GR-SUSTUT 84A

~~CONFIDENTIAL~~

COAL ANALYSES

704

COAL ANALYSES

SAMPLE LOCATION	LAB NO.	SAMPLE NO.	ADM %	MOIST %	ASH %	VOL %	F.C. %	S %	CV CAL/GM	S.G.	BASIS
ST-84-1	3008	84-0512	3.80	1.68	43.10	20.50	34.80	0.27	4160	1.69	adb
				5.34	41.46	19.72	33.48	0.26	4002		arb
					43.80	20.83	35.37	0.27	4228		db
ST-84-2	3009	-0513	3.70	1.20	26.70	26.40	45.70	0.24	5809	1.49	adb
1.2 - 1.7 m				4.86	25.71	25.42	44.01	0.23	5594		arb
					27.02	26.72	46.26	0.24	5880		db
ST-84-2	3010	-0514	4.10	1.10	53.90	20.20	24.80	0.19	3129	1.85	adb
3.05 - 3.45 m				5.15	51.69	19.37	23.78	0.18	3001		arb
					54.50	20.42	25.08	0.19	3164		db
ST-84-DH-1	3018	-0607	2.40	1.00	54.80	21.60	22.60	0.64	2971	1.91	adb
34.0 - 34.84 m				3.38	53.48	21.08	22.06	0.62	2900		arb
					55.35	21.82	22.83	0.65	3001		db
ST-84-DH-1	3019	-0608	3.30	0.90	65.20	18.10	15.80	0.83	2291	2.03	adb
49.84 - 50.48 m				4.17	63.05	17.50	15.28	0.80	2215		arb
					65.79	18.26	15.94	0.84	2312		db
ST-84-DH-1	3020	-0609	1.50	0.80	42.10	25.60	31.50	3.99	4443	1.71	adb
51.0 - 51.2 m				2.29	41.47	25.22	31.03	3.93	4376		arb
					42.44	25.81	31.75	4.02	4479		db
ST-84-DH-1	3021	-0610	2.20	0.80	48.10	23.70	27.40	0.58	3855	1.76	adb
51.96 - 53.42 m				2.98	47.04	23.18	26.80	0.57	3770		arb
					48.49	23.89	27.62	0.58	3886		db
ST-84-DH-1	3022	-0611	1.70	0.90	25.20	27.80	46.10	0.56	5881	1.53	adb
54.08 - 54.69 m				2.58	24.77	27.33	45.32	0.55	5781		arb
					25.43	28.05	46.52	0.57	5934		db
ST-84-DH-1	3023	-0612	1.80	1.10	57.30	21.70	19.90	0.20	2845	1.90	adb
57.4 - 58.28 m				2.88	56.27	21.31	19.54	0.20	2794		arb
					57.94	21.94	20.12	0.20	2877		db
ST-84-DH-1	3024	-0613	3.00	0.90	70.30	17.60	11.20	0.19	1645	2.17	adb
58.84 - 59.32 m				3.87	68.19	17.07	10.86	0.18	1596		arb
					70.94	17.76	11.30	0.19	1660		db
ST-84-DH-1	3025	-0614	3.90	1.20	62.90	18.10	17.80	0.39	2486	1.99	adb
61.09 - 62.8 m				5.05	60.45	17.39	17.11	0.37	2389		arb
					63.66	18.32	18.02	0.39	2516		db
ST-84-DH-1	3026	-0615	2.30	1.40	29.60	27.10	41.90	0.80	5416	1.55	adb
63.2 - 64.2 m				3.67	28.92	26.48	40.94	0.78	5291		arb
					30.02	27.48	42.49	0.81	5493		db
ST-84-DH-2	3027	-0616	2.90	1.20	41.90	25.20	31.70	0.49	4124	1.73	adb
23.8 - 27.5 m				4.07	40.68	24.47	30.78	0.48	4004		arb
					42.41	25.51	32.09	0.50	4174		db
ST-84-DH-2	3028	-0617	2.30	0.80	39.50	28.80	30.90	0.42	4147	1.73	adb
32.2 - 32.95 m				3.08	38.59	28.14	30.19	0.41	4052		arb
					39.82	29.03	31.15	0.42	4180		db
ST-84-DH-2	3029	-0618	2.30	0.70	52.80	23.50	23.00	5.22	3260	2.02	adb
35.1 - 35.4 m				2.98	51.59	22.96	22.47	5.10	3185		arb
					53.17	23.67	23.16	5.26	3283		db
ST-84-DH-2	3030	-0619	1.40	0.40	57.60	29.70	12.30	11.90	2389	2.25	adb
36.1 - 36.2 m				1.79	56.79	29.28	12.13	11.73	2356		arb
					57.83	29.82	12.35	11.95	2399		db

SUSTUT PROJECT - 1984
GEOLOGICAL REPORT

on

BRITISH COLUMBIA COAL LICENCES

7244 to 7249 Inclusive,
7322 to 7332 Inclusive, 7735, 7336,
7550 to 7553 Inclusive

LOCATED IN THE CASSIAR DISTRICT
TO BE FOUND ON NTS MAP SHEET
ABOUT Long. and Lat.

OWNED AND OPERATED BY

SUNCOR INC.
500 - 4th AVENUE S.W.
CALGARY, ALBERTA

AUTHOR, JOHN FISHER

WORK PERFORMED DURING THE PERIOD OF
JUNE 25th, 1984 - JULY 28th, 1984

REPORT SUBMITTED NOVEMBER 19th, 1984

This report was not examined re: Coal Act Reg.

Suncor Inc.
Resources Group

Resources Development Division

2191

1985-06-21

PROVINCE OF BRITISH COLUMBIA
Ministry of Energy, Mines & Petroleum Resources
Pariament Buildings
Victoria, B.C.
V8V 1X4

ATTENTION: Mr. Paul Hagen

Gentlemen:

RE: Sustut Coal Licences
7244 - 7249 inclusive
7322 - 7332 inclusive,
7735 & 7736,
7550 - 7553 inclusive
Cassiar Land District

Reference is made to your letter of June 5, 1985, pertaining to the 1984 work program conducted by Suncor Inc. on the above properties consisting of 10 bore holes.

On the anniversary dates of these licences, being October 14 and November 7, Suncor surrendered the captioned coal licences.

We apologize for the delay in submitting this report and we are pleased now to enclose same for your information and record and trust this will meet your requirements.

Yours truly,

SUNCOR INC.

John Fisher

J.A. Fisher
Project Geologist
Coal & Minerals Department

HMF/fln

ENCL.

cc: Mr. H.M. Fowler

P.O. Box 38, 500 - 4th Avenue S.W., Calgary, Alberta T2P 2V5 Telephone (403) 269-8100

Province of
British Columbia

Ministry of
Energy, Mines and
Petroleum Resources

Parliament Buildings
Victoria
British Columbia
V8V 1X4

June 5, 1985

John Fisher
Suncor Inc.
500-4th Avenue, S.W.
Calgary, Alberta
T2P 2V5

Dear Mr. Fisher:

RE: Sustut Coal Property
Cassiar Land District

It has come to my attention that Suncor completed a 1984 work program on the Sustut Property consisting of at least 13 bore holes. The purpose of this letter is to remind you that pursuant to Section 11(2) of the Coal Act (copy enclosed), a report of all work performed on the licences during 1984 was required within 90 days of the expiry of the subject coal licences. Since that time has long since passed, I would ask that you now submit the required report as soon as possible.

Sincerely,

Paul Hagen
Coal Administrator

PH/kjs

Province of British Columbia | Ministry of Energy, Mines and Petroleum Resources

MEMORANDUM

To: A. Matheson

Date: May 2, 1985

Suncor completed a 1984 work program on their Sustut Property consisting of at least 13 boreholes. There has not been an assessment report submitted and the licences have all been dropped (see attached). Could you contact John Fisher to see when we can expect this report? Thanks.

Claudia

C. Sturko

CS/bg
cc: Paul Hagen
attachment

only 1 rpt. received
A.M. did not feel it
necessary to check (?)

