-G, MED GY LST

ANG. FL. LT. GY DOLO AND DOLO LST

GULLEY

1470

MED GY LST

350 1480

1500 400

BRN-GY LST

450 1500

L-1

1515 500

LT GY LST

LST W/SOME LT GY F-G DOLO LST

LT GY F-G THIN BEDDED LST

550 1510 — 76

1500 600

MED GY LST 1495 650

THIN BEDDED LT GY LST — 80

LT GRN GY DOLO

1500 700

SAMPLE LST 24

MOSTLY LT GY LST MINOR DOLO

1485 750

GULLEY

1480 800

MOSTLY LST MINOR DOLO LST LOCALLY THIN BEDDED

79

850 1490

LT GY LST

SAMPLE LST 25

900 1495

950

1000 1480

MOSTLY F-G LT GY LST SOME C-G LST MINOR GY GRN F-G DOLO THAT WEATHERS BEIGE

1050 1465

MED GY LST

50 1450

L-3

100 1430

150 1420

200 1425

250 1425

LT GY-WTE LST MINOR ARGILL ROCKS

1415

800 1455 LT GY TO MED GY LST

750 1445

700 1445 LT GY LST

DK GY LST — MED GY LST

650 1440

600 1440

550 1435

500 1435 LST FL

1440 450

1440 400

1435 350

1440 300

1440 250

42

1435 200 THINLY BEDDED LST AND MED GY, M-G, BUFF WEATHERING DOLO.

150 1430

1430 100

1440 50

0 50 100 150

SCALE IN METRES

FIG. A-3

GEOLOGY
ROBERTSON CREEK #13
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

