EXLOG

COLUMBIA GAS DEVELOPMENT OF CANADA LTD.

COLUMBIA ET AL KOTANEELEE YT I-43

GEOLOGICAL REPORT

FEBRUARY 1980

COLUMBIA GAS DEVELOPMENT CANADA LTD. ET AL

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COLUMBIA GAS et al KOTANEELEE YT I-48

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OF EXPLORATION LOGGING CANADA LTD.

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I) FORMATION TOPS FOR KOTANEELEE YT I-48

AGE	FORMATION	DEPTH	SUB-SEA DEPTH
TRIASSIC	ABOVE LOGGED INTERVAL		
PERMIAN	Fantasque	ABOVE LOGGED INTERVAL	
MISSISSIPPIAN	Mattson Sand	256.6m	+570.7m
	Mattson Silt	1177m	-349.7m
	Mattson Chert	1497m	-669.7m
	Upper Flett	1735m	-970.7m
	Middle Flett	2144m	-1316.7m
	Lower Flett	2511m	-1683.7m
MISSISSIPPIAN/ UPPER DEVONIAN	Besa River	2615m	-1787.7m
	Horn River	3561m	-2733.7m
MID. DEVONIAN	Nahanni	3648m	-2820.7m
	Headless	3838.8m	-3011.5m
	Arnica	4026m	-3198.7m

N.B. These depths are subject to revision pending further log analysis.

II CORRELATION OF KOTANEELEE AREA FORMATION TOPS

FORMATION	I - 27	H - 38	E - 37	I - 48
Triassic (Depth)	359.4 (1179')	Cased	Cased	Cased
(Subsea)	+81.4 (+267')			
(Isopach)	348.7 (1144')			
Fantasque	708.1 (2323')	335.6 (1101')	596.8 (1958')	Cased
	-267.3 (-877')	+350.2 (+1149')	+24.4 (+80')	
	172.8 (567')	169.8 (557')	218.2 (716')	
Mattson Sand	880.9 (2890')	505.4 (1658')	815.0 (2674')	256.6
	-440.1 (-1444')	+180.4 (+592')	-193.8 (636')	+570.7
	852.5 (2797')	846.7 (2778')	919.9 (3018')	920.4
Mattson Silt	1733.4 (5687')	1352.1 (4436')	1734.9 (5692')	1177
	-1292.6 (-4241')	-666.3 (-2186')	-1113.7 (-3654')	-349.7
	288.6 (750')	336.5 (1104')	247.6 (901')	320.0
Mattson Chert	1962.0 (6437')	1688.6 (5540')	2009.5 (6593')	1497
	-1521.2 (-4991')	-1002.8 (-3290')	-1388.3 (-4555')	-669.7
	221.6 (727')	243.2 (798')	212.5 (697')	238.0
Upper Flett	2138.6 (7164')	1931.8 (6338')	2222.0 (7290')	1735
	-1742.8 (-5718')	-1246.0 (-4088')	-1600.8 (-5252')	-907.7
	167.0 (548')	281.7 (924')	293.5 (963')	409.0
Middle Flett	2350.6 (7712')	2213.5 (7262')	2515.5 (8253')	2144
	-1909.8 (-6266')	-1527.7 (-5012')	-1894.3 (-6215')	-1316.7
	277.7 (911')	320.3 (1051')	290.8 (954')	367.0
Lower Flett	2628.3 (8623')	2533.8 (8313')	2806.3 (9207')	2511
	-2187.5 (-7177')	-1848.0 (-6063')	-2185.1 (-7169')	-1683.7
	120.1 (394')	133.4 (372')	117.3 (385')	104.0
Besa River	2748.4 (9017')	2647.2 (8685')	2923.6 (9592')	2615
	-2307.6 (-7571')	-1961.4 (-6435')	-2302.4 (-7554')	-1787.7
	869.6 (2853')	809.2 (2655')	856.7 (2814')	946.0
Horn River	3618.0 (11870')	3456.4 (11340')	3781.3 (12406')	3561
	-3177.2 (-10424')	-2770.6 (-9090')	-3160.1 (-10368')	-2733.7
	88.4 (290')	89.6 (294')	111.6 (366')	87.0
Nahanni	3706.4 (12160')	3546.0 (11634')	3892.9 (12772')	3648
	-3265.6 (-10714')	-2860.2 (-9384')	-3271.7 (-10734')	-2820.7
	213.0 (699')	193.9 (636')	212.1 (696')	190.8
Headless	3919.4 (12859')	3739.9 (12270')	4105.0 (13468')	3838.8
	-3478.6 (-11413')	-3054.1 (-10020')	-3483.8 (-11430')	-3011.5
	188.7 (619')	158.2 +(519'+)	86+ (282')	187.2
Slica-Monetoe	4108.1 (13478')	Not Penetrated	Not Penetrated	4026
	-3667.3 (-12032')			-3198.7
	310.0+(1017'+)			403.0+
T.D.	4418.1 (14495')	3898.1 (12789')	4191.0 (13750')	4429.4

SUMMARY OF WELL DATA

1.	1. WELL NAME AND NUMBER:	COLUMBIA GAS et al KOTANEELEE YT I-48
	2. PERMITTEES:	DOME PETROLEUM ESSO RESOURCES CANADA LIMITED CANADIAN SUPERIOR OIL LIMITED AMOCO CANADA PETROLEUM CO. LTD CANADA SOUTHERN PETROLEUM LTD
	3. NAME OF OPERATOR:	COLUMBIA GAS DEVELOPMENT OF CANADA 1420 Standard Life Building, 637 - 5th Avenue S.W., Calgary, Alberta
	4. LOCATION:	YUKON TERRITORY UNIT: 1 SECTION: 48 Latitude: 60° 07' 35.917"N Longitude: 124° 07' 36.45"W
	5. LEASE NUMBER:	411 - 68
	6. DRILLING CONTRACTOR:	Nabours Drilling Ltd., Rig #9
	7. DRILLING AUTHORITY:	929
	8. CLASSIFICATION:	Development Well
	9. ELEVATIONS:	Ground: 827.3m R.K.B.: 834.95m
	10. SPUDDED:	April 21, 1979
	11. COMPLETED DRILLING:	February 15, 1980
	12. TOTAL DEPTH:	4429.4m
	13. WELL STATUS:	Gas Well
	14. RIG RELEASE DATE:	N/A
	15. HOLE SIZE:	660mm - 0m to 216m 444.5mm - 216m to 1075m 311mm - 1075m to 3270m 216mm - 3270m to
	16. CASING:	762mm Set at 19m 508mm Set at 215m 340mm Set at 1054m 245mm Set at 3265m

III CORED INTERVALS

CORE #	INTERVAL	CUT	RECOVERIES
1	3660-3665.7m	5.7m	4m
2	3665.7-3668.8m	3.1m	1.85m
3	3668.8-2672.1m	3.3m	1.7m
4	3723-2741m	17m	17m
5	374103759.2m	17.2m	17.2m
6	3759.2-2771.6m	12.4m	11.75m
7	2771.6-2774.2m	2.4m	2.25m
8	2774.2-2782.4m	8.2m	3.3m
9	3910.4-3912.6m	2.2m	1.93m
10	3912.6-2916m	3.4m	2.2m
11	2949.2-3956.8m	7.6m	7.6m
12	4035-4036.6m	1.6m	1.55m
13	4036.6-4043.6m	7.0m	7.0m
14	4043.6-4046m	2.4m	2.0m
15	4158.2-4165.2m	7m	6.5m
16	4424.4-4429.4m	5m	3.65m

IV

CORE DESCRIPTIONS

CORE #1: 3660m - 3665.7m Nahanni Formation

Cut 5.7m Recovered 4.09m (71.7%)

3660 - 3660.5 DOLOMITE, medium and dark grey, hard, micro and fine crystalline, brecciated appearance in general. Subrounded to subangular clasts of very dark grey to black dolomitized mudstone. The clasts are surrounded by white, fine to coarse crystalline dolomite. The rock contains small to large vugs which show incomplete to complete infill with predominantly white dolomite along with some quartz and a trace of calcite. Some of the vugs have been partially filled with black carbonaceous material having a vitreous lustre and conchoidal fracturing. This section contains moderate to abundant fracturing, partially to completely filled with white dolomite and occasionally with some carbonaceous material. Sequence of infill of the vugs and fractures.

1. White dolomite
2. Clear authigenic quartz
3. Black carbonaceous material

The effective porosity of the section is poor to fair consisting of open to partially filled, small to large vugs. There is also some pin point porosity ovserved in the dark grey dolomite and mudstone clasts.

3660.5 - 3661.9 DOLOMITE, medium and dark grey, hard, micro and fine crystalline, subangular to subrounded clasts of dolomitized mudstone surrounded by white microcrystalline dolomite giving a brecciated appearance. Some brachiopod and coral replacement between 3660.85 and 3661.15m. There are small to medium vugs showing the infill sequence of dolomite, Quartz and black carbonaceous material. The vugs

CORE #1 CONTINUED

Are partially to completely filled. The effective porosity is poor in this section with some partially non effective open vuggy porosity. The core shows a moderate amount of fracturing with nearly all the fractures completely filled with white dolomite, quartz and a trace of sphalerite. Trace galena at 3661.15m.

3661.9 - 3663.65 DOLOMITE, medium and dark grey, brecciated appearance with dark grey to black clasts of dolomitized mudstone surrounded by white crystalline dolomite. The clasts often showing small white crystalline dolomite veins. Abundant white crystalline dolomite infilling between 3662.4 and 3662.53m with a good trace of sphalerite. Small to large vugs and vertical fractures partially to completely filled with white crystalline dolomite and clear authogenic quartz. Traces of brachoipod and coral replacement by white crystalline dolomite. Effective porosity is poor to occasionally fair consisting or partially infilled vugs and fractures along with some non-effective vuggy porosity.

3663.65 - 3664.09 DOLOMITE, in this area it appeared dark grey and black, fine to microcrystalline and hard. This section is predominantly non brecciated, with white crystalline dolomite completely infilling small vugs. Occasionally is was observed as being only partially infilled. The porosity in this section is generally poor with occasional non effective vuggy porosity.

CORE #2: 3665.7 - 3668.8m Nahanni Formation

Cut 3.1m Recovered 1.9m (61.2%)

3665.7 - 3668.8 DOMOLMITE, medium and dark grey, hard to very hard, fine to micro crystalline. The core has a brecciated appearance with clasts of dolomitized mudstone ranging in size from a few millimeters to 5 centimeters. The clasts are predominantly surrounded by white crystalline dolomite. Throughout the core there is occasionally small to medium size vugs being partially to completely filled with white crystalline dolomite and clear authogenic quartz and occasionally with a trace of sphalerite. There is a small amount of fractures in part throughout the sore completely being infilled with white dolomite. Some fossil replacement is observed throughout the core by white crystalline dolomite predominantly of thin shelled brachiopods and a few coral.

The porisity throughout the core is poor to very poor with occasional pin point porosity being predominantly within the clasts. Also there is some patchy non effective open vuggy porosity along with some pore porosity observed in incompletely filled fractures but is non effective.

Observations: There was an odour of slightly sour gas when the core was broken and a small amount of gas could be seen bleeding throughout the core.

CORE #3: 3668.8-3672.1m Nahanni Formation

Cut 3.3m Recovered 1.7m (51.5%)

3668.8-3670.5 DOLOMITE, Medium and dark grey, hard to very hard, tight, fine to microcrystalline with a distinctly brecciated appearance. Distorted subangular clasts or nodules (possibly Phosphatic) occur within a grey to dark grey dolomitic matrix which becomes silty and shaley in appearance over much of the cored section. In places the rock appears as a brecciated bio-micrite.

Porosity was seen to be very poor, consisting of a few unconnected vugs, mostly filled with quartz and dolomite, and rarely some pin-point porosity. An earlier vertical fracture pattern has been all-but obliterated.

The whole cored section showed severe alteration - the dolomitic character may well be secondary - most noticeably by quartz in close association with sphalerite, the crystals of which are frequently well formed. The presence of small geodes, most of which are filled with quartz and dolomite, both of secondary nature, suggests some form of mineral percolation through the rock. A black mineral (possibly bitumenous) was also present as was a tiny amount of galena. The sequence of alteration as described in Core #1 was again seen to be exhibited: dolomite-quartz-black mineral. A white grainy, non calcareous, porphyroblastic-looking mineral was seen partially replaced in one vug.

A poor to fair dolomitic content is apparent. This varies from 10% at the base to 38% in the middle and 58% at the top of the cored section. The calcite percentage was zero, except at the base where 3% was measured.

Bivalves, corals and bryozoa, all replaced by dolomite, are scattered throughout - possibly in broad horizons.