W-390

Sustut Coal Property

Coal licence nos. 7244 - 7259 issued October 14, 1981

7244 - 7249 forfeited October 14, 1984 ✓
7250 - 7255 forfeited October 14, 1983 ✓
7256 - 7259 forfeited October 14, 1982 ✓

Coal licence nos. 7322 - 7337 issued November 7, 1981

7322 - 7332 forfeited November 7, 1984 ✓
7333 - 7334 forfeited November 7, 1982 ✓
7335 - 7336 forfeited November 7, 1984
7337 forfeited November 7, 1982 ✓

Coal licence nos. 7550 - 7553 issued November 7, 1982

7550 - 7553 forfeited November 7, 1984 ✓

PROFESSIONAL VERIFICATION OF REPORT

ENTITLED: SUSTUT PROJECT, REPORT ON EXPLORATION AND DRILLING, 1984 JOHN FISHER, AUTHOR

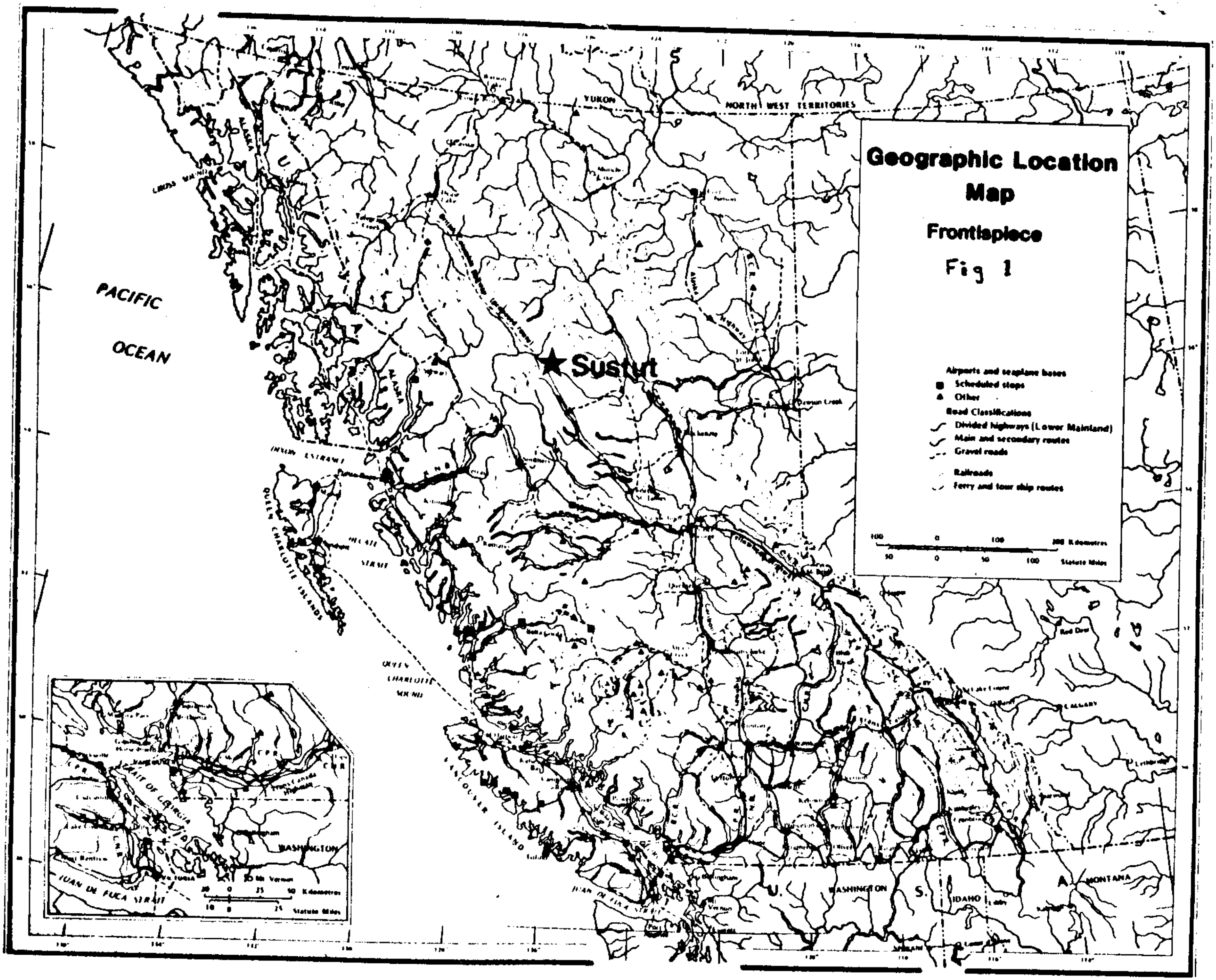
Mr. John Fisher planned and carried out the geological exploration and drilling program on the SUSTUT Coal Licences held and operated by SUNCOR Inc. He also prepared this report.

JOHN FISHER, B.Sc., graduated in geology from the University of Calgary in 1974. His experience in Western Canadian coal exploration since 1974 includes positions with;

SPENCE TAYLOR & Assoc. Ltd., Calgary, Alberta
SHELL CANADA RESOURCES Ltd., Calgary, Alberta
CROWS NEST RESOURCES Ltd., Calgary, Alberta
SUNCOR INC., Calgary, Alberta

I consider JOHN FISHER to be well qualified to undertake the responsibilities which were assigned to him on this project. I am satisfied that the attached report has been competently prepared and justly represents the information obtained from this project.

R. D. Moss
P. Eng.


Geographic Location Map
Frontispiece
Fig 1
Sustut
PACIFIC OCEAN
YUKON
NORTH WEST TERRITORIES
Airports and seaplane bases
Scheduled stops
Other
Road Classifications
Divided highways (Lower Mainland)
Main and secondary routes
Gravel roads
Railroads
Ferry and tour ship routes
Kilometres
Statute Miles
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
QUEEN CHARLOTTE SOUND
VANCOUVER ISLAND
JUAN DE FUCA STRAIT
STRAIT OF GEORGIA
WASHINGTON
IDAHO
MONTANA
U. S. A.

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LIST OF FIGURES, TABLES AND ENCLOSURES

TABLE OF CONTENTS

SUMMARY

Suncor Inc. holds 23 coal licences to 6,624 land approximately 10 km north east of Bear Lake, B.C., (see Index map and Coal Licence map), or 170 km NNE of Smithers, B.C.

During the period July 1 to July 26, 1984 a combined drilling and mapping program was carried out on the licenced area. The drill used was a heli-portable LONGYEAR 38 diamond drill. Ten holes were cored for a total of 1022 m.

The area was flown and photographed in 1983, at a scale of 1:25,000. From these photographs a photo mosaic of the property has been produced and an orthophoto map of the COAL BOWL area produced at a scale of 1:5,000 with a 5 metre contour interval.

Drill holes were surveyed and a survey map produced.

CONCLUSIONS AND RECOMMENDATIONS

The drilling and exploration program carried out during the 1984 field season indicates that the thick coal seams seen in the Coal Bowl do not extend beyond that area for any significant distance.

Of the 19 holes drilled and cored during 1983 and 1984 only six were found to contain coal and these were grouped at three locations. Further drilling and exploration demonstrated that these locations, on the north, east and west flanks of the property, were isolated occurrences and not continuous throughout the project area. There is no mineable coal in the vast area of Main Creek Valley.

Because the coal seams present have proven to be isolated occurrences, and there are no significant reserves of mineable coal present, I recommend that SUNCOR INC. allow these coal licences to lapse and revert to the Crown.

LOCATION

GEOGRAPHIC LOCATION

The licenced area is to be found on NTS map sheet 94-D, McCONNEL CREEK. The licences are within an area bounded by:
Longitudes 126°28'30" West to 126°45'00"W
Latitudes 56°14' North to 56°22' North

LICENCES AND TENURE

SUNCOR Inc. holds twenty-three coal licences here for a total of 6624 hectares of land. The licences and work commitment status break down as shown in Table Number 1 and Fig. 2 on the following two pages.