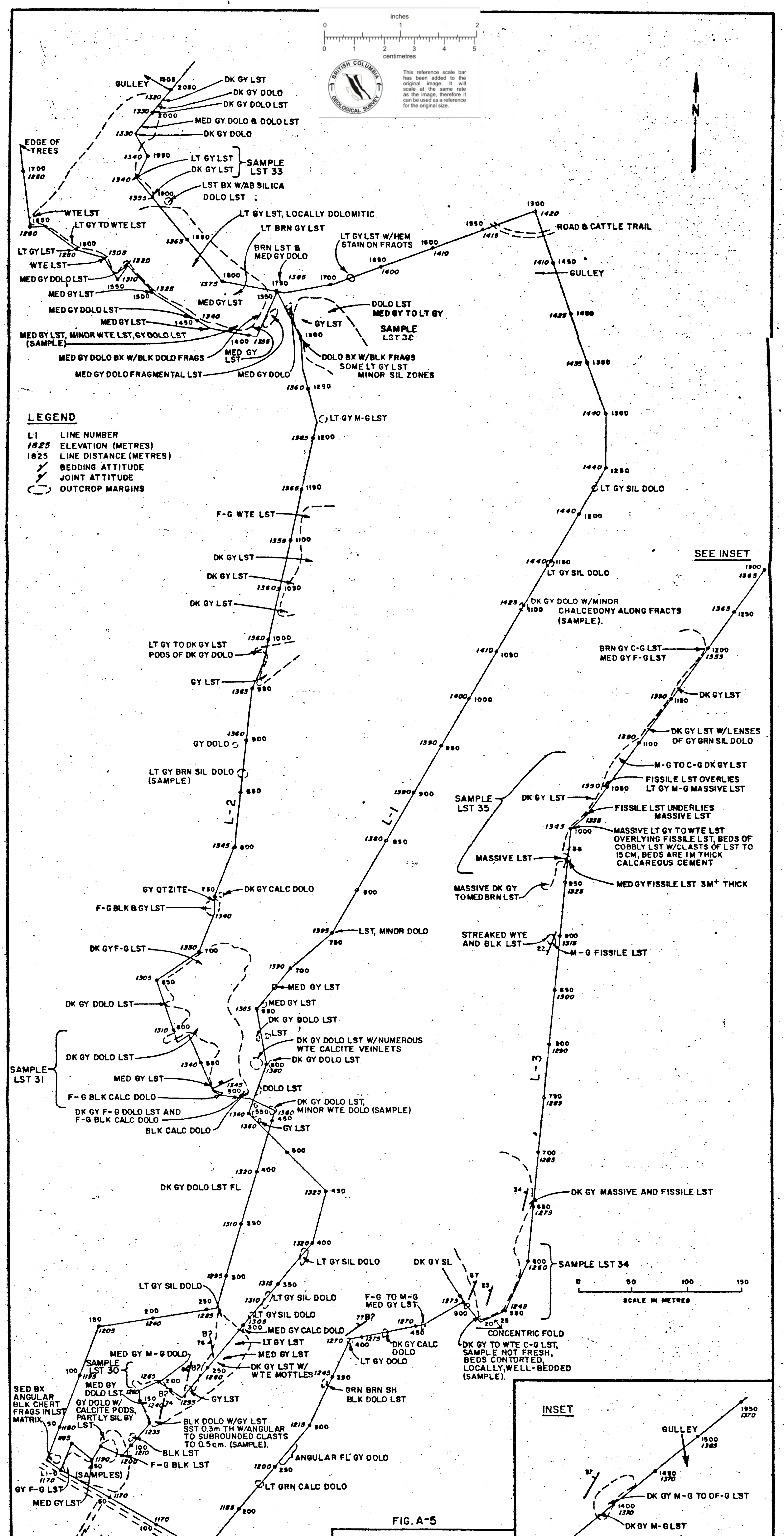

FIG. A-5

GEOLOGY
LANGLEY LAKE #6
LIMESTONE - DOLOMITE AREA
NEAR HAT CREEK

Group 2 - 15 percent
Light grey, fine grained lst.-slightly coarser than above weathers light to medium brown - few calc. veins on fracts.

Group 3 - 8 percent
Medium grey, fine grained lst., w/ab. wte. calcite veins to 0.5 cm wide, weathers light grey.

Group 4 - 2 percent
Medium grey, fine grained lst. w/num. closely spaced fracts. 0.5 cm apart - bedding(?).

SAMPLE LST-22

Group 1 - 45 percent
Grey to dark grey, medium-grained, massive, strongly calcareous lst., minor calcite, blocky.

Group 2 - 45 percent
White to light grey, medium to fine grained, generally massive, strongly calcareous lst., parallel fracture set.

Group 3 - 5 percent
White, medium to fine grained, massive, very strongly calcareous lst.

Group 4 - 5 percent
Black, medium to fine grained, massive, strongly calcareous lst., some calcite veinlets, blocky.

SAMPLE LST-23

Group 1 - 60 percent
Medium grey, fine grained, lst. minor dolo.

Group 2 - 25 percent
Light grey, fine grained, dolo. minor lst. (somewhat sil?).

Group 3 - 10 percent
Wte. to light grey, m-g. dolo. minor lst.

Group 4 - 5 percent
Dark grey, fine grained, well layered lst.

SAMPLE LST 24

Group 1 - 45 percent
Light grey, coarse to medium grained, massive, strongly calcareous lst., some calcite stringers, blocky.

Group 2 - 40 percent
Dark grey, medium grained, massive, strongly calcareous lst., occasional calcite stringers, blocky.

Group 3 - 13 percent
Light grey to greenish grey, fine grained, massive, weakly calcareous, siliceous lst.

Group 4 - 1 percent
White, medium to fine grained, weakly bedded, strongly calcareous lst.

Group 5 - 1 percent
Brown to grey, medium grained, massive, strongly calcareous lst.

SAMPLE LST-25

Group 1 - 80 percent
Medium grey, fine grained lst.

Group 2 - 15 percent
Light grey, fine grained to medium grained, dolo., some dolo.-lst.

Group 3 - 3 percent
Medium grey, fine grained lst. blebs of calc. to 0.5 cm.

Group 4 - 1 percent
Well layered medium grey to light grey, fine grained lst.

Group 5 - 1 percent
Wte. to light grey, fine grained lst.

Group 6
Minor hem. stained dolo. lst.

SAMPLE LST 26

Group 1 - 60 percent
Light brown to light grey, very fine grained lst. w/mod. layering.

Group 2 - 20 percent
Light grey to medium grey, fine grained lst.

Group 3 - 2 percent
Medium grey lst. breccia w/frags to 1.0 cm, some rust weathering.

Group 4 - 5 percent
Light grey to white fine grained lst.

Group 5 - 3 percent
Dark grey almost black, fine grained lst.

Group 6 - 2 percent
Wte. and red brown, fine grained lst.