Between 3670.25m and 3670.3m a dark grey, tight, non-calcareous and non-fossiliferous shaley band was observed. Here several horizontal quartz and dolomite-filled fractures cut across the section.

Observations: The distinct aroma of hydrogen sulphide was prevalent during removal of the core from the core barrel, cleaning of the core, chipping hand specimens and acidizing of hand specimens.

DEPTH:	3724m	Nahanni Formation
CUTTING CORE	#4 3724-3741m Cut 12m in 7 hrs 51 min Cut 17m Recovered 17m (100%)	
CORED AT:	19 to 33 min/m	
TOTAL GAS:	28 to 45 units	

3724-3741m DOLOMITE, grey to dark grey, rarely white speckled, hard to very hard, brittle, splintry, tight, fine to micro-crystalline with a brecciated appearance, frequently with distorted darker shaley clasts or nodules in a lighter shaley dolomitic matrix.

Porosity was seen to be very poor (2-3%) but permeability was locally very good consisting of connected vigs and fractures.

Permeable areas were separated by tight shaley areas.

Fracturing was vertical, oblique and horizontal.

Fractures were lined with dolomite, small amounts of quartz.

Some evidence of pressure solution exists plus occasional small zones of shear.

Mineralization inluded traced of sphalerite disseminated in quartz and small localized amounts of pyrite as well as large amounts of dolomite.

Fossilization consisted of crinoids, bryozoa, corals and bivalves all replaced by dolomite.

Observations: Sour gas was seen bleeding from the core. The smell was persistent.

CORE #5: 3741.0-3759.2m Nahanni Formation

Cut 17.2m in 3 hrs 21 mins
Cut 17.2m Recovered 17.2m (100%)

DEPTH: 3741-59.2m cored at 7 to 14 min/m

TOTAL GAS: 60 to 90 units of total gas

3741-59.2m DOLOMITE, grey to dark grey to light grey, frequently white speckled, hard to very hard, becoming cleaner, fine to microcrystalline, brecciated appearance, distorted clasts or nodules of silty or shaley texture are dispersed in a dolomitic ground mass.

Porosity was 2 - 3% and of vuggy nature. Pin point porosity was occasionally apparent.

Permeability was good locally, following mainly horizontal dolomite and quartz-lined veins and occasional vertical fractures.

Mineralization included a graphitic texture black mineral, especially along horizontal fracture planes, some of which give the appearance of being slickensided. Ubiquitous creamy white dolomite and clear secondary quartz present the bulk of fracture-fill.

The section appeared almost devoid of fossilization.

Observations: Hydrogen sulphide in fair quantities was present and was seen bleeding from the cored section.

DEPTH:	3759.2m	Nahanni Formation
CUTTING CORE	#6 3759.2m - 3771.6m Cut 12.4m in 5 hrs 03 min Cut 12.4m Recovered 11.75m (94.7%)	
CORED AT:	12 to 49 min/m	
TOTAL GAS:	80 - 160/0 units	

3759.2-3771.6m DOLOMITE, grey to light grey, dark grey, locally white speckled, hard to very hard, clean, locally silty, locally shaley, fine to microcrystalling, mostly tight, brecciated appearance, with light grey and dark grey distorted clasts or nodules in a dolomitic matrix.

Porosity is less than 5%, vugular, rarely pin-point, mostly poor rarely becoming poor-fair.

Permeability is locally very good-along fracture-connected vugs, Fractures and vugs are lined with or filled with dolomite and small quantities of quartz.

Mineralization includes locally large quantities of a graphite-like mineral which frequently fills stylolites. Pressure solution features are locally exhibited as are penecontemporaneous sedimentary features (distorted ball and pillow structures).

Possible replaced corals are to be found in the lower sections of the cored interval.

Observations: Hydrogen sulphide was again present, but dissipated rapidly probably due to the reasonably good permeability displayed.

DEPTH:	3771.6m	Nahanni Formation
CUTTING CORE	#7 3771.6m - 3774.2m Cut 2.4m in 1 hr 50 min Cut 2.4m Recovered 2.25m (93.8%)	
CORED AT:	44 and 47 min/m	
TOTAL GAS:	30/0 units	

3771.6-3774.2m DOLOMITE, grey, occ light grey, rarely dark grey, locally white speckled, hard to very hard, tight, locally shaley, fine to microcrystalline. Included in the grey dolomite are lighter rounded to subrounded dolomitic clasts or nodules which are distorted.

Porosity is restricted to vugular spaces and is poor becoming fair.

Permeability is vugular. Locally vugs are well interconnected resulting in good permeability.

A distinct fracture system is exhibited, showing horizontal, subhorizontal, vertical and oblique fractures. The latter seems to be more recent as all features in the cored section seem to be affected.

Lighter dolomitic inclusions in the grey dolomite matrix resemble penecontemporaneous structures. These may be related to fossil replacement and/or secondary mineralization. Mineralization consists of mainly white/cream dolomite expecially in horizontal and subhorizontal fracture/vug systems. Occasionally clear quartz of secondary character is also present.

Observations: A strong obour of hydrogen sulphide was prevalent on openings of the core barrel and removal of the core.

DEPTH: 3774.2m Nahanni Formation

CUTTING CORE #8
3774.2m - 3782.4m
Cut 8.2m in 4 hrs 38 min
Cut 8.2m Recovered 3.3m (40.2%)

CORED AT: 24 to 40 min/m

TOTAL GAS: 15 to 36 units

3774.2-3782.4m DOLOMITE, grey to light grey, dark grey, white speckled, white hard to very hard, brittle, angular, tight, finely crystalline, occasionally microcrystalline, frequently silty, mostly massive.

Porosity is very poor (1%) and consists of rare vugular spaces.

Permeabilityis poor to very poor. There is some fracturing and rarely fracture-connected vugs.

Fractures are oblique, vertical and horizontal throughout most of the core. Some evidence of pressure solution exists. Several stylolites point to a lateral shortening in the rock mass.

Mineralization includes a graphite-like mineral and some clear quartz as well as large amounts of white vein dolomite.

Possible coral replacement exists in the lower part of the core.

Observations: The smell of sour gas was again present. Gas was seen bleeding through fractures on removal of the core from the core barrel. Lost circulation on a small scale occurred during cutting of the first six meters of the core.

DEPTH: 3910.4m Nahanni Formation

CUTTING CORE: #9
3910.4m - 3912.6m
Cut 2.2m in 58 mins
Cut 2.2m Recovered 1.93m (87.7%)

DEPTH: 3910.4 CORING TIME:
3912 23 min/m
3912.6m 34 min/m

TOTAL GAS: 80 units

3910.4-3912.6m DOLOMITE, light grey to grey to dark grey, white or cream speckled, hard, brittle, angular, tight, finely crystalline with a somewhat brecciated appearance, becoming silty locally.

Porosity is poor becoming fair locally, vuggy, with open fractures and some pin-point porosity.

Permeability is fair to good consisting of fractures and fracture-connected vugs.

Fractures are vertical, oblique and horizontal and are frequently filled with pure, white or cream crystalline dolomite. Oblique fractures and frequently filled with a dark grey mineral. Severe pressure solution is apparent in several areas, particularly near the top of the cored section. There are also many stylolites in this top area, some of which seem to possess no fill and denote some lateral shortening of the rock mass as a whole.

There are many solution cavities of small size, probably formed by leaching. Most of these remain unconnected.

Mineralization consists of dolomite - white and well crystalline - and a black mineral.

There is an apparent absence of fossilization.

Observations: The strong initital odour of hydrogen sulphide dissipated rapidly, probably due to the reasonably good permeability.

DEPTH:	3912.6m	Nahanni Formation
CUTTING CORE	#10 3912.6-3916.0m Cut 3.4m in 1 hr 33 min Cut 3.4m Recovered 2.2m (65%)	
CUT AT:	27 to 43 min/m	
TOTAL GAS:	40 - 80 units	

3912.6-3913.5m DOLOMITE, grey to dark grey, white speckled, hard to very hard, with bands of white dolomite lining fractures and vugs.

Porosity is very poor (2 - 3%) and vugular.

Permeability may be good locally due to vugs. There are numerous small vugs as in core #9.

At the base of this section a more massive shaley dolomite section is graded into. This lacks both porosity and permeability on any significant scale.

3913.5-3914m DOLOMITE, grey; white and creamy vein dolomite showing coarser crystallinity and aligned horizontally in the form of undulating discontinuous and lenticular laminations which occurs in a darker, shaley, dolomitic matrix.

Porosity is poor, becoming fair locally (small to large vugs).

Permeability is locally fair (veins, fracture-connected vugs).

There is much evidence to suggest the activity of pressure solution and some evidence of shearing in the section.

3914-3914.8m DOLOMITE, grey to light grey, hard to very hard, brittle, angular fracture, tight, massive, creamy-white veins of dolomite are rare.

Porosity is extremely poor in this lower section.

Permeability is likewise very poor.

Fossilization was not evident throughout the whole cored section.

Mineralization included a graphite-like mineral coating fracture planes between the lowest and middle of the cored sections.

Observations: Sour gas was again present. Extreme difficulty was found in coring this section and the core repeatedly jammed.

DEPTH:	3949.2m	Nahanni Formation
CUTTING CORE	#11 3949.2 - 3956.8m Cut 7.6m in 5 hrs 17 mins Cut 7.6m Recovered 7.6m (100%)	
CORED AT:	36 to 67 min/m	
TOTAL GAS:	25 - 80 units	

3949.2-3951.38 DOLOMITE, grey to light grey, hard to very hard, brittle, tight, finely crystalline, massive, with occasional mineralized stylolites, white dolomite veins are associated with a black metacrystalline bitumen, a grey manganese-like mineral is also present. There is rarely a trace of pyrite. Fractures are mostly horizontal, occasionally vertical and oblique.

Porosity is extremely poor.

Permeability is very poor.

3951.38-3951.96 DOLOMITE, grey to light grey, hard to very hard, brittle, tight, finely crystalline, with many white dolomite veins and occasional small vugs. There is a trace of clear quartz.

Fracturing is mainly horizontal but also vertical and oblique.

Porosity is very poor.

Permeability is poor, locally fair.

3951.96-3952.56 DOLOMITE, grey, hard to very hard, brittle, tight, fine to microcrystalline, massive, rarely with small vertical fractures or stylolites. A graphitic like mineral is locally apparent.

Porosity is extremely poor.

Permeability is very poor.

3952.56-3953.1 DOLOMITE, grey, hard to very hard, highly fracuted and brecciated.

A fair amount of white vein dolomite slickensides and smears of a graphitic-like mineral on fracute planes suggest that this may be a zone of fracturing in which permeability may be good.

3953.1-3954.65 DOLOMITE, light grey to grey, hard, brittle, tight, fine to microcrystalline silty massive no visible porosity but some horizontal fracturing may provide a very poor permeability.

3954.65-3955.3 DOLOMITE, grey to light grey, hard to very hard, brittle, tight, finely crystalline, with many white dolomite-filled veins and a few very small vugs.

Fractures are vertical, oblique and horizontal.

Porosity is very poor (vein and occasional vug).

Permeability is poor, possibly ascending locally to fair.

Mineralization included a graphitic-like mineral, meta-crystalline bitmen and a trace of clear secondary quartz.

3955.3-3956.8 DOLOMITE, grey, hard to very hard, brittle, tight, finely crystalline, massive, with a few small vertical fractures and rarely stylolites and one small area of dolomite veining.

A black reaky nature in parts may be mineralization, possibly in situ stress phenomenon or penecontemporaneous.

Porosity is extremely poor.

Permeability is very poor.

Possible replaced corals and brachiopods occur in lower parts of this section.

Observations: Sour gas was only very faintly detected.

DEPTH: 4035m Arnica Formation

CUTTING CORE #12
4035-4036.6m
Cut 1.6m in 56 min
Cut 1.6m Recovered 1.55m (96.9%)

DEPTH: 4035
4036 CORED AT: 22 min/m
4036.6 37 mon/m

TOTAL GAS: 37 and 64 units (respectively)

4035.0-4035.9m DOLOMITE, light grey, hard, brittle, angular fracture, very finely crystalline. A dolomitzed micrite.

Fracturing is severe, mainly in the vertical and horizontal planes. Vertical fractures are rarely filled with white crystalline dolomite which is occasionally associated with a black crystalline mineral. Slickensiding is occasionally present in horizontal fracture planes.

Porosity is extremely poor.

Permeability is mostly very poor and is totally reliant on small fractures.

4035.9-4036.6 DOLOMITE, grey to dark grey, hard to very hard, finely to microcrystalline, tight, massive, brittle, occasionally almost subconchoidal fracture. A dolomitized micrite.