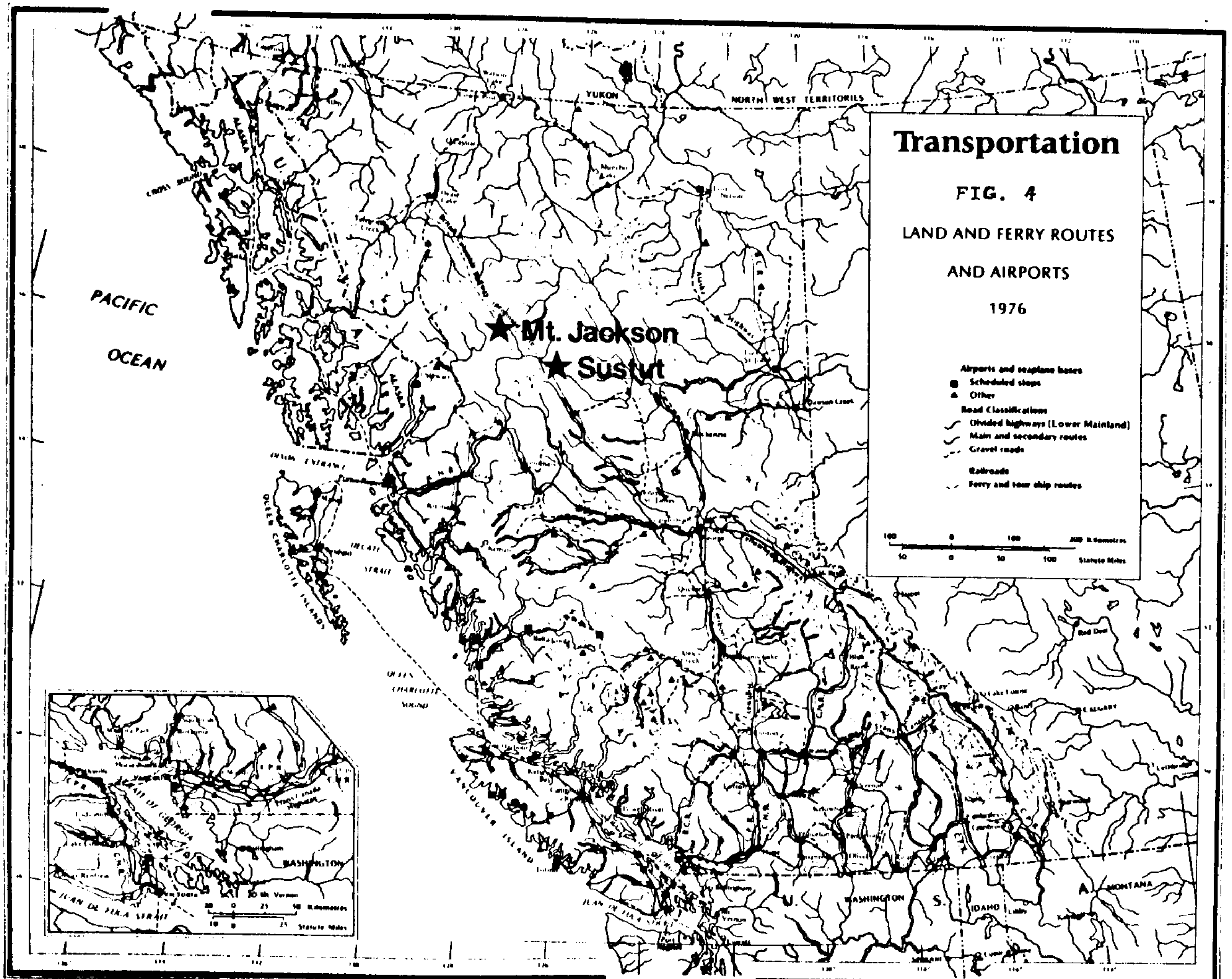

Transportation
FIG. 4
LAND AND FERRY ROUTES
AND AIRPORTS
1976
Mt. Jackson
Sustut
PACIFIC
OCEAN
YUKON
NORTH WEST TERRITORIES
WASHINGTON
IDAHO
MONTANA
CALGARY
VANCOUVER ISLAND
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
QUEEN CHARLOTTE SOUND
JUAN DE FUCA STRAIT
STRAIT OF GEORGIA

Table No. 1

SUSTUT COAL LICENCES

Licence No.	Date Issued	Map Area	Units	Hectares
7244	Oct. 14, 1981	94-D-7, Blk B	43,44,53,54	288
7245	Oct. 14, 1981	94-D-7, Blk B	45,46,55,56	288
7246	Oct. 14, 1981	94-D-7, Blk B	63,64,73,74	288
7247	Oct. 14, 1981	94-D-7, Blk B	65,66,75,76	288
7248	Oct. 14, 1981	94-D-7, Blk B	83,84,93,94	288
7249	Oct. 14, 1981	94-D-7, Blk B	85,86,95,96	288
7322	November 7/81	94-D-7, Blk A	1,2,11,12	288
7323	November 7/81	94-D-7, Blk A	3,4,13,14	288
7324	November 7/81	94-D-7, Blk A	5,6,15,16	288
7325	November 7/81	94-D-7, Blk A	21,22,31,32	288
7326	November 7/81	94-D-7, Blk A	23,24,33,34	288
7327	November 7/81	94-D-7, Blk A	25,26,35,36	288
7328	November 7/81	94-D-7, Blk A	27,28,37,38	288
7329	November 7/81	94-D-7, Blk A	43,44,53,54	288
7330	November 7/81	94-D-7, Blk A	45,46,55,56	288
7331	November 7/81	94-D-7, Blk A	47,48,57,58	288
7332	November 7/81	94-D-7, Blk A	49,50,59,60	288
7335	November 7/81	94-D-7, Blk A	69,70,79,80	288
7336	November 7/81	94-D-7, Blk B	61,62,71,72	288
7550	November 7/82	94-D-1, Blk L	89,90,99,100	288
7551	November 7/82	94-D-2, Blk J	81,82,91,92	288
7552	November 7/82	94-D-7, Blk B	41,42,51,52	288
7553	November 7/82	94-D-8, Blk D	9,10,19,20	288
	23 Licences		TOTAL	6624

Suncor inc

COAL LICENCES   SUSTUT, B.C.

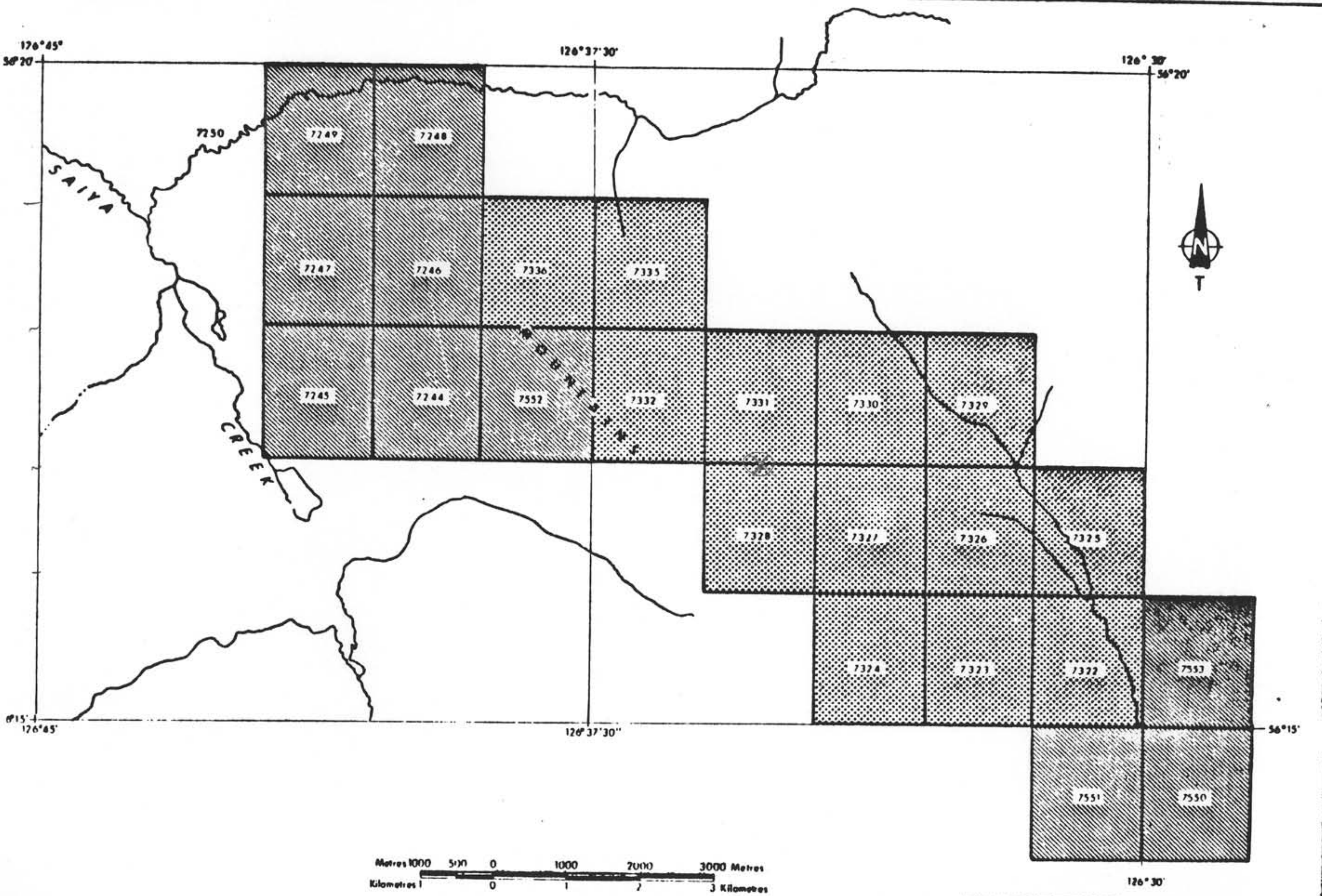
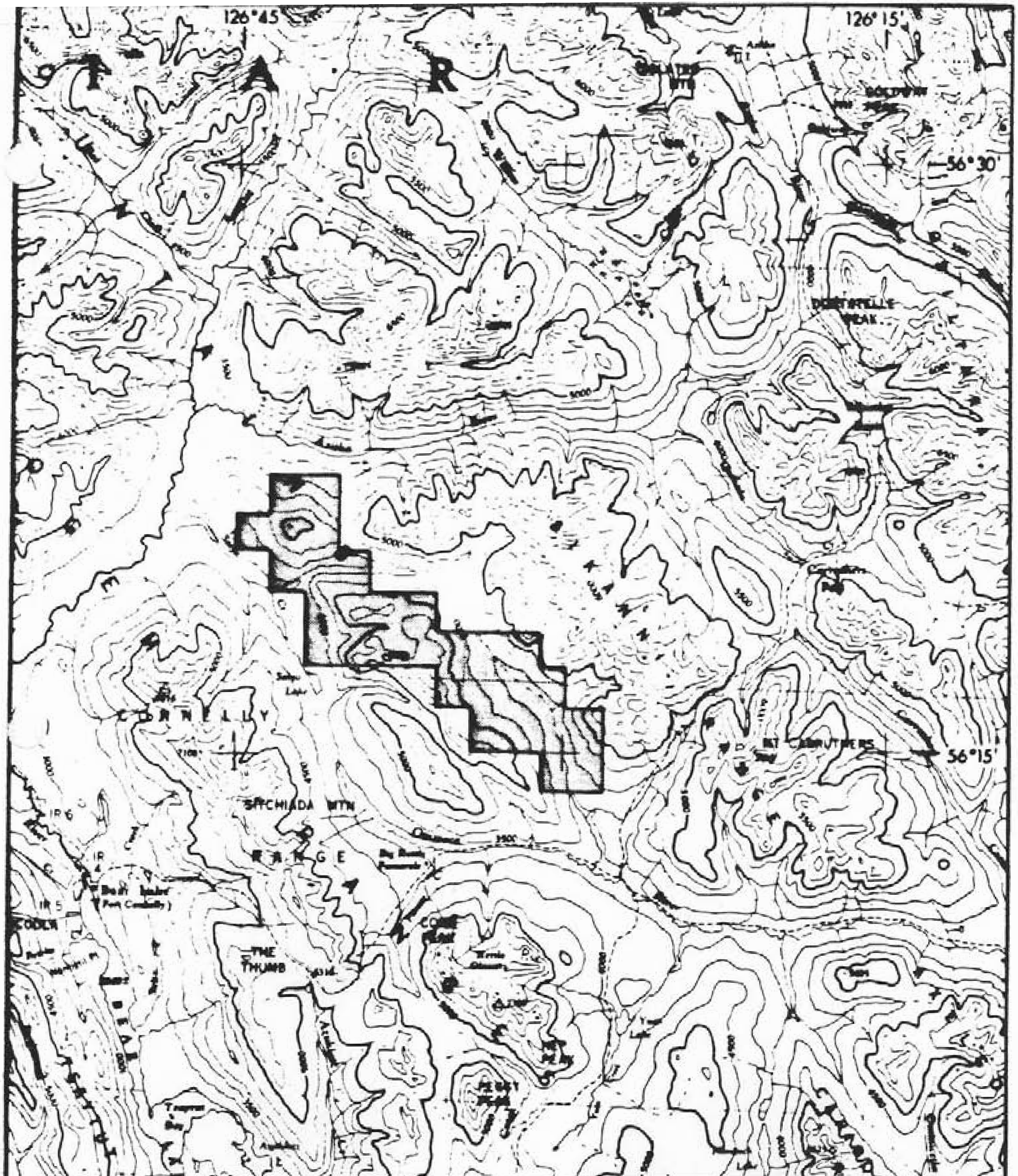