Group 7 - 2 percent
Dark grey, very fine grained lst.

Group 8 - 3 percent
Fine grained, medium grey lst.

Group 9 - 3 percent
Medium grained, medium grey lst.

SAMPLE LST 27

Group 1 - 60 percent
Whitish grey to light grey, fine grained, strongly calcareous, massive, blocky lst.

Group 2 - 40 percent
Dark grey, medium to fine grained, generally massive, calcite stringers, strongly calcareous lst.

SAMPLE LST 28

Group 1 - 31 percent
Fine grained black lst. w/minor wte. blebs and veinlets.

Group 2 - 31 percent
Fine grained black lst. w/abundant wte. calc. blebs and veinlets.

Group 3 - 20 percent
Dark grey w/light grey lst. layers, some layers thin and discontinuous, but others are through going.

Group 4 - 5 percent
Banded dark grey, fine grained, lst. w/abundant light grey to wte. layers.

Group 5 - 3 percent
Light grey, medium grained, lst. some wte. calc. layers.

Group 6 - 5 percent
Dark grey to black, finely streaked lst., streaks are light grey lst. minor veinlets.

Group 7 - 3 percent
Medium gray lst. breccia w/frags. to 0.75 cm; frags. rounded to subang.

Group 8 - 2 percent
Black lst. as angular frags. in wte. calc. matrix.

SAMPLE LST-29

Group 1 - 65 percent
Whitish grey to light grey, medium to fine grained, generally massive, but some thinly bedded, strongly calcareous lst., with calcite veinlets.

Group 2 - 35 percent
Dark grey to black, fine grained, massive, strongly calcareous lst.

SAMPLE LST-30

Group 1 - 61 percent
Black w/mod. calc. blebs and veinlets, fine grained lst. some samples devoid of veinlets.

Group 2 - 30 percent
Massive to mod. bedded medium grey lst. locally coarse grained, mostly fine grained.

Group 3 - 5 percent
Light grey, fine grained, lst. streaked w/wte. calc.

Group 4 - 2 percent
Wte., fine grained, locally coarse grained lst.

Group 5 - 1 percent
Medium grey, fine grained lst.

Group 6 - 1 percent
Dark grey lst. w/abundant calcite stringers and blebs of wte. calc.

SAMPLE LST-31

Group 1 - 70 percent
Medium gray, fine grained, massive, strongly calcareous lst., some calcite.

Group 2 - 20 percent
Dark grey to black, fine grained, massive, strongly calcareous lst., minute calcite stringers.

Group 3 - 10 percent
Whitish light grey, fine grained, massive, strongly calcareous lst.

SAMPLE LST-32

Group 1 - 75 percent
Dark grey, fine grained lst. w/minor to moderate calc. veinlets, minor dark grey dolo. lst.

Group 2 - 12 percent
Medium gray lst. w/minor to moderate calc. veinlets.

Group 3 - 2 percent
Dark grey lst. breccia w/wte. matrix, frags. to 0.5 cm commonly 0.3 mm, approximately 10 percent matrix.

Group 4 - 5 percent

Dark grey lst. breccia w/wte. calc. matrix frags. to 0.5 cm, commonly <0.1 mm, approximately 50 percent matrix.

Group 5 - 5 percent
Light grey lst. w/abundant calc. veinlets mostly fine grained, some medium grained.

Group 6 - 1 percent
Light grey lst. mostly fine grained, some medium grained.

SAMPLE LST-33

Group 1 - 75 percent
Medium to dark grey, fine grained, massive, some calcite, moderately calcareous dolo. lst.

Group 2 - 25 percent
White to light grey, fine grained, thinly beeded, some calcite, strongly calcareous lst.

SAMPLE LST-34

Group 1 - 90 percent
Massive to thin bedded, dark grey to black lst. fine grained.

Group 2 - 10 percent
Dark grey w/abundant wte. blebs and veinlets of calcite, fine grained lst.

SAMPLE LST-35

Group 1 - 45 percent
Medium gray, fine grained, massive, with some calcite, strongly calcareous lst.

Group 2 - 35 percent
Dark grey to black, fine grained, massive, strongly calcareous lst.

Group 3 - 20 percent
White to light grey, medium to fine grained, with calcite, generally massive, strongly calcareous lst.