Fracturing is mainly vertical and horizontal but oblique fractures are also common. On all three planes slickensides may be found. Fractures are occasionally filled in with coarsely crystalline white dolomite-especially in the lower part of this section where the rock becomes faintly banded with recrystallized dolomite and where pressure solution and stylolites are to be found.

In the one large attached mass of cored section, permeability appears to be extremely poor-despite the fracturing-and porosity is likewise poor.

Observations: A slight odour of sour gas was detected. This prevaled over a longer time interval than in previous cores, suggesting a poorer permeability.

DEPTH:	4036.6m		Arnica Formation
CUTTING CORE	#13 4036.6-4043.6m Cut 7.0m in 8 hrs 35 mins Cut 7.0m Recovered 7.0m (100%)		
DEPTH:	4036.6		
	4038	CORED AT:	85 min/m
	4039		62 min/m
	4040		70 min/m
	4041		90 min/m
	4042		65 min/m
	4043.6		50 min/m
TOTAL GAS:	23 to 32 units		

4036.6-4037.54 DOLOMITE, dark grey, hard to very hard, tight, brittle, angular, finely crystalline, massive, shaley texture, appears as a dolomitized micrite.

Fracturing is mostly horizontal, occasionally oblique. Slickensiding and pressure solution are locally exhibited.

Porosity if very poor.

Permeability is poor to very poor.

Mineralization inlcudes a vitreous. Sometimes graphitic-textured, black bitumenous mineral smeared on fracure planes.

4037.54-4038.14 DOLOMITE, light grey to grey, appears lighter banded, hard to very hard, very tight, brittle, angular, very finely to microcrystalline massive, appears like a dolomitized micrite.

Fracturing is horizontal, oblique and vertical as well as a few small, black, discontinuous veins of a mineral with a large sulpher content.

Porosity is extremely poor.

Permeability is very poor.

4038.14-4039.94 DOLOMITE, dark grey, hard to very hard, tight, brittle, angular, fine, occasionally of medium crystallinity.

Fracturing is mostly horizontal, consisting of white dolomite-filled veins which give a locally brecciated appearance to parts of this section with dolomitic clasts in white vein dolomite and this may indicate mineralization under pressure. Pressure solution is also exhibited as is slickensiding.

Porosity consists of fracture spaces and rarely pin-point. It is very poor.

Permeability is poor.

Mineralization includes a vitreous bitumenous mineral.

4039.94-4041.79 DOLOMITE, dark grey, hard to very hard, tight, brittle, massive.

Fractures are mostly horizontal and oblique and are frequently filled with white, coarsely crystalline dolomite. Vugs are well developed in this section, although they are frequently unconnected and/or filled with dolomite.

Brecciation similar to that in the above section is exhibited.

Porosity is poor to fairly good.

Permeability is poor to fairly good.

4041.79-4042.12 DOLOMITE, dark grey, hard to very hard, tight, brittle, angular, fine to medium crystallinity, massive.

Fracturing is horizontal, frequently oblique and occasionally vertical. Rarely, slickensiding is exhibited as is pressure solution.

DEPTH: 4043.6m Arnica Formation

CUTTING CORE #14
4043.6-4046.0m
Cut 2.4m in 1 hr 09 min
Cut 2.4m Recovered 2.0m (83.3%)

DEPTH: 4043.6
4044 CORED AT: 58 min/m
4045 24 min/m
4046 34 min/m

TOTAL GAS: 32 units

4043.6-4044.72 DOLOMITE, grey, hard to very hard, tight, brittle, angular, finely crystalline massive.

This section is highly fractures. Fracture planes are mainly oblique and horizontal giving a large-scale blocky character.

Porosity is poor, but permeability-at surface-may be fairly good due to the extensive fracturing.

4044.72-4045.6 DOLOMITE, dark grey, hard to very hard, tight, brittle, angular, finely crystalline, massive.

Highly fractured with horizontal, vertical and oblique fractures. This results in a rubble particularly near the contact with the above section. This contact consists of a fracture plane lined with a graphitic to vitreous textured bitumenous mineral.

Porosity is very poor. There are two small vugs near the base of the retrieved lowest section. These are connected by a few small dolomite filled veins.

Permeability may be fairly good due to the severe fracturing.

Observations: A slight, but persistent smell of hydrogen sulphide was detected.

DEPTH: 4034.6m Arnica Formation

CUTTING CORE #14
4034.6-4046.0m
Cut 2.4m in 1 hr 09 min
Cut 2.4m Recovered 2.0m (83.3%)

DPETH: 4043.6
4044 CORED AT: 58 min/
4045 24 min/
4046 34 min/m

TOTAL GAS: 32 units

4043.6-4044.72 DOLOMITE, grey, hard to very hard, tight, brittle, angular, finely crystalline, massive.

This section is highly fractured. Fracture planes are mainly oblique and horizontal giving a large-scale blocky character.

Porosity is poor, but permeability-at surface-may be fairly good due to the extensive fracturing.

4044.72-4045.6 DOLOMITE, dark grey, hard to very hard, tight, brittle, angular, finely crystalline, massive.

Highly fractured with horizontal, vertical and oblique fractures. This results in a rubble, particularly near the contact with the above section. This contact consists of a fracture plane lined with a graphitic to vitreous textured bitumenous mineral.

Porosity is very poor. There are two small vugs near the base of the retrived lowest section. These are connected by a few small dolomite filled veins.

Permeability may be fairly good due to the severe fracturing.

Observations: A slight, but persistent smell of hydrogen sulphide was detected.

DEPTH: 4158.2m Arnica Formation

CUTTING CORE #15
4158.2-4165.2m
Cut 7.0m in 2 hrs 20 min
Cut 7.0m Recovered 6.47m (92.4%)

DEPTH:	CORED AT:
4158.2	
4159	18 min/m
4160	16 min/m
4161	16 min/m
4162	22 min/m
4163	24 min/m
4164	21 min/m
4165	17 min/m

TOTAL GAS: 40 to 75 units

4158.2-4160.1 DOLOMITE, grey, hard to very hard, tight, massive, finely crystalline. This section has a small amount of tiny fractures occuring vertically and horizontally. A few filled veins give a locally brecciated appearance to parts of the section with dolomite clasts in white vein dolomite. Vugs are well developed in this section ranging in size from 2mm-8mm, being frequently connected and filled with dolomite crystals. There is also some slight evidence of pin point porosity throughout.

Porosity is fair to poor throughout this section and the permeability is poor to fair.

4160.1-4162.0 DOLOMITE, grey, hard to very hard, brittle, tight, finely crystalline. Many tiny fractures are evident throughout this section occuring mainly horizontally and frequently vertical. Fractures are occasionally filled with white coarsely crystalline dolomite. A few small veins have been filled with a soft black mineral. A few tiny vugs were obsered in the lower part of the section. Porosity is extremely poor and the permeability is poor throughout the section.

4162.0-4163.6 DOLOMITE, grey, hard to very hard, tight, brittle, angular finely crystalline, massive. This section has a shaley texture to it appearing as a dolomitized

Micrite. Fracturing is mainly horizontal occasionally vertical. The fractures are frequently filled with white coarsely crystalling dolomite. The porosity is poor along with the permeability which is mainly dependant upon the large amount of tiny fractures.

5163.6-4164.7 DOLOMITE, grey, hard to very hard, tight, massive, brittle finely to medium crystalline. There are numerous fractures throughout the section running vertically, horizontally and obliquely. Fractures are occasionally infilled with white coarse crystalline dolomite giving a brecciated appearance to the top of this section. There is evidence of some small vugs occurring near the bottom of the section. The pososity and permeability are generally poor in this section of the core.

DEPTH:	4424.4m
CUTTING CORE	#16 4424.4 - 4429.4m Cut 5m in 1 hr Cut 5m Recovered 3.65m (73%)
CORED AT:	9 - 13 min/m
TOTAL GAS:	20 - 25 units

4424.4-4429.4m DOLOMITE, grey to light grey, locally dark grey, hard to very hard, very light, fine to microcrystalline, massive, locally shaley.

Fractures exist in horizontal, vertical and oblique planes. Pressure solution is exhibited locally.

Porosity is very poor.

Permeability is likewise poor.

Mineralization includes white vein dolomite and small quantities of a graphicitc-like mineral, possibly pyrobitumen.

Observations: The odour of sour gas was again present, but this was not as strong or as persistent ad in the previous cored sections.

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SAMPLE DESCRIPTIONS

COLUMBIA ET AL KOTANEELEE YT I-48 May 11, 1979

Geological Samples Description

Gas Readings: Ditch gas range (background gas) 2-4 units with a blender cuttings gas of 1-2 units.

Lithology:

303 - 321m Sandstone, 100%, medium to light grey-brown, moderately hard, very fine to fine-grained, moderately well sorted, sub-angular to sub-rounded, calcareous, siliceous cement, occasionally trace of calcite, occasionally pyritic, moderately silty, very small trace of glauconite.

Average drilling rate: 1.8m/hr.

321 - 324m Sandstone, 60%, as above.

Siltstone, 40%, medium grey to medium brown, firm to moderately hard, blocky to sub-fissile, slightly dolomitic, commonly pyritic.

Average drilling rate: 1.5m/hr.

324 - 327m Sandstone, 100%, light to medium grey, hard, very fine to fine-grained, sub-angular, moderately well sorted, calcareous and siliceous cement, moderately silty.

Average drilling rate: 2.2m/hr.

369 - 405m Sandstone, 10-100%, medium grey-brown to white, moderately soft, friable, very fine to fine, sub-rounded, quartzose, calcareous cement, slightly silty in part.

Siltstone, 10-90%, as above, trace loose sand, medium to coarse grains.

Limestone, trace, off-white, soft, amorphous.

Average ROP: 46 min/m.

405 - 415m Siltstone, 30-40%, light green-grey, moderately soft, non calcareous, commonly interlaminated with sandstone. Locally grading up to a sandy siltstone.

Sandstone, 40-70%, as above.

Average ROP: 24 min/m.

COLUMBIA ET AL KOTANEELEE YT I-48 May 15, 1979

Geological Samples Description

Gas Readings: Gas shows: Shows seen (fluorescent and solvent cut) have declined. Started as trace of slow, pale blue stream crush cut, now practically no cut at all, and very little sample fluorescence at all.

Ditch gas range: 10 - 20 units
Maximum cuttings gas: 41 units
Total gas: 1 unit petroleum vapor
Blender range: 1-0 to 16-1 units.

Lithology:

415 - 427m Sandstone, 80-90%, light grey to clear, very fine, locally fine to medium grains, rounded, locally sub-angular, poorly sorted. Fine to medium grains predominately quartz with dark lithic fragments. Locally silty, calcareous cement, poor to moderate porosity.

Siltstone, 0-10%, medium green-grey, micromicaceous, soft, noncalcareous with a little dark grey-brown, hard siltstone.

Limestone, 0-10%, white to off-white, soft, amorphous, locally with quartz or dark lithic fragments grading to calcareous sandstone in part. Trace of calcite, clear, milky, crystalline, and pyrite nodules. Also disseminated with siltstone and sandstone.

Towards the bottom of this interval, an increasing amount of siltstone, medium to dark grey, hard, blocky, brittle, very calcareous.

Average ROP: 42 min/m.

427 - 435m Siltstone, 60-80%, light green-grey, soft, micromicaceous, noncalcareous, also with some dark grey, hard, blocky, calcareous siltstone.

Sandstone, 20-40%, as above.

Very good trace of pyrite over this interval.

Slight trace of limestone.

Average ROP: 23 min/m.

435 - 445m Sandstone, 70-100%, as above.

Siltstone, trace-30%, medium grey to grey-green, soft, interlaminated with some sandstone.

Trace of pyrite.

Average ROP: 37 min/m.

445 - 453m Siltstone, 50-70%, medium grey-brown, hard, brittle variety.

Sandstone, 20-40%, generally as above, very silty.

Limestone, 10-20%, medium to light grey, medium hard, very silty.

Average ROP: 44 min/m.

COLUMBIA ET AL KOTANEELEE YT I-48 May 16, 1979

Geological Samples Description

Gas Readings: Ditch gas range: Background gas: 1 unit total gas
0 unit petroleum vapors

No max. and no cuttings gas.
Mud Blender range: 5 - 8 units total gas
0 - 2 units petroleum vapors.

Trip for bit at 466.3m

Negative fluorescence and negative solvent cut at 453 to 469m.

Depth at 0900 hours: 470m

Lithology:

453 - 462m Siltstone, 90%, medium to dark grey-brown, hard, brittle, blocky, calcareous, commonly light grey-brown to off-white. Soft, very calcareous grading to a silty limestone.