FIGURE #3

WORK COMMITMENT VALID TO

1986   1987

Suncor inc Resources Group	COAL AND MINERALS DEPARTMENT		
SUSTUT COAL LICENCES			
82-12	AS SHOWN	94D/7E	



LEGEND

SUSTUT PROJECT AREA

For details see Enclosure
SUSTUT AREA FIG. 2
East and West Half

Suncor Inc Resources Group — COAL AND MINERALS DEPARTMENT

SUSTUT AREA

BRITISH COLUMBIA

DATE	SCALE	N.T.S.	DRAWING No.
83 - 12	1: 250,000	94/D	

PROJECT AREA PHYSIOGRAPHY

The coal licences cover some 6624 hectares between the HOGEN and SIKANNI Ranges of the STIKINE MOUNTAINS. Topographic relief in the area is in the order of 875 metres from the floor of Main Creek valley, at approximately 1067 m ASL, to the higher elevations in the western portion of the property at 1942 m. The mountain ranges have a northwest/southeast trend in this region.

Though the licenced area does contain high alpine plateaus and ridges, approximately 60% of the property is comprised of a broad, undulating, gently sloping valley. The flanks of the valley are steep sided mountain slopes.

The majority of the northeast facing slopes present are steep-to-vertical. Cirque basins are common in the area. Over most of the main valley the terrain slopes very gently towards Main Creek on the northeastern side of the valley.

ACCESS

At the present time the only reasonable access to the property is via helicopter.

A good gravelled air strip is adjacent to the BC Rail Line some four km north of the northern tip of Bear Lake and 11 km from our licences.

It is most probable that if a mine were to be built here a rail spurline would be constructed from a point on the BC rail line south of Bear Lake into the licence area via the valley of the Omineca River. There is an abandoned road/trail which passes the south end of the licenced property but does not cross the Omineca river.

The airstrip at our campsite on the Bear River is capable of taking a DC-3 or a Cariboo. The BC rail line passes within 100 metres of our campsite and could be utilized with very little maintenance or upgrading. It is not being used at this time.

RECLAMATION

Our campsite will be used again by Suncor personnel in 1985, therefore the wooden tent frames were left in place at Bear Lake camp.

No adits or major excavations were dug.

No roads were constructed, all movement being by helicopter and on foot.

Site preparation was done by hand. Most sites were on open, flat, ground and required little or no preparation. Soil disturbance was negligable.

Our base camp was adjacent to the airstrip on the BEAR RIVER, 4 km north at BEAR LAKE. At the conclusion of the project the pit and the sump were filled in.

DRAINAGE

Several streams drain the area of our licences. These are: Main Creek, Hate Creek, Coal Bowl Creek, Willow Creek, Lo-coal Creek and No-coal Creek. There are also several other very small un-named creeks.

Characteristically the stream profiles are steep in the upper reaches, rapidly becoming gentle as they leave the proximity of the valley walls. Generally they form a dendritic pattern.

Main Creek is a fourth order stream while Hate Creek is third order and all others are of second and first order.

The gentle slopes in the cirques and in Main Valley are very poorly drained. In the cirques and the broad alpine meadows water lies in sheets which vary in depth from saturated moss to 15 cm deep. Though these areas appear stagnant, at first view, the water is in fact moving slowly across an almost flat plane.

The property forms a part of the PACIFIC/ARCTIC continental divide with Hate Creek flowing to the Pacific Ocean and Main Creek flowing to the Arctic Ocean though their headwaters are only metres apart.

The licenses primarily occupy wide glaciated valleys containing streams. The streams on the valley floor are meandering low energy systems compared to the streams which drain the steeper valley walls and side valleys.

Precipitation in the lower elevations of north central British Columbia is typically 450-550 mm annually. Snowfall generlly accounts for 40-45% of the total precipitation, increasing with elevation. May to September rainfall contributes most of the remainder. Snowpack accumulation at elevations similar to the coal licenses ranged from 80-120 cm on May 1st. The water equivalence of the spring snowpack can range from 200-400 mm. This value is critical in determining the potential annual flood as a result of snowmelt.

On both sides of the drainage divide the annual maximum flows are generated by snowmelt water and the peak generally occurs in June. The minimum annual flows are usually in March. The steady decline of flows from June through to March is interrupted by a minor peak in October which is generally associated with heavy autumn frontal precipitation. Melting of early snowfalls may also be a factor in this event. Both the Skeena River and Omineca River flood records contain the above features although the Skeena River is an order of magnitude larger than the Omineca.

Systems as small as those which drain the coal licenses will follow the general trend of the larger basins. However, very small streams are more sensitive to single events such as thunderstorms or isolated showers.

The Omineca River is normally frozen over by the middle of November in this region, although freeze-up may range from November 1 to December 28. The river is usually ice-free by the beginning of May, although it has been as early as April 21 and as late as May 28. It is likely that the small streams within the coal licenses will generally freeze over earlier and thaw later due to the higher elevation and smaller volume of water.

CLIMATE

Our experience during the 1983 field season in this area led us to believe that this is one of the wettest locations in this part of the country. In June 87.7 mm of rain was recorded. This is 168% of the normal rainfall. July received 284% of normal precipitation. In August we broke camp and departed the area. (The data above are from the government weather station at Smithers and were published in the local newspaper). Heavy rains and brief, severe, snow storms were experienced during the 1984 field season.

Suncor's coal licenses are located on the eastern edge of the northern interior plateau region in the western ranges of the Omineca Mountains. The regional climate can be described as modified continental, with short, cool summers and long, cold winters. The region is drier than the coastal areas but receives more precipitation than areas east of the Rocky Mountains.

Temperatures range from greater than 20°C in the summer to less than -20°C in the winter. The temporary station at Bear Lake recorded a maximum of 27.9°C in July of 1975 and a minimum of -36.1°C in March of 1976.

The proximity of the Omineca Mountains to the east of the licenses creates a slightly wetter regime than generally associated with north central interior sites. The annual total precipitation is in the order of 500 mm spread fairly evenly throughout the year. The driest period is generally February to May. June to September are the months with the heaviest rainfall.

Snowfall typically accounts for 40-45% of the total precipitation at the lower elevations. This contribution could increase at the higher elevations of the coal licenses. Snow accumulations at elevations similar to the licenses reach an average maximum of 113 cm in April. The extreme depths can range from 124 to 185 cms. Accumulation of the seasonal snowpack begins in October.

On-site climatology is required as a data base for several related disciplines. Hydrological analyses and associated engineering designs rely on local precipitation characteristics. Over a longer term the development of a reclamation program will require such data as frost free period, growing degree days, precipitation records and other climate related data. An analysis of the local wind field will be required for assessment of the dispersion climatology, and transport of fugitive dust emissions.