SAMPLE LST-36 Hand Specimen

East Side Logging Road - 87.5 km marker. Medium gray, fine grained lst.

SAMPLE LST-37 Hand Specimen

East Side Logging Road - 91 km marker. Dark grey to black, fine grained sil. lst.

SAMPLE LST-38 Hand Specimen

End of East Side Road. Light grey, fine grained dolo.

The analyses of each of the samples are listed in Table A-1. Dolomitic limestone appears to be common over extensive areas near Langley Lake and Robertson Creek. No drilling has been undertaken, so the thickness of the dolomitic limestone is unknown. Tests run at Westinghouse (Ulerich et al, 1982) indicated that even limestones on the Ridge where samples LST-27 to LST-29 were taken provided moderate sorbency. The samples would have to be tested, rather than simply analyzed, in order to predict their sorbency.

The rejects from the 20 kg samples have been stored in two drums (labelled H.C.-LST) which are in a shed at Burrard Thermal Plant.

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CERTIFICATE OF ASSAY

TO : B.C. HYDRO & POWER AUTHORITY

BOX 12121-555 WEST HASTINGS STREET
VANCOUVER, B.C.
V6B 4T6

CERT. # : A8312551-00
INVOICE # : I8312551
DATE : 18-JUL-88
P.O. # : P-104

ATTN: P.T. McCULLOUGH - GENERATION PLANNING DEPARTMENT

Sample description	Prep code	SiO2 (WRA) %	Al2O3 (WRA) %	Fe2O3 (WRA) %	TiO2 (WRA) %	MgO (WRA) %	CaO (WRA) %
LST 20	208	3.72	0.02	0.12	0.02	2.61	53.37
LST 21	208	2.35	0.02	0.11	0.02	1.87	54.96
LST 22	208	2.07	0.03	0.10	0.03	1.69	55.55
LST 23	208	2.40	0.02	0.13	0.02	9.97	44.08
LST 24	208	2.27	0.02	0.12	0.02	5.30	50.22
LST 25	208	2.17	0.02	0.14	0.02	8.52	46.20
LST 26	208	1.56	0.02	0.09	0.02	2.82	54.26
LST 27	208	1.68	0.02	0.11	0.02	2.31	54.29
LST 28	208	1.92	0.02	0.10	0.02	2.03	54.76
LST 29	208	2.92	0.02	0.13	0.02	3.56	52.51
LST 30	208	10.49	0.03	0.14	0.03	2.93	43.38
LST 31	208	5.38	0.02	0.10	0.02	3.39	48.37
LST 32	208	9.88	0.02	0.11	0.02	10.59	39.43
LST 33	208	27.20	0.03	0.15	0.03	9.42	31.77
LST 34	208	3.04	0.02	0.26	0.02	1.91	53.32
LST 35	208	2.79	0.02	0.23	0.02	4.41	51.09
LST 36	208	2.81	0.02	0.20	0.02	1.87	54.90
LST 37	208	61.44	0.03	0.33	0.03	0.77	21.67
LST 38	208	7.15	0.02	0.19	0.02	17.52	32.56

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TELEPHONE: (604) 984-022
TELEX: 043-5259

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CERTIFICATE OF ASSAY

TO : B.C. HYDRO & POWER AUTHORITY

BOX 12121-555 WEST HASTINGS STREET
VANCOUVER, B.C.
V6B 4T6

CERT. # : A8312551-CO
INVOICE # : I8312551
DATE : 18-JUL-88
P.O. # : F-104

ATTN: P.T. McCULLOUGH - GENERATION PLANNING DEPARTMENT

Sample description	Prep code	Na2O (WRA) %	K2O (WRA) %	LOI (WRA) %	P2O5 (XRF) %		
LST 20	208	0.02	0.02	38.82	0.02	--	--
LST 21	208	0.02	0.02	38.83	0.02	--	--
LST 22	208	0.03	0.03	37.29	0.06	--	--
LST 23	208	0.05	0.02	40.87	0.05	--	--
LST 24	208	0.02	0.02	40.29	0.02	--	--
LST 25	208	0.07	0.02	41.98	0.02	--	--
LST 26	208	0.02	0.02	38.88	0.02	--	--
LST 27	208	0.11	0.02	39.93	0.02	--	--
LST 28	208	0.02	0.02	40.14	0.02	--	--
LST 29	208	0.02	0.02	39.87	0.02	--	--
LST 30	208	0.04	0.03	36.95	0.03	--	--
LST 31	208	0.02	0.02	39.16	0.02	--	--
LST 32	208	0.02	0.02	39.23	0.03	--	--
LST 33	208	0.03	0.03	31.96	0.05	--	--
LST 34	208	0.12	0.02	40.91	0.02	--	--
LST 35	208	0.10	0.02	40.18	0.05	--	--
LST 36	208	0.06	0.02	38.02	0.02	--	--
LST 37	208	0.03	0.03	16.77	0.07	--	--
LST 38	208	0.02	0.02	41.34	0.06	--	--