Limestone, 10%, snowy white to off-white to light grey-brown. Amorphous, predominately soft, locally medium hard, argillaceous, marly appearance. Silty, grading to a very calcareous siltstone.

Sandstone, trace. Also trace of crystalline calcite.

Average ROP: 49 min/m.

462 - 465m Limestone, 70%, as above.

Siltstone, 30%, as above.

Average ROP: 55 min/m.

COLUMBIA ET AL KOTANEELEE YT I-48 May 17, 1979

Geological Samples Description

Gas Readings: Background Ditch gas: 1 unit total gas
0 units petroleum vapors

Mud Blender range: 4 units total gas
0 units petroleum vapors

No max. cuttings gas.

Depth (at 0900 hours): 484m

Lithology:

465 - 471m Sandstone, 70%, clear, quartzitic and clear grained in a white matrix, commonly dark grey lithic fragments, color now approaching dark grey. Moderately hard, occasionally friable, very fine to medium, occasionally coarsegrained. Sub-angular to sub-rounded, poorly sorted with predominately calcareous cement, occasionally siliceous. Moderate porosity. Locally very silty.

Siltstone, 20%, medium to dark grey-brown, hard, brittle, blocky, very calcareous.

Limestone, 10%, snowy white to off-white to light grey, soft to firm, amorphous, locally very sandy.

No show. Negative fluorescence. Negative solvent cut.

Average ROP: 41 min/m.

471 - 477m Sandstone, 60%, generally as above, but far less clean. Increase of medium to dark grey lithic fragments.

Limestone, 30-40%, pale milky white, locally appears translucent, pure, hard, brittle, amorphous, locally sandy with also a trace of soft, snowy white to off-white limestone as above.

Chert, trace-10%, pale blue-white, very hard, splintery, translucent.

40-70% sample fluorescence, dull to moderate yellow color. Very slow pale-blue stream solvent cut fluorescence.

Average ROP: 24 min/m.

477 - 480m Sample lost in hole.

480 - 481m Drilling break. Partial lost circulation. Sample lost in hole. Average ROP: 4 min/m.

481 - 484m Drilled with no returns.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 4, 1980

Depth: 3534m

Geological Samples Description

~~Gas Readings:~~ Drilling rate range: 29 - 69 minutes per meter
Average: 39 minutes per meter

Ditch gas range: 18 units to 32 units

Cuttings gas range: 2 units to 4 units

Average ROP: 1.54m/hr.

RETYPE SHEET

3516 - 3522m Shale, 50%, light grey to medium grey, firm, becoming softer, blocky, sub-fissile.

Dolomite, 40%, medium to dark grey, occasionally black, blocky, firm to moderately hard, microcrystalline.

Siltstone, 10%, light grey, brown, firm but soft, silty, noncalcareous.

Trace of calcite.

3522 - 3525m Shale, 80%, light grey, occasionally dark grey, firm to moderately hard, sub-fissile, occasionally fissile, blocky, associated with pyrite.

Dolomite, 15%, dark grey, black, microcrystalline, blocky, firm to hard.

Siltstone, 5%, as above.

Good trace of calcite and trace of pyrite.

3525 - 3528m Shale, 70%, generally as above, occasionally grading to limestone and generally becoming softer.

Dolomite, 20%, as above.

Siltstone, 10%, as above.

Trace of clear quartz crystal.

3528 - 3534m Shale, 65%, light to medium grey, occasionally black, firm to moderately hard, occasionally soft, sub-fissile, blocky, associated with calcite veins.

Dolomite, 25%, dark grey, occasionally very light, grading to limestone, firm to moderately hard, occasionally soft, blocky.

Siltstone, 10%, light grey to brown, soft, silty, noncalcareous.

Trace of clear quartz crystal and a good trace of calcite.

GEOLOGICAL SAMPLES DESCRIPTIONS

Bypassing shale shakers over entire interval, so not getting any gas readings, excepting at 524m when shale shakers were used for a short period. Small trace of total gas. Blender/cuttings gas range: Trace to 2 units total gas.

Lithology:

484 - 492m

Drilling with partial lost circulation. Samples very heavily contaminated with lost circulation material. Getting very few cuttings through.

Sandstone, a lot of loose sand, very small trace of limeston.

Aver ge ROP: 1.1m/hr.

492 - 512m

Drilling with partial lost circulation. Samples here are slightly less contaminated with lost circulation material.

Sandstone, 100%, light grey-brown, moderately hard, fine to medium grained, commonly very fine, sub-angular to sub-rounded, locally silty, moderately to poorly sorted. Quartzonse with common grey lithic fragments. Calcareous cement, locally poorly consolodated.

Limestone, slight trace, white, moderately firm, amorphous. Slight trace of pyrite.

Average ROP: 1m/hr.

512 - 525m

Sandstone, as above, but generally a much more poorly consolodated sandstone, resulting in a lot of loose quartz grains. Getting towards a full circulation. Running at full circulation at 8:00 AM, May 22.

Average ROP: 6m/hr.

Still bypassing shale shakers over this interval; so ditch gas report. Trace of cuttings/blender gas. Sample quality good. Lost circulation at 546m. Drilling ahead with partial lost circulation.

529 - 546m

Sandstone, 100%, light grey-white, locally light grey-brown, moderately hard to hard, predominately fine-grained, commonly very fine, occasionally medium-grained. Sub-angular to sub-rounded, moderately well sorted with high grain:cement ratio. Quartzose and primarily dolomitic cement, locally calcareous. 50% sample fluorescence, very dull to dull yellow in color and slight trace of slow pale blue weeping cur fluorescence.

Limestone, trace, white to off-white, soft, amorphus.

Average ROP: 2m/hr.

546 - 555m

Sandstone, 100%, predominately as above, with predominately calcareous cement, locally dolomitic and common black lithic fragments, occasionally some pyrite.

30 - 60% sample fluorescence, dull yellow color, trace of slow pale white-blue streaming.

Average ROP: 0.9m/hr.

Bypassed Shale Shakers
Drilling with partial returns
Trip for bit at 560m.

555 - 562m Sandstone, 100%, light grey, friable, fine-grained, quartzose, moderately sorted, sub-rounded, calcareous dolomitic cement, tight, local patchy bitumen staining. Dull yellow fluorescence on 20% of washed sample. Slight trace of slow streaming blue-white cut.

COLUMBIA ET AL KOTANEELEE YT I-48 May 25, 1979

Geological Samples Description Depth: 584m

Still bypassing the shale shakers. Still having lost circulation material contamination.

15% dull yellow fluorescence over this entire interval. Trace of streaming blue-white cut.

Lithology:

563 - 576m Sandstone, 100%, light to medium grey, fine grained, locally very fine, friable to moderately hard, commonly unconsolodated, sub-angular to sub-rounded, quartzose with scattered fine bitumen specks. Siliceous and calcareous dolomite cement. High grain:cement ratio.

Average ROP: 1m/hr.

576 - 584m Sandstone, 90%, as above, but more siliceous and less bitumen.

Siltstone, 10%, medium to dark grey-brown, calcareous and siliceous cement, hard to very hard, grading to sandstone.

Average ROP: 1.7m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 May 26, 27 & 28, 1979

Geological Samples Description Depth: 647m (8:00 AM May 28)

Gas Readings: Bypassing shale shakers with the exception of the interval from 620 - 626m. Gas readings at this point showed trace of ditch gas.

Lost circulation material in the system. Cuttings are being recirculated down the hole. Trip for bit at 644m.

Lithology:

584 - 639m Sandstone, 100%, white, clean, quartzose, friable to moderately hard, fine grained, predominately dolomite cement, local calcite cement. 50% unconsolodated, probably due to being recirculated down the hole. Sub-rounded, moderately sorted, occasional bitumen, declining to trace amounts downwards. Trace of siltstone and dolomite.

639 - 647m Sandstone, 90%, as above. Bitumen very rare.

Dolomite, 10%, medium grey-brown, moderately hard, micro-crystalline, calcareous, very silty.

Average ROP: 1m/hr.

NOTE: All references to chert in previous reports should be to lost circulation material.

COLUMBIA ET AL KOTANEELEE YT I-48 May 29, 1979

Geological Samples Description Depth: 669m

Gas Readings: Bypassing shale shakers with the exception of the interval from 663 - 666m. Trace of ditch gas at this interval.
Trace of cuttings gas at 666m.
General oil shows: 0 - 40% sample fluorescence.

Lost circulation material in the mud.

Lithology:

647 - 663m Sandstone, 90-100%, white, predominately clean, moderately hard, fine-grained, sub-rounded, well sorted, dolomitic cement, tight, largely unconsolodated.

Siltstone, 0-10%, medium grey, moderately hard, sub-fissile, argillaceous and dolomitic cement, locally grading to very fine-grained sandstone.

Dolomite, trace.

663 - 669m Sandstone, 70-80%, as above.

Siltstone, 20-30%, as above.

Dolomite, trace.

40% dull yellow fluorescence and faint blooming blue-green cut.

ROP: 0.9m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 May 30, 1979

Geological Samples Description Depth: 690m

Using shale shakers since 669m. Partially removed lost circulation material. No oil shows.

Lithology:

669 - 684m Sandstone, 70-90%, white to medium grey, friable to moderately hard, fine-grained, commonly silty, angular to sub-rounded, moderately sorted, calcareous cement, tight.

Siltstone, 10-30%, medium grey, moderately hard, blocky, argillaceous and calcareous cement, grading to very fine-grained sandstone.

Dolomite, trace.

ROP: 1 m/hr.

Ditch gas range: trace - 2 units.
Cuttings gas range: trace - 6 units.

684 - 690m Sandstone, 40%, as above.

Siltstone, 60%, as above.

Dolomite, trace.

ROP: 0.9 m/hr.

Ditch gas range: 6 units.
Cuttings gas range: 6 units.

COLUMBIA ET AL KOTANEELEE YT I-48 May 31, 1979

Geological Samples Description Depth: 712m

Gas Readings: 690 - 707m: Ditch gas range: 1 - 2 units
Cuttings gas range: 2 - 12 units
Trace of bitumen and occasional fluorescence.

Shale shakers used over interval 690 - 707m. Removed most of lost circulation material.
707 - 711m - shale shakers bypassed. More lost circulation material added.

Lithology:

690 - 702m Sandstone, 30-70%, white to light grey, moderately hard to friable, fine-grained, sub-rounded, well sorted, siliceous and dolomitic cement, quartzose, trace of lithic fragments, trace of pyrite.

Siltstone, 20-50%, medium grey, moderately hard, calcite and argillaceous cement.

Shale, 0-40%, medium grey, soft, fissile, grading to siltstone, trace of pyrite, trace of limestone.

ROP: 1.3m/hr.
Ditch gas range: 1 - 2 units
Cuttings gas range: 4 - 12 units

702 - 711m Sandstone, 70-90%, as above, but more friable with more argillaceous cement. Silty, trace to good trace of bitumen.

Siltstone, 10-30%, as above.

ROP: 0.9m/hr.
Ditch gas range: 1 - 2 units
Cuttings gas range: 1 - 4 units
Trace of moderately yellow fluorescence.

COLUMBIA ET AL KOTANEELEE YT I-48 June 1, 1979

Geological Samples Description Depth: 729m

Bypassing the shale shakers; lost circulation material added to the mud and getting no gas readings and very poor samples. No mud loss at present, but continuing to bypass the shale shakers.

Lithology:

712 - 726m Sandstone, 50-90%, white to light grey, slightly friable, moderately hard, very fine-grained, sub-rounded to sub-angular, calcite and dolomitic cement, tight, silty, trace of bitumen.

Siltstone, 10-50%, as above (see May 31).

Dolomite, trace

Limestone, trace.

Ditch gas: 0 readings.
Cuttings gas range: trace to 3 units.
Oil shows: trace of bitumen
occasional dull yellow-green fluorescence.

COLUMBIA ET AL KOTANEELEE YT I-48 June 4, 1979

Geological Samples Description Depth: 778m

Gas Readings: Ditch gas range: 1 - 2 units
Cuttings gas range: 1 - 5 units
Oil Shows: trace of pale yellow cut fluorescence at 729 - 732m.

Lithology:

Poor returns until 750m.

726 - 750m Sandstone, 30-80%, clear, grey to off-white, friable to moderately hard, predominately moderatly friable, very fine- to occasionally medium-grained, predominately sub-angular, poor to moderately sorted, nil to slightly calcareous, rare trace of bitumen.

Siltstone (sandy), 20-50%, brown-grey, slightly hard to hard, non-calcareous, very sandy locally, trace to good trace of disseminated pyrite, blocky.
732 - 735m - siltstone becomes very calcareous, trace of chert, fair to good trace pyrite.