The existing data are adequate to describe the regional precipitation and temperature regimes for altitudes of 600-800 metres in valley bottoms. A temporary station was run at Bear Lake by the Air Studies Branch (B.C. Ministry of Environment) from March, 1975 to September, 1976. Unfortunately only temperatures are very few precipitation recordings were recorded.

The climatic characteristics of mountainous areas such as the coal licenses can be extrapolated from the existing data base. A climate station will be required to provide satisfactory on-site evaluations of the temperature, precipitation and wind regimes. It is recommended that such stations be operated for at least one year and preferably three or more, in order that the data can be normalized to records from long term stations.

GROUNDWATER

The Geological Survey of Canada's Report No. 24, GROUNDWATER IN CANADA, states that the SKEENA RIVER basin receives 48.25 cm of precipitation annually and has a Mean Annual Runoff of 83.8 cm. The difference could be accounted for as being from groundwater sources.

The principal environmental issue to be considered is the relationship of groundwater to surface flows and the potential implications for water quality. Since much of the groundwater information must be collected for mine planning purposes to estimate requirements for dewatering, it is recommended that groundwater assessment be coordinated with exploration drilling. Piezometers should be installed in selected drill holes and water quality samples taken.

WILDLIFE

The area seemed remarkably devoid of wildlife when one considers the nature of the terrain, its location in the Cordillera, and the apparently favourable regime for ungulates. This is probably a function of the deep winter snows at the altitude of the licences and the very late spring/summer melt and runoff. The licence area is not free of snow until late June or early July.

The area includes parts of Management Unit 7-38 which is administered from Prince George and Management Unit 6-19 which is administered from Smithers.

In general, very little site specific information on wildlife resources is available, although some wildlife and habitat related work was carried out in the vicinity of the Sustut property. Pojar and Meidinger (1982) report on plant ecology in the Skeena Management areas, and Osmond-Jones et al (1972) provided ecological information (i.e. species lists for birds and mammals) for the neighbouring Tatlatui Wilderness Park, approximately 70 km north of the Suncor property.

The most recent studies on wildlife and vegetation were conducted within the framework of B.C. Hydro's Stikine transmission line corridor project (Houseknecht, 1982). This work focussed on the existing B.C. Rail corridor and its immediate surroundings.

The Suncor properties are part of the high snowfall areas which characterize the northern sections of Region 6 and 7. Suitable winter range in high snowfall areas is considered critical and limiting to ungulate populations. It is unknown whether the Suncor propertly sustains ungulate winter range. Although several ungulate species such as mosse, caribou and mountain goat are known to occur in the area (Warren, pers. comm. 1983), the status of the corresponding populations and their habitats is unknown. Some information on big game species distribution and relative abundance is provided through the occasional carry-over-counts from the Fish and Wildlife Branch.

The last aerial survey was conducted in 1980 (Warren, pers. comm. 1983). Bergerud (1978) surveyed the area for caribou in 1977. Grizzly and black bear are believed to occur as well as fur-bearing species such as wolf, lynx, marten, fisher and wolverine (Pojar, pers. comm. 1983).

FIELD WORK

PREVIOUS WORK PERFORMED

The earliest reported geological reconnaissance of the area was in 1914 by G.S. Malloch who briefly visited the Sustut Valley in conjunction with his work in the Groundhog Coalfield to the north. In 1948, the Geological Survey of Canada published Memoir 251 on the McConnell Creek Map area. The field work for this report was directed by C.S. Lord during 1941 and again in 1944/45. (See Map No.).

Lord discovered coal bearing strata in the area around Red Creek, to the east of Saiya Creek and to the north of the Omineca River. He assigned the majority of these showings to the Jurassic with minor occurrances in the U. Cretaceous and Paleocene. Two reported analyses show the coals to be of high to medium volatile bituminous in rank.

General overviews of the Jurassic-Paleocene sedimentation and tectonic activity were provided by Souther and Armstrong in 1966, G.H. Eisbacher in 1973 and Tipper and Richards in 1976.

The 1976 geological map of the McConnell Creek area (G.S.C. O.F. 342) compiled by T.A. Richards generally shows the same geological distribution as Lord's original map although nomenclature and structure have been substantially altered.

Recent work was undertaken at Suncor's request by D. Pearson in 1981. This entailed a brief reconnaissance of the licence area primarily to establish coal seam thicknesses and quality.

1982 FIELD WORK

During 1982 geological mapping of the Sustut licences was undertaken between June and September. To support these activities a base camp was constructed adjacent to the airstrip immediately north of Bear Lake. The camp site had previously been used by construction crews working on the British Columbia Railway in the mid 1970's and no clearing of vegetation was required. The location was a level, gravel terrace above the Bear River which provided a suitable water supply. A previously excavated gravel pit was utilized for garbage disposal once it had been incinerated.

All camp equipment, fuel and initial food supplies were air lifted from Smithers by a Trans Provincial Airlines DC-3. Additional supply flights were provided throughout the season by Central Mountain Air Services of Smithers, all supplying and expediting being done through this town. At the end of the season the camp equipment and remaining fuel were air lifted back to Smithers by Kelowna Flightcraft. After removal of the camp, the site was tidied and garbage and latrine pits filled.

The physical task of carrying out the geological mapping was borne by a crew of 6 geological assistants supported by a cook, helicopter pilot and engineer.

The field crews were transported daily (weather permitting) from the camp to the licences by Bell 206B Jetranged III helicopter, a journey of approximately 10 minutes.

On June 10th, 1983, Suncor's field personnel constructed a field camp on the Bear River, 4 km north of Bear Lake. The construction material, supplies, food and fuel were flown in by a Cariboo aircraft owned by Kelowna Flightcraft Ltd. Unfortunately this aircraft had the misfortune to make a "wheels up", landing and, consequently, we lost the use of it for the remainder of the summer. The rest of our supply flights were made by an "Islander", owned by Central Mountain Air Services Ltd. We also utilized their Cessna 206 and 185 for transporting personnel. The Islander, it's pilot, Mel Melisson, and four passengers disappeared in August 1983 and has not yet been found despite the most intense air search in Canadian history.

There were six geological personnel, four drill crewmen, one geophysicist, two helicopter personnel and two cooking staff in camp. For a period of five days there was also a survey party of three for a total of eighteen persons. We were also able to accommodate four senior personnel visiting from our Calgary office, giving a total of 22 persons in camp.

The campsite is adjacent to a gravelled, well drained, airstrip 1370 metres long which can accommodate aircraft up to Hercules size. A Bell 206B helicopter, owned by Associated Helicopters Ltd., was used to move personnel and the Longyear 38 drill rig. The first rig move took 41 flights for a total flight distance of over 900 km. At this time we exchanged the BELL 206 for an ASTAR, also owned by Assoc. Helicopters. In any future work of this nature I would consider the ASTAR to be the absolute minimum type machine to be used and would prefer a machine with greater lifting capability.

A heli-portable Longyear 38 diamond drill rig was used on this project and performed well, drilling a total of 1462.2 m. Core recovery was not as good as had been hoped for as, in most cases, the coal was severely shattered. The core was described and the coal intersections sampled.

A major drawback to the 1983 work was the lack of an adequate map with which to work. The maps used were 1:250,000 NTS maps blown up to 1:5000 with 100 foot contours extrapolated. These were inaccurate and unsatisfactory.

In early August of 1983 the area was flown and photographed at a scale of 1:25,000. From these photos a photomosaic has been produced, showing the licenced area. We now have an orthophoto map of the COAL BOWL area at a scale of 1:5000 with a 5 m contour interval.

All drill holes were targetted with airphoto panelling and the locations surveyed using a TOPCON Model GTS 10D which has a capability of reading angles to 10 seconds and distances to 5 mm. Those trenches which were not targetted were measured from nearby targets, (less than 30 m distant). All trenches were described and sketches drawn to scale in each case.

Geological mapping was carried out using aerial photographs, where possible, due to the inaccuracy of the available NTS maps.

Thirty one trenches were dug for a total of 262 metres.

The mapping covered an extensive area but the nature of the land is such that there are large areas which are devoid of outcrop.

Nine holes were drilled on the licences during 1983. Of the nine holes, two were abandoned due to severe hole conditions. These were holes 1 and 8.

Coal was found in holes 2, 4, 5, 6 and 8. Holes 4 and 5 were drilled at the same locations with the mast at an angle of 70 degrees for hole 4 and 50 degrees for hole 5. Hole 8 was abandoned when the drill became stuck at 108.8 metres. Although no core was recovered at that depth the drill was in coal at the bottom of the hole.

Drilling was very difficult in this area and a remarkable amount of expensive drilling mud was utilized to complete the holes. A lot of the problems arose when the drill encountered high angle faults. Also, when the softer and shattered material caused the hole diameter to increase, consequent rod vibration caused major damage to the drill rods.

Weather was an important factor during this season's work. Rain fell for some portion of almost every day. Snow was not completely gone from the northern slopes at higher elevations until mid July. Snowfalls of 10 cm occurred twice in early July. (The local Indians assured me that 1983 was an unusual year).

Drill holes were logged geophysically by Century Geophysical Ltd. The following logs were run: Natural Gamms, Vertical Deviation, Density, Focused Resistivity and Caliper.