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B.C. HYDRO

GEOLOGICAL MAP
SHOWING
POTENTIAL LIMESTONE AND DOLOMITE AREAS
NEAR HAT CREEK
FIGURE A-2

B.C. HYDRO

LOCATION MAP SHOWING POTENTIAL LIMESTONE AND DOLOMITE AREAS NEAR HAT CREEK

FIGURE A-1

TRUCK ELEVATION – 1310 METRES

N

LEGEND

L1 LINE NUMBER
1825 ELEVATION (METRES)
1825 LINE DISTANCE (METRES)
BEDDING ATTITUDE
JOINT ATTITUDE
OUTCROP MARGINS

0 50 100 150
SCALE IN METRES

MED GY LST
W/WTE CALCITE VEINS
SAMPLE-ROBERTSON CR. #14
0 *1355*
50 *1350*
100 *1345*
MED GY LST
LT BRN GY SIL DOLO FL
150 *1345*
SAMPLE LST 27
LT GY F-G LST W/MOD CALCITE VEINING, MINOR LOCAL DOLO
63
1350
200
SIL DOLO FL
LT GY LST
LT GY F-G LST
THIN BEDDED LST
76
250
MED GY LST
1340
300
L1
1350
350
MED GY LST
400
SAMPLE LST 28
MED GY LST
MED GY LST
MED GY LST
1340
450
DK GY LST
DK GY LST
500
DK GY LST
1325
550
DK GY LST
DK GY LST
DK GY LST W/LOCALLY ABUND. CALCITE VEINS
600 *1330*
MED GY LST
MED GY LST
650 *1325*
MED GY TO DK GY LST
700 *1325*
SAMPLE LST 29
750 *1330*
800 *1335*
850 *1330*
MED GY TO LT GY ALMOST WTE LST
LT GY F-G LST
900 *1325*
LT GY DOLO FL
950 *1330*
MED GY LST
LT GY LST
1000 *1320*
DK GY LST
GY LST
MED GY DOLO LST AND DOLO
1315
100 *1295*
LT GY DOLO
GULLEY
L-2
150 *1265*
200 *1275*
250 *1290*
300 *1320*
THINLY BEDDED LT GY LST
1420
F-G MED GY LST
650
1440
1410
600
R #13
L4-50
R #14
L3-685
F-G LT BRN LST
1410
550
WTE LST
1400
500
MED GY LST
1385
450
LT GY LST
SAMPLE LST-26
MOSTLY LT GY LST
MINOR LT BRN CALC DOLO
1370
400
LT GY LST
LT GY LST
1365
350
F-G LT GY LST
WTE LST
300 *1360*
M-G WTE LST
250 *1350*
LT GY LST
L3
WTE TO LT GY LST
200 *1345*
WTE LST
1340
150
LT GY LST
SOME THIN BEDDED LST
MINOR LT GRN M-G DOLO
M-G LT GY LST
1350
100
F-G LT GY LST
1345
50
F-G LT GY LST
62
1340
M-G LT GY LST

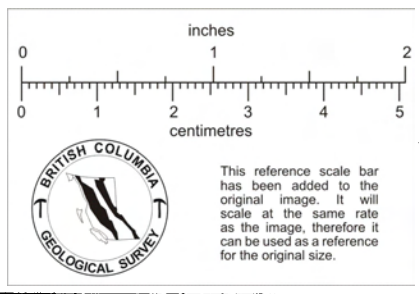

FIG. A-4

GEOLOGY
ROBERTSON CREEK #14
LIMESTONE – DOLOMITE AREA
NEAR HAT CREEK