Limestone, trace-10%, grey, hard, very argillaceous, grading to limey siltstone.

732m - moderately yellow-green sample fluorescence,
- very pale yellow cut fluorescence.
- no visible cut.

750 - 774m (Shale shakers returned to use.)
750-760 - abundant LCM.

Sandstone, 70-90%, white to medium grey, friable, moderately hard, very fine- to occasionally medium-grained, some angular quartz grains, sub-rounded, moderately sorted, trace of bitumen.

Siltstone, 10-30%, as above.

Dull yellow sample fluorescence
No cut fluorescence
No visible cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 5, 1979

Geological Samples Description Depth: 793.5m

Gas Readings: Ditch gas range: 1 - 3 units
Cuttings gas range: 2 - 5 units

Oil Shows: Poor to fair cut fluorescence between 774 and 780m. No visible oil, no visible cut.

Lithology:

774 - 786m Sandstone, 40-70%, clear, white to light grey, slightly friable - moderately hard, very fine to medium grained, sub-rounded, moderately sorted, very slight calcareous cement.

Siltstone, 30-60%, brown, brown-grey, firm to slightly hard, blocky, locally very sandy grading to sandstone.

Pyrite, very good trace throughout.

783m - good trace of bitumen.
40% pale yellow sample fluorescence grading to dull yellow down hole.
Also pale yellow to trace of moderately bright yellow cut fluorescence. No visible cut.

786 - 792m Sandstone, 70-90%, as above with finer grain size, more well sorted and common calcareous cement.

Siltstone, 10-30%, as above.

Shale, trace, carboniferous.

30% dull yellow sample fluorescence. Very fait pale blue cut fluorescence at 784m. No visible cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 6, 1979

Geological Samples Description Depth: 807.5m

Gas Readings: Ditch gas range: 1 - 3 units
Cuttings gas range: 3 - 6 units

General Lithology Change: Encountered soft grey shale at 792m, which becomes harder and darker down section. Siltstone decreases down section. Sandstone is locally clean, but commonly silty to very silty. Bitumen in the sandstone.

Lithology:

792 - 795m Sandstone, 90%, as above. (See June 5)

Siltstone, 10%, as above.

Shale, trace

20-30% dull yellow sample fluorescence. No cut fluorescence.

795 - 802m Sandstone, 60-80%, as above.

Siltstone, 10%, grey to brown to dark brown, moderately firm to slightly hard, blocky, sandy, slightly to moderately calcareous, trace of disseminated pyrite.

Shale, 10-30%, medium grey, soft to moderately firm, sub-fissile, slightly calcareous.

30-40% dull yellow sample fluorescence. No cut fluorescence.

802 - 807m Sandstone, 70%, as above.

Shale, 30%, dark grey to black, hard, fissile, brittle, non-calcareous, some grey shale softer, but slightly calcareous, blocky to sub-fissile.

60% dull yellow to yellow-green sample fluorescence.
Very slight to moderately milky yellow cut fluorescence.

COLUMBIA ET AL KOTANEELEE YT I-48 June 5, 1979

Geological Samples Description Depth: 793.5m

Gas Readings: Ditch gas range: 1 - 3 units
Cuttings gas range: 2 - 5 units

Oil Shows: Poor to fair cut fluorescence between 774 and 780m. No visible oil, no visible cut.

Lithology:

774 - 786m Sandstone, 40-70%, clear, white to light grey, slightly friable - moderately hard, very fine to medium grained, sub-rounded, moderately sorted, very slight calcareous cement.

Siltstone, 30-60%, brown, brown-grey, firm to slightly hard, blocky, locally very sandy grading to sandstone.

Pyrite, very good trace throughout.

783m - good trace of bitumen.
40% pale yellow sample fluorescence grading to dull yellow down hole.
Also pale yellow to trace of moderately bright yellow cut fluorescence. No visible cut.

786 - 792m Sandstone, 70-90%, as above with finer grain size, more well sorted and common calcareous cement.

Siltstone, 10-30%, as above.

Shale, trace, carboniferous.

30% dull yellow sample fluorescence. Very fait pale blue cut fluorescence at 784m. No visible cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 6, 1979

Geological Samples Description Depth: 807.5m

Gas Readings: Ditch gas range: 1 - 3 units
Cuttings gas range: 3 - 6 units

General Lithology Change: Encountered soft grey shale at 792m, which becomes harder and darker down section. Siltstone decreases down section. Sandstone is locally clean, but commonly silty to very silty. Bitumen in the sandstone.

Lithology:

792 - 795m Sandstone, 90%, as above. (See June 5)

Siltstone, 10%, as above.

Shale, trace

20-30% dull yellow sample fluorescence. No cut fluorescence.

795 - 802m Sandstone, 60-80%, as above.

Siltstone, 10%, grey to brown to dark brown, moderately firm to slightly hard, blocky, sandy, slightly to moderately calcareous, trace of disseminated pyrite.

Shale, 10-30%, medium grey, soft to moderately firm, sub-fissile, slightly calcareous.

30-40% dull yellow sample fluorescence. No cut fluorescence.

802 - 807m Sandstone, 70%, as above.

Shale, 30%, dark grey to black, hard, fissile, brittle, non-calcareous, some grey shale softer, but slightly calcareous, blocky to sub-fissile.

60% dull yellow to yellow-green sample fluorescence.
Very slight to moderately milky yellow cut fluorescence.

COLUMBIA ET AL KOTANEELEE YT I-48

June 7, 1979

Geological Samples Description

Depth: 812m

Gas Readings: 1 - 2 units total gas
0 units petroleum vapors

Cuttings gas: 3 units total gas
0 units petroleum vapors

Show: slight trace.
10-20% dull yellow fluorescence
slight trace of milky cut.

Lithology:

808 - 812m

Sandstone, 70-80%, light grey-brown, locally off-white, friable to firm, occasionally moderately hard, very fine to fine-grained, sub-rounded to rounded, locally slightly silty, moderately well sorted, high grain:matrix ratio, poor porosity, cement is locally dolomitic, commonly no cement at all. Occasionally some pyrite.

Shale, 20-30%, light to medium grey, firm, splintery, sub-fissile, commonly silty, slightly dolomitic, locally micro-micaceous. Very good trace of pyrite.

Limestone, slight trace, off-white, soft, amorphous.

Average ROP: 1.1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 June 8, 1979

Geological Samples Description Depth: 838m

Gas Readings: Ditch gas rarge: 1 - 2 units total gas
0 - trace petroleum vapors

Mud blender cuttings gas range: 3 - 7 units total gas
0 units petroleum vapors

Lithology:

812 - 822m

Average ROP: 1.3m/hr.

Sandstone, 90%, light to medium grey, locally white with common black thick fragments. Moderately hard, very fine to fine grained, sub-rounded, predominately well sorted. Slightly calcareous, locally dolomitic cement. Poor to moderately poor porosity.

Shale, 10%, medium to dark grey, firm to moderately hard, sub-fissile, commonly silty grading to very silty shale.

Limestone, trace.

Pyrite, trace.

Shows: slight trace of show - 20-40% dull yellow-brown sample fluorescence. Slight trace to trace of pale milky cut fluorescence.

822 - 837m

Average ROP: 1.1m/hr.

Sandstone, 50-80%, as above.

Shale, 10-20%, as above.

Siltstone, 10-30%, light to medium grey, soft to firm, only locally moderately hard, predominately blocky, moderately calcareous, locally sub-fissile and very argillaceous grading to very silty shale.

Shows: trace to good trace of show - 30-70% medium straw-yellow sample fluorescence. Trace to good trace of milky blue streaming cut. Slight trace of a visible cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 9, 10, 11, 1979

Geological Samples Description Depth: 899m

Shows: trace. Sample fluorescence 60-8-%, dull to moderately straw gold color.
Fairly common milky white streaming cut.
Occasionally visible cut, brown tint, straw color.

867m - POH to change bit.

Gas Readings: 1 - 2 units total gas
0 units petroleum vapors

Cuttings gas (blender) range: 2-10 units total gas
0 units petroleum vapors

Chromatograph: C_2 - trace (only rarely)

Lithology:

838 - 843m
ROP: 1m/hr.

Sandstone, 70%, light to medium grey, occasionally white with black lithic fragments, predominately moderately hard, very fine to fine with occasional medium grains, sub-rounded, moderately well sorted, calcareous cement, locally silty becoming very silty grading to a siltstone. Generally poor porosity.

Siltstone, 30%, medium grey-brown, soft to very firm, predominately blocky, locally becoming sub-fissile, grading into a silty shale. Moderately to fairly calcareous.

Limestone/Gypsum, trace, white to dirty white, soft, amorphous.

840 - 843m - very abundant trace of pyrite.

843 - 846m
ROP: 1.1m/hr.

Sandstone, 40%, generally as above, locally friable with increased amount of white, quartzitic sandstone.

Siltstone, 60%, as above, commonly with disseminated pyrite.
Pyrite, abundant trace
Limestone/Gypsum, slight trace.
Shale, silty, trace.

846 - 864m
ROP: 1.2m/hr.

Sandstone, 50-80%, generally as above, locally with calcitic veins becoming increasingly argillaceous.

Siltstone, 20-40%, locally very sandy grading to a silty sandstone. Abundant disseminated pyrite. Occasional massive pyrite grains.

Limestone/Gypsum, 10%, from 852 - 855m. Soft, white, amorphous. Generally moderately to very calcareous, predominately gypsum.

864 - 873m ROP: 1.4m/hr.	Sandstone, 70-80%, much cleaner, clear to off-white with some black, carbonaceous specks and some black, lithic fragments. Predominately friable, locally moderately hard, very fine to fine grained, sub rounded, well sorted, poor porosity and calcareous cement.
	Siltstone, 10-15%, as above.
	Shale, trace - 10%, as above, sometimes laminated.
	870 - 873m - Pyrite, abundant trace (almot 5-10%).
	864 - 867m 870 - 873m - Limestone/Gypsum, 10%.
873 - 879m ROP: 1.7m/hr.	Sandstone, 85-90%, as above.
	Shale, trace - 5%, as above.
	Siltstone, 10-15%, as above.
	Limestone/Gypsum, decreasing trace.
	Pyrite, trace.
879 - 888m ROP: 1m/hr.	Siltstone, 80%, as above.
	Sandstone, 10-20%, as above.
	Shale, 0-10%, as above.
	Pyrite, abundant trace from 882 - 885m. Trace throughout.
888 - 897m ROP: 1.25m/hr.	Sandstone, 60-90%, dirty, medium grey to medium grey-brown with some tan colored. Friable to moderately hard, very fine to fine, occasionally medium grains. Moderately well sorted, non to slightly calcareous, locally very silty grading to a siltstone. Grains are sub-angular to sub-rounded, poor porosity.
	Siltstone, 10-40%.
	Limestone/Gypsum, trace decreasing.
	Pyrite, trace decreasing.

COLUMBIA ET AL KOTANEELEE YT I-48 June 12, 1979

Geological Samples Description Depth: 924m

Gas Readings: Ditch gas range: 1 - 2 units total gas
0 - 1 unit petroleum vapors

Mud blender cuttings gas range: 1 - 7 units total gas
0 units petroleum vapors

Chromatograph readings:

897 - 906m:	C_1	- 200 ppm.
906 - 912m:	C_1	- 300 ppm.
	C_3	- 12 ppm.
912 - 924m:	C_1	- 480 ppm.
	C_2	- 11 ppm.
	C_3	- 18 ppm.

Lithology:

897 - 900m
0.6m/hr.

Sandstone, 75%, 50/50 clear to white quartzitic sandstone and medium grey to medium grey-brown sandstone, as above.

Shale, 10%, medium grey to medium grey-brown, moderately hard, locally friable, commonly grading to silty shale. Also commonly with disseminated pyrite.

Pyrite, 5%, disseminated with shale and siltstone. Also some massive grains.

Gypsum, good trace, snowy white to dirty white with common black streaks, soft to only firm, amorphous, locally slightly calcareous.

40-50% dull to bright yellow sample fluorescence and pale milky to yellow streaming cut.

900 - 909m

Sandstone, trace - 10%, as above.
Shale, 60%, as above.
Siltstone, 30%, as above.
Pyrite, trace - 10%, as above.
Trace to 10% sample fluorescence, dull yellow. Slight cut from sandstone.

909 - 924m
1.25m/hr.

Sandstone, good trace to 10%.
Siltstone, 60-90%, as above. Slightly calcareous, locally very calcareous, commonly with pyrite, commonly grading to silty shale. Containing crinoids and bivalves.
Shale, trace - 10%, as above, locally grading to siltstone.
Limestone, good trace - 10%, off-white to tan to light brown color, occasionally dark brown. Moderately hard, crystalline, silty, sandy in part.
Pyrite, good trace - 5%, as above.
5-30% dull yellow sample fluorescence, predominately no cut.
Slight milky steaming cut from 918 to 921m.