The camp was struck on August 6. The wooden tent frames were left in place to be used in 1984. All field equipment was inventoried, reconditioned, and stored in a hangar at Smithers airfield at the end of the season.

WORK PERFORMED DURING 1984 FIELD SEASON

Ten holes were drilled on the licensed area. These covered the length and breadth at the property. All of the holes were cored and geophysically logged. The drilling amounted to 1022 m.

While the drilling was being carried out, on a 24 hour/day basis, the geological staff were traversing the areas surrounding the leases in an attempt to extend the known coal occurrences.

When the sedimentary sequences, in the licensed area, had been examined in detail the geological staff were put on traverses where there were indications of mineralization. Samples were taken and sent for assay.

The period spent in the Bear Lake area was from June 25 to July 26th.

GEOLOGY

The geological staff carried out an extensive program of field traverses and mapping in an attempt to extend the known coal occurrances beyond their presently mapped areas. Though all known outcrops were visited no other occurrances of potentially mineable coal were seen.

Over most of Main Creek Valley volcanics were found to be in excess of 100 metres thick. There was no coal found in Main Creek Valley nor in the valley wall opposite drill holes 1 and 2 where coal was expected to be found.

I estimated that more than 80 percent of the licenced area is underlain by volcanics, 10 percent by the Tango Creek Formation, which contains only very thin seams of coal, 10 percent by the coal bearing Ashman Formation.

When the drilling was completed on our coal licences geological mapping at the area ceased. The geological staff were then employed in prospecting for minerals in the area to the west of our base camp. Their findings will be dealt with in another report on that area.

LOGISTICS

The field party was flown from Smithers, British Columbia to their campsite, adjacent to the Bear Lake airstrip. The trip was made in a twin-engined Piper Navajo belonging to Central Mountain Air Services Ltd. at Smithers. All camp equipment, supplies and fuel were flown into the camp by Central Mountain's Navajo and Beech 18 aircraft.

Consequent re-supply and personnel flights were arranged by our Expeditors, Sharon Bruns and Kelly Melisson of Aero Expeditors Ltd. of Smithers.

Field work was performed, and the drill rig moved, utilizing the services of a Hughes 500 helicopter belonging to Viking Helicopters Ltd.

Ten holes were drilled and cored using a Longyear 38 heli-portable drill belonging to J.T. Thomas Drilling Ltd. of Smithers.

The holes were geophysically logged using a coal cominbation sonde and verticality and dipmeter soudes belonging to B.P.B. Instruments (Canada) Ltd. of Calgary.

Drillhole locations were surveyed by McWhite Surveyors of Smithers.

PERSONNEL

The field party consisted of:

Projects Geologist, John Fisher
Party Chief and Geologist, Jiri Bartek
Geidl Geologist, Kevin Brown and Paulette Tercier
Field Assistants, Greg Cave, Rob McDonald and
Donna Kapicki
Drill Crew, 2 drillers and 2 roughnecks
supplied by J.T. Thomas Drilling Ltd.,
Smithers, B.C.
Geophysical Logger, Bill Cavendish, BPB Instruments Ltd.
Helicopter Pilot, Doug McRea
Helicopter Engineer, Doug Kaza
Cook, Suzanne Perrault
Cook's Helper, Myrna Boucher
Surveyors, 3 surveyors supplied by
McWilliam, Whyte, Goble & Assoc.
Expeditors, Sharon Bruns - Aero Expeditors Ltd.
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Kelly Melisson

GEOLOGY

REGIONAL STRATIGRAPHY

The Sustut licences lie within the intermontane belt of north central B.C. and are underlain primarily by rocks of Mesozoic and Paleocene age.

The basement rocks of the area are of U. Proterozoic age and outcrop some 30 miles to the NE of the property. The overlying strata are of Carbo-permian age belonging to the Cache Creek Group and are comprised of marble, chert and slate. It is postulated that these sediments were deposited in an extensive shallow sea with a shore line to the east in the neighbourhood of the present day Omineca Mountains.

The overlying Asitka Group is presumed to be of Permian age comprising rhyolite, tuff, andesite and minor limestone. It outcrops in the extreme southeastern corner of the property and was probably a precursor to the mid-Triassic orogeny.

The intense tectonic activity in the early to mid-Triassic resulted in the folding and metamorphism of the Cache Creek and Asitka Groups. The majority of these folds, however, have since been masked by subsequent tectonism.

In the late Triassic a broad basin developed accompanied by an extensive marine transgression. The earliest deposits of this basin belong to the Takla Group, resulting from widespread, mainly submarine, volcanism. Associated clastic sediments were derives primarily from a reworking of these volcanics. Takla lithologies are mainly andesites, basalts and argillites, with an approximate total thickness of 10,000 metres in the McConnell Creek map area.

Uplift along the early Jurassic Pinchi Fault, which trends NW-SE through the central part of the McConnell Creek map area, split the area of the Triassic marine basin into an eastern sedimentary trough and a western, dominantly volcanic area. Prior to the Jurassic deposition of the Hazelton Group, the diorites, monzonites and granodiorites forming the Hogem Batholith were intruded.

The earliest deposits of the Hazelton Group in the Sustut area belong to the Telkwa Formation, being basaltic to rhyolitic lavas with subordinate greywackes and shales. The overlying Nilkitkwa Formation was laid down in NW-SE trending, subsiding depression within the broader expanse of the Hazelton Trough, in which marine sedimentation was relatively continuous throughout the Lower and Middle Jurassic. The Nilkitkwa deposits comprise up to 1,000 metres of interbedded shale, greywacke, andesitic to rhyolitic tuff and minor limestone, with frequent basaltic flows in the lower members. The uppermost unit of the Hazelton Group, the Smithers Formation, consists of sandstones, shales and greywackes with minor volcanics.

In Bajocian times, uplift resulted in the formation of the Skeena Arch to the south and the development of the Bowser Basin, the eastern extent of which was marked by the Pinchi and Ingenika faults. The lower unit of the Bowser Lake Group, the Ashman Formation, rests conformably upon the Smithers Formation. It has a thickness up to 760 metres and comprises shales, sandstone, greywackes and conglomerates dervied from erosion of the land mass immediately to the east.

The upper part of Bowser Lake Group rests conformably upon the lower unit showing a continuation of similar lithologies with the exception of coal deposition and volcanics. The entire Bowser Lake Group is characterized by a phase of regressive deltaic sedimentation continuing until the Kimmeridgian when deposition ceased.

The major hiatus that occurred between the Kimmeridgian and U. Cretaceous culminated with the uplift of the Coast Range and induced deformation into the sediments of the Bowser Basin. It was during this interval that the majority of the Omineca granitic and dioritic intrusives were emplaced. Sedimentation did not recommence in the area until the U. Cretaceous, with the formation of the Sustut Basin.

The Sustut Basin occupied a narrow belt between the Skeena and Omineca Mountains in which was deposited a non-marine clastic sequence of Sustut Group of Cenomanian to Paleocene age. Its lower Tango Creek Formation rests unconformably upon the Bowser Lake Group. It commences with a basal conglomerate, passing up into a sandstone/mudstone succession with occasional discontinuous coals. The deposition of the Tango Creek Formation can be attributed to a meandering river system with an easterly and northeasterly provenance. The maximum thickness in the Bear Lake area is thought to be about 700 metres. During the deposition of the Tango Creek Formation, the Axelgold Gabbro was emplaced.

The overlying Brothers Peak Formation rests conformably on the Tango Creek sediments. It commences with acidic tuffs and conglomerate units and fines upwards into sandstones, mudstones and the occasional thin coal. The Brothers Peak Formation appears to have been deposited as an alluvial fan with a west to north provenance.

The Brothers Peak Formation represents the final phase of sedimentation in the area. From the Eocene until the present day erosion has been the dominant process, punctuated by periods of intrusive and volcanic activity. The Kastberg Granodiorite was intruded during the Eocene along with associated dykes and sills. In the late Tertiary and Quaternary the final phase of tectonic activity produced plateau and valley basalts.

The Pleistocene glaciation resulted in the erosion of material from the peaks and ridges and deposition of ground moraine and gravels on the lower slopes and valley bottoms. More recently the post-glacial drainage pattern has produced gravel terraces and alluvial fans.

REGIONAL STRUCTURE

The area has been subjected to three discernable orogenic events since the end of the Paleozoic era. The first of these occurred in the mid-Triassic and resulted in the folding and regional metamorphism of the Cache Creek and Asitka formations. These folds have since been masked by later tectonic activity, but generally folds in these older rocks appear much tighter.

The second orogenic event signalled the end of Bowser deposition and reached its peak in the mid to late Cretaceous. These movements correspond to the Columbian and Pacific Orogenies. The structural trend is NW to SE with movement in a northeasterly direction affecting the pre-Sustut strata. On a local scale the fold-systems conform to the margins of fault bounded blocks, with the folds in the Bowser Basin conforming to the outlines of the basin itself. The region appears broken into many separate crustal blocks bounded by deep faults which influenced the pattern of deformation. The locus of most of the faulting is the Pinchi-Ingenica system, itself a major thrust zone.