COLUMBIA ET AL KOTANEELEE YT I-48 June 13, 1979

Geological Samples Description Depth: 933m

Gas Readings: Ditch gas range: 1 unit total gas
0 units petroleum vapors

Blender cuttings gas range: 1 unit total gas
0 units petroleum vapors

Chromatograph readings: C_1 - 160 ppm

Lithology:

924 - 927m
ROP:
0.9m/hr.

Sandstone, 10%, as above.
Siltstone, 80%, as above.
Shale, 10%, as above.
No show.

927 - 933m
ROP:
1m/hr.

Sandstone, 40%, white to tan to light grey, locally white with black carbonaceous specks, friable, predominately very fine grained, commonly fine grained, occasionally medium grained and locally very silty. Sub-angular to sub-rounded, moderately poorly sorted, poor porosity, calcareous cement, commonly with disseminated pyrite, locally grading to sandy siltstone.

Siltstone, 50%, light to medium grey, firm to moderately hard, locally hard when occurs with pyrite, fairly siliceous, locally becoming fissile and only slightly calcareous, grading to a silty shale.

Shale, 10%, light to medium grey, locally grey-black, sub-fissile and slightly calcareous.

Limestone, abundant trace, dirty white, soft, amorphous, locally silty, locally sandy. Also a slight trace of light brown, hard, microcrystalline limestone.

Pyrite, very abundant trace (up to 5%), disseminated with the sandstone and siltstone. Also massive pyrite and also seen as fine laminations in the siltstone and shale.

70% sample fluorescence, medium to bright straw color. Trace of milky, streaming cut from the white sandstone with black carbonaceous specks.

COLUMBIA ET AL KOTANEELEE YT I-48 June 14, 1979

Geological Samples Description

Gas Readings: Ditch gas range: trace - 4 units total gas
0 - 1 unit petroleum vapors.

Cuttings Blender range: 1 - 18 units total gas
0 - 1 unit petroleum vapors

C_1 - 152 - 900 units.

C_2 & C_3 - 12 - 21 units (942 - 951m)

IC_4 & N_4 - slight trace (945 - 951m)

Lithology:

933 - 936m
ROP:
1.8m/hr.

Sandstone, 40-75%, as above.
Siltstone, 20-50%, as above. Locally becoming sub-fissile, grading to a silty shale.
Shale, trace - 10%, as above.
Limestone, trace, as above.
Slight trace of fossils (crinoid stems).
Pyrite.

70% sample fluorescence, medium straw color.
Milky streaming cut from speckled sandstone, as above.

936 - 954m

Sandstone, trace-20%, as above.
939 - 942m: 30%

Siltstone, 20-70%, medium grey-brown, predominately firm, locally moderately hard, blocky, locally becoming sub-fissile, sandy in part and occasionally very sandy. Moderately calcareous, occasionally disseminated pyrite, locally grading to silty shale.

Shale, 20-70%, as above.

Limestone, good trace - 10%, light grey to light brown, hard, moderately argillaceous, very rarely pure, crystalline.

945 - 954m - abundant fossil trace, predominately crinoid stems, calcite replaced, commonly pyritic. Slight trace of cephalopod fossils.

40-50% sample (mineral) fluorescence.
Slight, occasional cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 15, 1979

Geological Samples Description Depth: 976m

Gas Readings: Ditch gas range: 2 - 4 units total gas
0 units petroleum vapors

Blender Cuttings gas range: 1 - 7 units total gas
0 units petroleum vapors

Gas Breakdown: C_1 - throughout
C_2 - local trace
C_3 - rare trace

Lithology:

954 - 963m
ROP:
0.8m/hr.

Sandstone, 50-80%, predominately light grey-brown, occasionally white to clear, quartzitic, predominately friable, occasionally moderately hard, fine-grained, sub-rounded, well sorted, tight porosity, predominately calcareous, some loose coarse grains, angular to sub-angular.

Siltstone, 10-20%, medium to dark grey, very firm to moderately hard, calcareous, locally becoming sub-fissile, grading to a silty shale. Locally with disseminated pyrite.

Shale, 5-20%, medium to dark grey, firm to slightly hard, sub-fissile to fissile, commonly slightly to moderately silty, non to moderately calcareous with increasing silt content. Locally with disseminated pyrite.

Limestone, trace-10%, light grey to tan, very hard, pure to predominately argillaceous, local calcite veins.

Fossils, good trace, predominately crinoid stems, rare cephalopod and rarer fenestrate (pryozoa-like) fossils.

Pyrite, good trace, disseminated within the siltstone and shale, also some massive pyrite.

Coal, slight trace, black, brittle to soft, resinous.

50% sample fluorescence, moderate straw yellow color.
Slight trace of milky white streaming cut, as above.

963 - 975m

Sandstone, trace-20%, as above, predominately light brey-brown variety.

Siltstone, 30-60%, as above.

Shale, 20-70%, as above, becoming more pure from 969m.

Limestone, good trace-15%, as above.

Coal, trace.

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963 - 975m (Continued)

Fossils, decreasing trace from 969m.

Pyrite, trace massive, trace disseminated.

10-20% dull yellow gold fluorescence.
Slight trace of cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 16, 17 & 18, 1979

Geological Samples Description Depth: 1054m

Gas Readings: Ditch gas: 975 - 1036m: 2 - 4 units total gas
0 - 1 unit petroleum vapors
1036 - 1054m: 6 - 12 units total gas
1 - 2 units petroleum vapors
Mud Blender Cuttings gas: 4 - 18 units total gas
0 - 2 units petroleum vapors

Chromatograph Analysis: 975 - 1036m: C_1 with common C_2 & C_3.

1036 - 1054m: C_1, C_2, C_3 and NC_4.

Lithology:

975 - 978m
1.1m/hr.

Shale, 50%, medium grey-brown, generally pure, but commonly silty to very silty, firm to very firm, sub-fissile to fissile, slightly calcareous.

Siltstone, 40%, medium grey-brown, firm to moderately hard, locally becoming sub-fissile and grading to a silty shale.

Sandstone, 10%, light to medium grey, very fine, friable to moderately hard, sub-angular, locally silty grading to a siltstone, slightly calcareous cement.

Limestone, abundant trace, light brown to tan, hard, commonly dolomitic; also white, soft, amorphous, silty limestone.

Fossils, abundant trace, crinoid stems.

Pyrite, trace, massive and disseminated in both shale and siltstone.

No show.

978 - 987m
1.8m/hr.

Shale, 50-65%, as above. Introduction of shale cavings (up 1 or 2 inches long).

Siltstone, 30-50%, as above. Locally with calcite veinings.

Limestone, good trace, dolomitic as above. 5% from 981-984m.

Pyrite, good trace.

Sandstone, slight trace.

Chert, 5% from 984-987m. Light to medium brown, hard, slightly calcareous along fissures, very argillaceous.

No show.

987 - 999m
1.8m/hr.

Shale, 80-100%, medium to dark grey-black, firm, occasionally moderately hard (siliceous content), blocky, fissile, commonly only sub-fissile, occasionally calcareous.

Siltstone, abundant trace-20%, as above.
Chert, abundant trace-5%, as above.
Dolomite, good trace, calcareous.
Fossils, trace to abundant trace. Crinoid stems and occasional bi-valves.
Pyrite, good trace.
No show.

999 - 1002m
1.4m/hr.

Shale, trace.
Siltstone, 85%, as above, locally grading to sub-fissile, occasionally becoming a silty shale, but predominately massive and blocky. Occasionally sandy.
Limestone, 15%, as above, tan brown and soft white.
Fossiles, trace.
Pyrite, abundant trace, with occasional green, glauconite bits.
Sandstone, abundant trace. Very silty, grading to siltstone.
20-30% sample fluorescence, dull yellow color.
Slight trace of cut.

1002 - 1005m
1m/hr.

Shale, trace.
Siltstone, 60%
Limestone, 10%
Sandstone, 30%, light grey to off-white, predominately very fine, occasionally fine, friable to slightly hard, sub-angular, well sorted, slightly to moderately calcareous cement, locally very silty, grading to silty sandstone.
Fossils, trace
Pyrite, trace.
20-30% sample fluorescence, dull to moderately yellow color.
Trace of solvent cut, milky white.

1005 - 1008m
1.4m/hr.

Shale, 60%
Siltstone, 30%
Sandstone, 10%
Limestone, trace.
Pyrite, abundant trace.
Fossils, slight trace.
No show.

1008 - 1029m
2m/hr.

Shale, abundant trace - 30%, as above, very silty, locally with some disseminated pyrite.
Siltstone, 70-100%, as above, locally very siliceous and very hard, almost becoming a silty chert.
Sandstone, trace -10%
Pyrite, trace - 5%
Limestone, local trace.
Chert, trace throughout, medium to dark brown, blocky, occasionally slightly calcareous along fissures, slightly dolomitic. Locally silty, locally very silty, becoming siliceous siltstone.
No show.

1029 - 1032m
1.1m/hr.

Shale, 60-80%
Siltstone, 20-25%
Limestone, 15%
Chert, trace.
Pyrite, trace.
Fossils, slight trace, crinoids.
No show.

1032 - 1035m
1.7m/hr.

Shale, 25%, generally cleaner and less siliceous, still very silty locally. Locally slightly calcareous and dolomitic.
Siltstone, 65%
Limestone, 10%
Pyrite, abundant trace.
Fossils, slight trace, predominately crinoids, occasional bi-valves.
No show.

1035 - 1053m
2m/hr.

Shale, 70-100%, becoming much cleaner, only locally silty.
Siltstone, trace-30%
Pyrite, trace-5%
Limestone, trace.
Sandstone, trace.
Fossils, decreasing amount.
Chert, decreasing amount of siliceous material in shale, siltstone.
No show.

COLUMBIA ET AL KOTANEELEE YT I-48 June 27, 1979

Geological Samples Description Depth: 1071m

Gas Readings: Ditch gas range: 1 - 2 units

Lithology:

1058 - 1068m
ROP: 1.0m/hr.

Sandstone, 20-40%, clear to light brown, moderately hard, very fine to fine grained, sub-rounded to sub-angular, moderately sorted, slightly calcareous cement, tight.

Siltstone, 40-70%, medium to dark brown, hard to very hard, blocky, occasionally sub-fissile, slightly calcareous, traces of fossils, possibly crinoids, trace of pyrite.

Shale, 10-20%, brown, firm to hard, blocky to sub-fissile, micromicaceous, trace of pyrite.

30% sample fluorescence in the sandstone.
No cut.

COLUMBIA ET AL KOTANEELEE YT I-48 June 28, 1979

Geological Samples Description

1068 - 1071m
ROP:
1.1m/hr.

Shale, 70%, dark brown, firm to hard, blocky to sub-fissile, occasionally fissile, micromicaceous, slightly fossiliferous (crinoids), trace of disseminated pyrite.

Siltstone, 20%, light to dark brown, firm to hard, occasionally very hard, blocky, slightly to very calcareous, sandy in part, trace of disseminated pyrite.

Sandstone, 10%, light grey-brown, moderately hard, very fine to fine grained, sub-rounded, moderately well sorted, tight porosity, slightly calcareous cement.

1071 - 1074m
ROP:
0.8m/hr.

Shale, 20%, as above.
Siltstone, 80%, as above.
Sandstone, trace, as above.

Very slight trace of show: Trace-20% sample fluorescence, dull gold in color. Very rare milky-white solvent cut.

Gas Readings: Ditch gas range: 1 - 2 units total gas
0 units petroleum vapors

Cuttings gas range: 0 units total gas
0 units petroleum vapors

Predominately C_1, with only occasional trace of C_2

COLUMBIA ET AL KOTANEELEE YT I-48 June 29, 1979

Geological Samples Description

1074 - 1077m Shale, 90%, dark grey, firm to hard, blocky to sub-fissile, trace of pyrite.

Siltstone, 10%, dark grey to dark brown, hard to very hard, blocky.

1077 - 1080m Shale, 40%.
Siltstone, 30%.
Sandstone, 30%, light grey, very fine grained, sub-rounded, well sorted, calcareous cement. Faint yellow fluorescence and instant yellow cut.

1080 - 1083m Shale, 70%, as above.
Siltstone, 20%, as above.
Sandstone, 10%, as above.

1083 - 1092m Shale, 90%, as above.
Siltstone, 10%, as above.

June 30, 1979

1094 - 1110m Shale, 90-100%.
Siltstone, 0-10%.

1110 - 1116m Shale, 40%.
Siltstone, 60%.

1116 - 1119m Shale, 10%.
Siltstone, 70%.
Sandstone, 20%, light grey to brown, moderately hard, very fine grained, sub-rounded, well sorted, slightly calcareous cement, tight.

1119 - 1122m Shale, 50%.
Siltstone, 40%.
Sandstone, 10%.

1122 - 1133m Shale, 60-90%.
Siltstone, 10%.
Sandstone, 10%.

July 1, 1979

1134 - 1143m Shale, 70-100%.
Siltstone, 0-30%.

1143 - 1146m Sandstone, 60%, light to medium brown, hard, fine grained, occasionally very fine grained, sub-rounded to sub-angular, tight.

Shale, 40%.

July 1, 1979 (ont'd)

1146 - 1149m Sandstone, 90%, light brown, hard, fine grained, occasionally very fine grained, sub-angular to sub-rounded, well sorted, slightly calcareous cement, tight. Trace of pyrite, occasional black carbonaceous inclusions.

Shale, 10%.

1149 - 1158m Sandstone, 100%, as above.

July 2, 1979

1157 - 1164m Sandstone, 100%, white to off-white to tan to light brown, friable to hard, fine to very fine-grained, sub-rounded, moderately sorted, calcareous cement, locally argillaceous.

1164 - 1173m Sandstone, 80%, as above.
Siltstone, 20%, dark grey, firm, blocky, sandy in part.

1173 - 1176m Sandstone, 60%.
Siltstone, 40%.

1176 - 1179m Shale, 10%, dark grey, firm, fissile, slightly micromicaceous, grading to siltstone in part.

Silstone, 80%.
Sandstone, 10%.

1179 - 1191m Siltstone, 100%, dark grey, hard, occasionally very hard, blocky, sandy in part. Trace of pyrite.

July 3, 1979

Gas Readings: Ditch gas range: 3 - 9 units
Cuttings gas range: 2 - 6 units

Depth: 1221m

Lithology:

1191 - 1194m Siltstone, 100%, dark grey, hard, blocky, sandy in part. Trace of pyrite.

1194 - 1200m Shale, 80%, dark grey, firm to hard, blocky to sub-fissile, trace of pyrite.

Siltstone, 20%.

1197 - 1200m Sandstone, 90%, off-white to mid-brown, predominately light brown, hard, occasionally friable, fine to very fine grained sub-angular to sub-rounded, tight with siliceous cement.

1200 - 1203m Sandstone, 90%, as above.
Shale, 10%, as above.

July 3, 1979 (Cont'd)

1203 - 1207m — Siltstone, 80%, dark grey, hard, occasionally very hard, blocky, micromicaceous, sandy in part, trace of pyrite.

Sandstone, 20%.

1209 - 1221m — Siltstone, 100%.

July 4, 1979

Depth: 1241m

Gas Range: Ditch gas: 2 - 7 units total gas
Cuttings gas: 2 - 8 units total gas

1221 - 1224m — Siltstone, 100%, dark grey-brown, firm to hard, blocky, occasionally sub-fissile, slightly micromicaceous, locally with a trace of pyrite.

1224 - 1230m — Siltstone, 80%, as above.

Sandstone, 20%, off-white to medium brown, friable to hard, fine to very fine grained, sub-angular to sub-rounded, calcareous cement, locally argillaceous, poor porosity, locally grading to a siltstone in part. Tight.

1230 - 1239m — Siltstone, 90%, as above.

Sandstone, 10%, as above.

July 5, 1979

Depth: 1271m

Gas Range: Ditch gas: 2 - 10 units total gas
Cuttings gas: 2 - 12 units total gas
Chromatograph breakdown: Mainly C_1 with C_2 and occasional trace of C_3.

1240 - 1242m
ROP:
1.1m/hr. — Siltstone, 100%, dark grey, moderately hard to hard, blocky, locally becoming sub-fissile, locally grading to a silty shale, micromicaceous, slightly calcareous, commonly non-calcareous. Locally with a trace of pyrite. Occasionally sandy to very sandy. Slight trace of crinoid fossils.

1242 - 1248m
ROP:
2.4m/hr. — Siltstone, 40-70%, as above.

Sandstone, 30-60%, light grey, moderately hard, very fine grained, locally with some fine grains, locally very silty, sub-rounded, quartzitic, calcareous cement, moderately well sorted, poor porosity. Locally grading to a sandy siltstone.

1248 - 1260m ROP: 2.0m/hr.	Siltstone, 80%, as above. Sandstone, 20%, as above.
1260 - 1269m ROP: 1.5m/hr.	Siltstone, 100%, as above. Sandstone, slight trace.

COLUMBIA ET AL KOTANEELEE YT I-48 July 6, 7, 8 & 9.

Geological Samples Description July 9 Depth: 1379m

1271 - 1377m: No fluorescence, No cut.

Background Gas (Ditch gas): 2 - 8 units total gas (C_1, C_2 & C_3).

0 - 1 unit petroleum vapors.

Cuttings Blender Gas: 3 - 34 units total gas
0 - 2 units petroleum vapors.

1353m - trip for bit; trip gas: 27 units total gas
0 units petroleum vapors

1364m - connection gasses: 7 units total gas (IC_4 & NC_4).
0 units petroleum vapors

During reaming and circulating to bottom (11 or 12 hours), there were large volumes of cavings (shale, generally quite small and flaky).
- connections during reaming: up to 300 units total gas, trace of petroleum vapors. Predominately C_1, with C_2 & C_3, and rare IC_4 and NC_4.

Lithology:

1271 - 1284m ROP: 2.0m/hr.	Siltstone, 100%, medium to dark grey-black, firm to moderately hard, locally hard, blocky, occasionally becoming sub-fissile and grading to a silty shale in part. Micro-micaceous, locally slightly calcareous and locally with some pyrite. Sandy in part. Sandstone, trace, medium grey, moderately hard, quartzitic, very fine, locally silty, sub-rounded grains, commonly grading to siltstone. Occasional coarse massive quartz grains.
1284 - 1302m ROP: 1.7m/hr.	Siltstone, 80-90%, as above. Sandstone, 10-20%, as above.
1302 - 1311m ROP; 1.8m/hr.	Siltstone, 100%, as above with trace of disseminated pyrite and occasional calcite veins.
1311 - 1320m ROP: 1.7m/hr.	Siltstone, 20-60%, more fissile, more commonly grading to shale. Shale, 40-80%, dark grey-black, predominately firm, occasionally moderately hard, silty, locally very silty and grading to siltstone. Vitreous lustre locally. Sub-fissile to fissile, locally micromicaceous and slightly calcareous. Trace of calcite, trace of pyrite, predominately massive, occasionally disseminated with the shale and siltstone.

1320 - 1323m ROP: 1.6m/hr.	Shale, 100%, as above. Siltstone, trace, as above. Dolomite, trace to good trace, dark grey-brown, hard to very hard, microcrystalline, blocky, angular fragments.
1323 - 1329m ROP: 1.6m/hr.	Shale, 30%, as above. Siltstone, 70%, as above. Dolomite, trace to good trace, as above.
1329 - 1350m ROP: 1.4m/hr.	Siltstone, 50-90%, as above. Shale, 10-50%, as above. Pyrite, trace, massive and disseminated. Dolomite, trace.
1350 - 1359m ROP: 1.2m/hr.	Siltstone, 20-30%, as above. Shale, 70-80%, as above. Dolomite, trace, and trace of crystalline calcite veins.
1359 - 1362m ROP: 1.2m/hr.	Siltstone, 50%, as above. Shale, 50%, as above.
1362 - 1377m ROP: 1.5m/hr.	Siltstone, 10-20%, as above. Shale, 80-90%, as above. Dolomite, trace to 5%, as above. Calcite veins, trace, predominately associated with the dolomite.

July 10, 1979

Gas Readings: Ditch Gas Range: 4 - 10 units total gas
0 - 1 unit petroleum vapors
During stringers of siltstone/sandstone, the background gas goes up to 24 units total gas,
0 - 1 unit petroleum vapors.

Cuttings Gas Range: 12 - 26 units total gas
0 - 1 unit petroleum vapors
In the siltstone/sandstone stringers, goes up to 56 units total gas and 1 unit petroleum vapors.

Predominately C_1, with C_2 and C_3.

Lithology:

1377 - 1383m ROP: 1.7m/hr.	Shale, 90-95%, as above. Siltstone, trace-5%, as above. Dolomite, trace-5%, as above.

1383 - 1386m
ROP:
2.9m/hr.

Shale, 50%, as above.
Siltstone, 50%, medium grey-brown to dark grey-black, moderately hard, locally hard, locally siliceous to very hard, commonly with very fine quartz grains grading to a very fine sandstone. Locally with calcite, crystalline, milky, sometimes with disseminated pyrite. Predominately non-calcareous, commonly slightly calcareous with predominately siliceous cement.

Sandstone, good trace, light grey, hard to very hard, very fine grained, quartizitic with a predominately siliceous cement, occasionally slightly calcareous cement. Silty to very silty in part grading to a sandy siltstone.

Dolomite, trace, light brown, firm to moderately hard, locally very hard angular fragments.

Pyrite, trace, disseminated with the siltstone, and also massive pieces, with a slight trace of loose, clear, coarse, rounded quartz grains.

1386 - 1389m
ROP:
3.0m/hr.

Shale, trace-40%, as above.
Siltstone, 60-90%, as above.
Sandstone, trace-10%, as above.
Dolomite, trace.
Pyrite, trace.

1389 - 1392m
ROP:
1.8m/hr.

Shale, 70%, as above.
Siltstone, 30%, as above.
Calcite, trace.

1392 - 1395m
ROP:
1.8m/hr.

Shale, 100%, as above.
Siltstone, trace, as above.
Dolomite, trace, as above.

1395 - 1398m
ROP:
2.1m/hr.

Shale, 80%, as above.
Siltstone, 20%, as above.

1398 - 1401m
ROP:
3.0m/hr.

Shale, 30%, as above.
Siltstone, 30%, as above.
Sandstone, 40%, as above, but slightly argillaceous, still very silty.
Fossils, slight trace.
Pyrtie, good trace.

1401 - 1407m
ROP:
2.5m/hr.

Shale, trace-10%, as above.
Siltstone, 70-80%, as above.
Sandstone, 20%, as above.
Pyrite, good trace, disseminated in the shale and siltstone, and also massive chunks.

1407 - 1410m
ROP:
2.1m/hr.

Shale, 30%, as above.
Siltstone, 70%, as above.

1410 - 1419m
ROP:
1.8m/hr.

Shale, 60-80%, as above.
Siltstone, 20-40%, as above.
Pyrite, slight trace.

1419 - 1422m
ROP:
2.2m/hr.

Shale, 90%, as above.
Siltstone, 10%, as above.

July 11, 1979

Depth: 1459m

1422 - 1425m
ROP:
2.0m/hr.

Shale, 80%, dark grey, friable, fissile.
Siltstone, 10%, dark grey, hard to very hard, blocky, calcareous.
Dolomite, 10%, dark grey, cryptocrystalline.
Pyrite, trace, massive.

1425 - 1455m
ROP:
2.1-5.0m/hr.

Shale, 90-100%, as above.
Siltstone, 0-10%, as above.
Pyrite, trace, massive.

Gas Readings (1422 - 1455m):

Ditch gas range: 5 - 11 units total gas
0 units petroleum vapors
Cuttings gas range: 16 - 24 units total gas
0 units petroleum vapors

July 12, 1979

Depth: 1505m

Gas Readings: Ditch gas range: 4 - 12 units total gas
0 units petroleum vapors
Cuttings gas range: 6 - 15 units total gas
0 units petroleum vapors
Trip gas - 56 units at 1462 when pulled out of hole.

1455 - 1494m
ROP:
4.0m/hr.

Shale, 90-100%, medium to dark grey, fissile, friable.

Silstone, 0-10%, dark grey, hard, blocky, calcareous cement.

Pyrite, trace.

1494 - 1497m
ROP:
2.2m/hr.

Shale, 90%, as above.

Sandstone, 10%, light to medium grey, moderately hard, very fine with occasioanl fine grains, sub-rounded to rounded, moderately well sorted, tight, locally argillaceous, calcareous and dolomitic cement.

1497 - 1503m
ROP:
2.1m/hr.

Shale, 30-60%, as above.

Siltstone, 0-40%, as above.

Sandstone, 30-40%, as above.

July 13, 1979

Depth: 1541m

Gas Readings: Ditch Gas Range: 1 - 7 units total gas
0 units petroleum vapors

Cuttings Gas Range: 2 - 10 units total gas
0 units petroleum vapors

Connection Gas: 2 units total gas at 1539m.