The final phase of tectonic activity took place in the early Eocene. The Sustut basin was a late orogenic basin in which molasse deposits of the Columbian and Pacific Orogens accummulated. This deposition was terminated by the Eocene movements which thrust the Sustut strata from the southwest and developed a series of open folds. Associated with the major thrusting are numerous small scale imbricate thrust faults directed to the northeast which affect both Sustut and Bowser assemblages and die out rapidly to the south of the Sustut River.

LOCAL GEOLOGY

The geological mapping of the Sustut property was carried out using air photo interpretation in scale 1:15,840. The Coal Bowl area has been mapped at a more detailed scale of 1:5,000.

One of the principal problems encountered during the mapping was the differentiation between the Lower to Middle Jurassic Ashman Formation and the Upper Jurassic/Lower Cretaceous upper part of Bowser Lake Group. The contact between these two units appears gradational and only the absence of coal from the former distinguishes it from the overlying coal bearing unit.

Another hindrance to the field work was the presence of extensive tracts of overburden, particularly on lower slopes and valley bottoms. Main Creek valley in particular exhibits a very low percentage of rock outcrop.
Maps have been prepared which show geology, the trench and drill hole locations and stratigraphic sections. These are contained in the pocket section at the end of the report.

STRATIGRAPHY

No strata older than the Lower Jurassic were encountered within the property, whilst the youngest rocks recognized were basalt flows of late Tertiary age. However, immediately to the east of the property, rocks belonging to the Upper Triassic Takla Group outcrop and may possibly extend beneath the Tertiary basalts and Pleistocene glacial deposits to sub-crop within the property.

TAKLA GROUP

As mentioned above the Takla Group is not seen to outcrop within the property, but its proximity to the eastern boundary of the block justifies a brief description. There is an entirely volcanic assemblage, comprised predominantly of green-grey, aphanitic andesite containing numerous amphibole phenocrysts. Quartz breccia was also seen to be present but only as a relatively minor continutent.

HAZELTON GROUP

Strata of Sinemurian to Bathonian age, belonging to the Telkwa and Smithers Formation of the Hazelton Group, outcrop at the northeast corner of the block.

The Telkwa Formation in the poorly exposed section examined, comprised grey, fine grained sandstones exhibiting loadcasts, siltstones and black, slickensided, pyritic shales. The more characteristic volcanic assemblages were not seen in this particular section, although they do occur elsewhere in the area.

The Smithers Formation was examined both in the northeast corner of the block and also approximately 3.5 km to the north. The principal lithology in a sequence of some several hundred metres is a fine grained sandstone associated with siltstones and shales. A marine influence is indicated by the presence of minor limestones and an abundant fauna of belemnites, pelecypods and ammonites.

BOWSER LAKE GROUP

The most economically important group of sedimentary rocks present within the property belongs to the Bowser Lake Group. Two units have been distinguished within this group. The lowermost is the Ashman Formation which is Callovian and Oxfordian in age, whilst the upper part of Bowser Lake Group extends from the late Oxfordian to the earliest Cretaceous. Within this latter unit are the Upper Jurassic Netzlzul, Volcanics.

ASHMAN FORMATION

The Ashman strata present the most extensive outcrop of the three Bowser Lake members within the licences.

Where examined, the Ashman Formation comprises essentially a clastic sequence of deposits, primarily sandstones, siltstones and shales with sub-ordinate conglomerates and rare limestones. The sandstone units predominate, being generally massive and light brown to grey in colour. Occasionally they are seen to be grey-green, probably indicating the presence of glauconite, a mineral indicative of marine deposition. In many instances the sandstones show a calcareous cementation and in general exhibit an abundant marine fauna of ammonites, belemnites and pelecypods.

The siltstones are generally gradational units between the sandstones and shales. They vary in colour from dark grey to light brown and can be massive or thinly bedded. A distinctive feature of the more shaly members if the presence of large numbers of ironstone concretions. These spherical bodies range in diameter from 1 or 2 cm to 30-40 cm being usually light brown or rust coloured and invariably structureless when broken. Such concretions have not been noted from any other formations within the property and have been used to indicate the presence of

Ashman strata where differentiation between it and the overlying Upper Bowser Group has been indistinct.

The shale and mudstone strata frequently occur in cyclothemic relationships with the sandstones and siltstones. They are almost always thinly bedded to laminated and individual units rarely exceed 30-50 cm in thickness. They are generally dark coloured, from grey to black and on occasion are carbonaceous, although plant fossils have not been found.

Isolated conglomerate units have been noted from several localities. They are poorly sorted with well rounded clasts of sandstone, quartz and andesitic and basaltic volcanics. Thicknesses are variable and most sections measured were incomplete.

Limestone units are almost always thin, less than 60 cm and usually dark grey in colour. They are not common, but where seen, they are interbedded with alternating sandstone/shale sequences.

UPPER BOWSER LAKE GROUP

Strata ostensibly belonging to the U. Bowser Lake Group outcrop in a discontinuous belt extending from just south of the southwest corner of the block, through Marmot Ridge, Coal Bowl and Willow Creek, to the confluence of Hate and Saiya Creeks. The sediments comprise an entirely clastic succession of sandstone, siltstone, mudstone, shales and coal which, in part at least, is non-marine. The sandstone units attain thicknesses up to 50 metres and are predominantly deltaic in origin as indicated by the type of cross-bedding and their association with coarsening upwards cycles and coal deposits. In general they are medium grained with sub-angular to sub-rounded grains which are usually well sorted. In the majority of cases cementation is non-calcareous. Fossils are sparse and when found are primarily pelecypods and disseminated plant debris.

Siltstones are gradational, being part of a fining upwards cycle and tend not to form thick units. They are generally light brown to buff coloured, in which respect they are similar to the sandstones, with argillaceous and carbonaceous inclusions.

The mudstone and shale units are less well exposed than the more resistant sandstone strata. Where seen, they comprise dark grey to black, thinly bedded, carbonaceous horizons, frequently containing thin stringers of coal. They do not appear to form thick units, although many of the low lying swampy areas could be underlain by more extensive argillaceous strata.

Coal seams occur throughout the U. Bowser Lake Group and will be mentioned in detail in a later section.

The aforementioned sedimentary sequence exhibits a marked lateral variation. Only in the case of one or two of the thicker and more resistant sandstone units can any continuation be traced along stike. A major problem in this respect is the restriction of outcrop to the headwaters of relatively minor creeks. Where more than 100-200 metres of cover separates creek sections, correlation becomes extremely tenuous. This is particularly marked below the tree line where large areas can be traversed without a single outcrop being encountered. A further complication is the high degree of structural disturbance which affects all the strata. The structure of the area will be discussed in the next section.

U. JURASSIC (NETZLZUL) VOLCANICS

Penecontemporaneous with the U. Bowser Lake Group are a suite of volcanics which have a thickness somewhat in excess of 100 metres. They have a north west to south east trend along the western edge of the Sustut properties and range from basaltic to andesitic in composition. They are invariably porphyritic with phenocrysts of plagioclase and pyroxene. The basaltic members tend to exhibit a reddish-brown colouration whilst the andesites are typically green-grey.

Important constituents of this volcanic assemblage are tuffs and agglomerates. The former are water lain and show sedimentary features such as cross-bedding and finding upwards cycles. The latter are generally interlayered with the tuffs and form thicker, ill-sorted units. Associated with these rocks is a volcanic mudflow or Lahar, remnants of which are encountered several times along the strike of the volcanics.

SUSTUT GROUP

The Sustut Group provides the youngest assemblage of sedimentary rocks found on the properties. It is subdivided into two members, of which only the lower Tango

Creek Formation has been recognized within the licence blocks. The upper division, the Brothers Peak Formation, occurs to the west along the Connelly Range and was only briefly examined.

TANGO CREEK FORMATION

The Tango Creek Formation rests unconformably upon the U. Bowser Lake Group. Eisbacher (1973) has subdivided the Tango Group Formation into a lower Niven Member and an upper Tatlatui Member. The former is primarily arenaceous with minor mudstones whilst the latter comprises essentially mudstones with subordinate arenaceous rocks and thin coals.

The sections of Tango Creek Formation examined within the property comprised conglomerates, sandstones, mudstones and coals, belonging to both Niven and Tatlatui Members.

The conglomerate units are generally interbedded with more dominant sandstones. Thicknesses are usually less than 10 metres and it is thought therefore that the thick basal conglomerate is either absent within the properties or lies at a lower elevation than that exposed. Many of the conglomerates recorded were channel fill deposits. The numerous sandstones showed a preponderance of fining upwards cycles, commencing with a thin conglomerate and terminating with either a siltstone or mudstone. They confirm a fluviatile mode of deposition and probably belong to the Niven Member. It is though that strata of this member outcrop predominantly within the central and southeastern parts of the property.

Associated with these Niven arenites are mudstones and carbonaceous layers which include thin coals. These latter are generally confined to the southeast area.

Evidence supporting the presence of the Tatlatui Member comes from the northern part of the Sustut property at Courage Ridge. Here a section measured over 150 metres recorded a predominantly argillaceous assemblage of black, grey and olive green shales and mudstones with subordinate fine grained silty sandstones. Towards the top of the section, two coal seams, Saiya A and B, occur, which have been proved to be younger than those to the southeast.

The strata encountered confirms a depositional environment in which the high energy fluvial conditions of Niven times gave way gradually to a lower river gradient during the Tatlatui culminating in flood basin swamps.

TERTIARY BASALTS

The volcanism that gave rise to the lavas, dykes and necks assigned to this group, probably commenced during the Miocene and continued into the Quaternary.

The basaltic lavas generally form caps on ridge tops, particularly along the western boundary of the property. However, the single most extensive flow is a valley fill deposit which extends from west to east across the Main Creek valley for a distance of 5.5 km and at its widest is 2.5 km across. The basalt is generally massive, fine grained, dark grey to black and very strong. The upper parts of many of the flows exhibit a vesicular texture and appear brown in colour. Columnar jointing can be seen near the base of the flow immediately above Coal Bowl and again where Main Creek cuts the basalt.

Only one dyke worthy of note was recorded during the summer. It cuts through the Tango Creek Formation some 1.5 km to the southeast of the block. Erosion has removed much of the surrounding sediment so that the vertical, 2 metre thick dyke, is left protruding 6 metres above the ground. It is composed of vesicular basalt with occasional inclusions of obsidian.

PLEISTOCENE AND RECENT

Glacial deposits are generally found below the tree line and become progressively thicker towards the valley bottoms. The majority of these deposits are ground moraine comprising a silty sand and gravel matrix with only minor clay, in which are embedded larger cobbles and boulders. Outwash sands and gravels of glacial origin occur at isolated localities throughout the more open valleys and almost all the larger creeks contain some alluvium.

Talus slopes are frequent, extending from the frost shattered ridges to beyond the tree line. Weathering and oxidation, particularly of the less resistant coals and shales, has been especially severe on slopes not steep enough for gravity to continually provide a fresh surface. A deep regolith of slumped and solifluction material often occurs in basin or cirque-like areas at the headwaters of many of the creeks, e.g., Coal Bowl. Gravity has also been responsible for the creep and cambering of rock outcrop down slope and is particularly noticeable in vertical or near vertical strata.

A final minor depositional phase has been that of calcareous tufa primarily to the south of the property. It is creamy grey in colour forming thin layers and resulting from the emanation of cold springs. The largest deposit occurs at Fumar Creek where a cone over 2 metres high has resulted, being known as Big Kettle fumerole.

STRUCTURE

The Sustut properties exhibit an extremely complex structure. Three separate orogenic events have contributed to this complexity resulting in faults, thrusts and tight folding affecting all the units except for the Tertiary basalts. The final phase of tectonic activity must therefore have been completed by the Miocene and it is probable that the outpouring of the late Tertiary basalts represented the last event of this orogeny.

FAULTING

The principal faults and thrusts which affect the properties trend from northwest to southeast. Minor east-west oriented faults also occur but generally have a small throw, dying out rapidly and being of only local significance. Evidence for the presence of the larger dislocations comes from several sources, e.g., brecciation, mineralization and slickensiding, juxtaposition of stratigraphic members, topographic expression and air photo interpretations. The magnitude and, to a lesser degree, the direction of these displacements is open to conjecture. However, reflectance data has indicated broad ranges for several of these movements and this work will be discussed in a following section.

Saiya Fault - It extends for a distance of approximately 25 km, forming the western boundary of the properties. Its position is marked by the break of slope along the eastern side of the Saiya valley. It diverges from the Saiya valley immediately south of Saiya Lake and follows the headwaters of the Omineca River in a south easterly direction before heading south. At its northern end it probably merges with the Sustut and Asitka faults at the confluence of these two rivers. The downthrow side appears to be to the southwest where strata of the Sustut Group dip to the northeast and strike parallel to the fault. Across the fault older strata of Upper Bowser Lake Formation have been thrown up against the Sustut Group. The throw of the fault would seem to be of the order of 200 to 500 metres, as the Tango Creek Formation of the Sustut Group rests alongside strata belonging to the middle part of the U. Bowser Lake Group.

Carruthers Faults - Another northwest trending dislocation, this time running along the eastern boundary of the block. It extends from just south of the Asitka River in the north to the Omineca River in the south, a distance of 32 km. It is probably a high angle thrust fault, responsible for pushing the lower and middle Jurassic strata to the west over the top of the Permian and Triassic rocks. Displacement seems considerable as a great deal of the Hazelton Group and some Takla Group are missing.

Asitka Fault - This is perhaps the principal east- west fault in the proximity of the Sustut properties. Its trace lies immediately north of the Asitka river, extending from the Sustut fault in the west to the Pinchi fault seom 20 km to the east. It downthrows to the south where Ashman Formation strata dip to the east and north east. To the north of the fault south dipping Telkwa Formation and uppermost Takla Group are exposed. The fault has been recorded as a high angle reverse fault and displacement would seem to be at least 1,000 metres and perhaps as much as 2,000 metres.

Main Creek Fault - It is inferred that a significant fault must run along Main Creek, probably being a splay from the Carruthers Fault. The exact location of the fault plane is unknown due to the extensive cover of glacial till. It is probably a high angle reverse fault which has thrown up Ashman Formation next to the Tango Creek Formation. This implies that the U. Bowser Lake Group is missing which would suggest a displacement of approximately 1,000 metres. However, as there is no direct evidence for the presence of Ashman Formation immediately west of the fault, the throw could be much smaller.

Coal Bowl Faults - A series of thrust faults has been assumed to occur in the Coal Bowl area to explain the repetition of coal seams. It is felt that at least two significant thrusts occur with displacements of between 100 and 200 metres. Additional minor faults would also seem to be present imparting an imbricate structure to the area. It is possible that these thrusts unite at depth and may originate in the Saiya Fault. This would assume that the Coal Bowl area and much of Marmot Ridge is composed of a series of thrust wedges.

Watney and Bass Faults - These two faults have a common origin at the northern end of Courage Ridge. They diverge from one another to the southeast, running either side of the ridge. The Watney fault separates the Tango Creek Formation from the Ashman Formation and may link with the thrusts of Coal Bowl. It would seem to be a high angle reverse fault and if it has resulted in the omission of the U. Bowser Lake Group, then its throw must be in the order of 1,000 metres. The Bass Fault appears to be less significant, separating the U. Jurassic (Netzlzul) volcanics from the Tango Creek Formation. The amount of throw is probably only a few hundred metres, resulting in the loss of the Niven Member of the Tango Creek Formation.

The majority of thrusting and faulting would seem to be the result of the early Tertiary orogeny. Undoubtedly the older orogenic events produced dislocations, but there is no conclusive evidence to assign specific faults to these events. Furthermore, it is most likely that older faults were reactivated by the younger tectonic movements.

FOLDING

The principal fold axes are oriented northwest to southeast, paralleling the fault trends. The earliest folding resulted from movements in the mid-Triassic and affected only pre-Triassic units. However no evidence of these folds was recognized during the field work.

The second orogenic phase which affected the pre-Sustut strata manifests itself far more obviously. These folds are particularly well marked in the Ashman Formation and

U. Bowser Lake Group which are more highly disturbed with tighter folds than the overlying Sustut Group.

The three principal fold axes within the property are the Worthington and Vaux synclines and the Harp anticline. The Worthington syncline trends northwest to southeast down Main Creek valley, the axis lying somewhere to the west of the creek. Evidence for the syncline comes from dip measurements in the Ashman Formation to the west, particularly along Low Coal Creek. The general dip is to the east becoming less steep towards Main Creek and the synclinal axis. Minor variations to this trend are apparent, so that the structure probably resembles a synclinorium. The synclinal axis presumably continues beneath the Tertiary Basalts as indicated by an area of Ashman Formation strata in the north half of the block where dips are consistant with the presence of a syncline. Dip readings tend to suggest that the syncline has a plunge to the northwest, confirming Lord's findings.

Approximately 2 km to the west of the Worthington syncline is the Harp anticline which parallels the former and probably runs along the eastern edge of Coal Bowl. It is certainly assymetrical in form, particularly near Coal Bowl and immediately north of the Tertiary Basalts where the western limb is much steeper. Again, as for the Worthington syncline, it is more an anticlinorium than a simple anticline. Generally, dips become steeper and structure more complex as the Coal Bowl area is approached, reflecting both the presence of thrusting and also the less competent coal measures. Both coal seams and shales exhibit a high degree of contortion and shearing whenever they are found within the area.

The Vaux syncline has been recognized within the Sustut Group rocks and is therefore of post- Paleocene age. It may be present within the older rocks to the south of Willow Creek but cannot be defined with any certainty. It is cut out by the Watney fault to the east of Courage Ridge in the north and disappears into the Tertiary Basalts in the south. It is a broader and more gentle structure than the older folds with dips rarely exceeding 40° and very few subordinate flank folds. The more competent and brittle nature of the Sustut Group strata undoubtedly affected the style of folding within this group, particularly within the lower Niven Member.

Only three of the many folds have been mentioned above. The same principles, however, apply to all the other folds recorded, that is, folds within the Sustut Group are less complex and more open than those in the Ashman Formation and U. Bowser Lake Group. Also, the less competent coal, shale and mudstone horizons exhibit the greatest deformation.