1503 - 1506m
ROP:
4m/hr.

Sandstone, 30%, light to medium grey, moderately hard, very fine grained, rounded to sub-rounded, moderately well sorted, tight, locally argillaceous, calcareous and dolomitic cement with siliceous cement in part.

Siltstone, 10%, dark grey, hard, blocky, calcareous cement.

Shale, 10%, medium to dark grey, firm, fissile, locally silty, slightly calcareous.

Chert, 20%, white, very hard, blocky, sandy grading to a siliceous sandstone.

Pyrite, trace.

1506 - 1515m
ROP:
4m/hr.

Sandstone, 60-70%, as above.
Siltstone, trace-20%, as above.
Shale, trace-10%, as above.
Chert, 10-20%, as above.
Pyrite, trace.
Limestone, trace.

1515 - 1518m ROP: 1.3m/hr.	Sandstone 30%, as above. Siltstone, 50%, as above. Shale, 10%, as above. Chert, 10%, as above. Pyrite, trace. Dolomite, trace.
1518 - 1527m ROP: 1.3m/hr.	Shale, 65-90%, medium to dark grey, fissile, friable. Siltstone, 10-30%, as above. Chert, trace-10%, as above. Dolomite, trace. Sandstone, trace.
1527 - 1539m ROP: 1.5m/hr.	Shale, 100%, as above. Dolomite, trace. Chert, trace. Pyrite, trace.

July 16, 1979

Depth: 1671m

Ditch gas range: 2 - 12 units total gas
0 - 1 unit petroleum vapors

Cuttings gas range: 3 - 11 units total gas
0 - 1 unit petroleum vapors

Last Connection gas: 3 units total gas
0 units petroleum vapors
at 1669m.

1539 - 1557m ROP: 0.8m/hr.	Shale, 100%, medium to dark grey, friable, fissile, trace of disseminate pyrite, trace of dolomite.
1557 - 1569m ROP: 2.6m/hr.	Shale, 60-80%, as above. Siltstone, 20-40%, as above, medium to dark grey-brown, hard, argillaceous, calcareous to very calcareous, trace dolomite, trace bryozoan,
1569 - 1671m ROP: 3.0m/hr.	Shale, 90-100%, as above, calcareous. Siltstone, 0-10%, as above. Limestone, trace.

COLUMBIA ET AL KOTANEELEE YT I-48 July 17, 1979

Geological Samples Description Depth: 1719m

Gas Readings:

Ditch gas range: 8 - 15 units total gas
0 - 1 unit petroleum vapors

Cuttings gas range: 6 - 14 units total gas
0 - 2 units petroleum vapors

Last Connection gas at 1708m - 12 units total gas
0 units petroleum vapors.

1671 - 1716m Shale, 90-100%, light to dark grey, soft to hard, fissile, trace of pyrite, slightly dolomitic, trace of calcite fracture filling.

Siltstone, 0-10%, dark grey, moderately hard, sub-fissile, dolomitic cement.

July 18, 1979

Depth: 1764m

Gas Readings:

Ditch gas range: 6 - 25 units

Cuttings gas range: 3 - 5 units.

Average ROP: 2m/hr.

1719 - 1725m Shale, 80%, light to dark grey, soft to hard, calcareous to very calcareous, associated with small, coarse, crystalline calcite veins.

Siltstone, 20%, dark grey, moderately hard, blocky, calcareous.

1725 - 1735m Shale, 90%, as above.
Siltstone, 10%, as above.
Limestone, trace.

1735 - 1740m Limestone, 40-50%, medium to dark grey, occasionally off-white to buff, medium grained, crystalline, very argillaceous, silty in part.

Shale, 40-50%, as above.
Siltstone, 10%, as above.

1740 - 1761m Limestone, 10%, as above.
Shale, 70-80%, as above.
Siltstone, 10-20%, as above.

COLUMBIA ET AL KOTANEELEE YT I-48 July 19, 1979

Geological Samples Description Depth: 1808m

Gas Readings: Ditch gas range: 4 - 12 units
Cuttings gas range: 3 - 8 units

1764 - 1767m Limestone, 10%, medium to dark brown, fine to medium grained, crystalline, very argillaceous, dolomitic, silty in part.

Siltstone, 30%, dark brown-grey, firm to hard, blocky, calcareous to very calcareous.

Shale, 60%, dark grey, firm to hard, fissile to sub-fissile, slightly calcareous, micromicaceous.

1767 - 1779m Limestone, 30%, as above.
Shale, 40%, as above.
Siltstone, 30%, as above.

1779 - 1785m Limestone, 20%, as above.
Shale, 40%, as above.
Siltstone, 40%, as above.

1785 - 1794m Limestone, 50%, off-white to buff, moderately hard, fine grained, crystalline, dolomitic, silty in part.

Shale, 20%, as above.
Siltstone, 30%, as above.

1794 - 1806m Limestone, 20-30%, as above.
Shale, 30-40%, as above.
Siltstone, 30-50%, as above.

July 20, 1979

Depth: 1815m

Gas Readings: Ditch gas range: 3 - 6 units
Cuttings gas range: 2 - 4 units.

1806 - 1815m Limestone, 30%, buff to light brown, occasionally grey, moderately soft, occasionally firm, microcrystalline, argillaceous.

Shale, 30%, medium grey to brown, hard, slightly calcareous, micromicaceous, associated with small calcareous veins.

Siltstone, 40%, light to medium grey and brown, moderately hard, occasionally firm, blocky, slightly to moderately calcareous, slightly micromicaceous.

COLUMBIA ET AL KOTANEELEE YT I-48 July 23, 1979

Geological Samples Description Depth: 1925m

Gas Readings:

Background Gas: 2 - 8 units total gas
Cuttings Gas: 3 - 5 units total gas

Lithology:

1815 - 1821m Limestone, 10%, off-white to light brown, mottled with black inclusions, fine to medium grained, crystalline, argillaceous, silty in parts.

Shale, 70%, medium to dark grey, firm to hard, sub-fissile to fissile, micromicaceous, non calcareous with a trace of pyrite.

Siltstone, 20%, medium to dark grey, hard, blocky, calcareous to very calcareous, locally grading to limestone.

1821 - 1827m Shale, 90%, generally as above, becoming slightly calcareous.

Siltstone, 10%, grading to shale in parts.

1827 - 1842m Siltstone, 30-40%, as above.
Shale, 60-70%, as above.

1842 - 1854m Shale, 90-100%, as above.
Siltstone, 0-10%, as above.

1854 - 1860m Shale, 40%, as above.
Siltstone, 50%, as above.
Calcite crystals, 10%, white, medium to coarse grained.

1860 - 1866m Shale, 20-40%, as above.
Siltstone, 60-80%, as above.

1866 - 1878m Limestone, 10%, off-white to light grey, moderately hard, fine to very fine grained, crystalline, argillaceous, silty in parts, locally grading to calcareous siltstone.

Siltstone, 70%, medium to dark grey, blocky, moderately hard to hard, predominately very calcareous, assoicated with calcite veins.

Shale, 20%, as above.

1878 - 1881m Limestone, 40%, as above.
Siltstone, 50%, as above.
Shale, 10%, as above.

1881 - 1896m Limestone, 20%, generally as above, locally grading to marl.

Siltstone, 50%, as above.

Shale, 20%, generally as above, becoming slightly calcareous.

Calcite crystals, 10%.

1896 - 1902m Limestone, 40-50%, as above.
Siltstone, 50%, as above.
Shale, 10%, as above.

Gas Peak: 42 units at 1899m.

1902 - 1920m Limestone, 10%, generally as above, becoming slightly more argillaceous and silty.

Shale, 10%, as above.
Siltstone, 80%, as above.

1920 - 1923m Shale, 20%, as above.
Siltstone, 80%, as above.

July 24 & 25, 1979

Depth 8:00 AM July 25: 2,006m

Gas Readings: Ditch gas range: 2 - 6 units
Cuttings gas range: 3 - 11 units.

ROP: 2 - 3 m/hr.

1926 - 1938m Shale, 20-40%, medium to dark grey, moderately hard, sub-fissile to fissile, non-calcareous with trace of calcite veining.

Siltstone, 60-80%, dark grey, hard, blocky, calcareous with a trace of calcite veining.

1938 - 1944m Shale, 60%, as above.
Siltstone, 40%, as above.

1944 - 1950m Shale, 60-70%, as above.
Siltstone, 10-30%, as above.
Marl, 10-20%, medium grey, soft, silty in parts, calcareous.

1950 - 1956m Marl, 40%, as above.
Shale, 40%, as above.
Siltstone, 20%, as above.

1956 - 1970m
Marl, 10%, as above.
Siltstone, 10%, as above.
Shale, 80%, dark grey to black, firm, occasionally moderately hard, sub-fissile to fissile, occasionally splintery, non-calcareous, micromicaceous with a trace of pyrite and trace of calcite veining.

1970 - 1972m
Marl, 10%, as above.
Shale, 80%, as above.
Sandstone, 10%, clear to white, occasionally light brown, hard, fine grained, sub-rounded, well sorted, slight calcareous cement, poor porosity.

1972 - 1980m
Shale, 90%, as above.
Siltstone, 10%, as above.

1980 - 2001m
Shale, 50-80%, as above.
Sandstone, 20-50%, as above.
Shale and siltstone both very gradational to each other.

July 26, 1979

Depth: 2027m

Gas Readings:

Background Ditch Gas range: 3 - 10 units total gas (C_1 with occasional C_2)
0 units petroleum vapors

Blender Cuttings Gas range: 10-15 units total gas
0 units petroleum vapors

Trip Gas: 22 units total gas at 2017m
(5840 ppm C_1, 56 ppm C_2, trace C_3)

Connection Gas: 2 units above background at 2006m

Lithology:

2001 - 2004m
ROP:
2.5m/hr.
Shale, 60%, medium to dark grey, firm to moderately hard, blocky to sub-fissile, occasionally fissile, slightly micro-micaceous, locally slightly calcareous, predominately non-calcareous, locally silty and grading to a siltstone, occasionally with some disseminated pyrite.

Siltstone, 40%, dark grey to dark grey-brown, firm, occasionally moderately hard, blocky and slightly dolomitic to very dolomitic, argillaceous.

Marl, slight trace, medium grey, soft, occasionally silty.

2004 - 2007m
ROP: 2.5m/hr.

Shale, 60%, as above.
Siltstone, 20%, as above.
Marl, 20%, as above.

2007 - 2010m
ROP: 3.0m/hr.

Shale, 40%, as above.
Siltstone, 30%, as above.
Marl, 30%, as above.

2010 - 2019m
ROP: 2m/hr.

Shale, 40-50%, predominately medium grey, locally light grey-brown, blocky to sub-fissile, occasionally fissile, firm to moderately hard, slightly dolomitic, locally very dolomitic and hard, locally silty and quite coarse. Occasionaly trace of calcite veinings.

Siltstone, 50-60%, medium grey, moderately hard to hard, blocky, slightly to very dolomitic and argillaceous to very argillaceous.

2019 - 2025m
ROP: 3.0m/hr.

Shale, 60-70%, as above.
Siltstone, 30-40%, as above.

July 27, 1979

Depth: 2086m

Gas Readings:

Ditch Gas range: 4 - 30 units total gas
0 units petroleum vapors

Mud-Blender Cuttings Gas range: 5 - 27 units total gas
0 units petroleum vapors

Total Gas is C_1 and C_2 only.

Connection gas: 3 units above background at 2080m.

2025 - 2040m
ROP: 3.0m/hr.

Shale, 50-60%, medium grey, locally light grey-brown, blocky to sub-fissile, firm to moderately hard, locally hard, slightly dolomitic, locally with calcite veins, also locally silty grading to a siltstone.

Siltstone, 40-50%, medium to dark grey, moderately hard to hard, locally very hard, angular fragments, slightly dolomitic to very dolomitic, also locally with calcite veins, occasionally with some disseminated pyrite. Argillaceous, locally becoming sub-fissile grading to a very silty shale. Slight trace of pyrite, massive.

2040 - 2049m
ROP: 2.7m/hr.

Shale, 70-80%, as above.
Siltstone, 20-30%, generally as above, occasionally dark grey-brown, very hard, siliceous, angular fragments. Slight trace of pyrite and slight trace of calcite.

2049 - 2064m
ROP: 2.7m/hr.

Shale, 50-60%, as above.
Silstone, 40-60%, light to dark grey, commonly grey-black, speckled, moderately hard to hard, locally very hard, dolomitic to very dolomitic, argillacoeus, locally becoming sub-fissile, very silty, locally micromicaceous, locally with calcite veins.

Marl, slight trace, light brown, soft.

2064 - 2070m
ROP: 2.7m/hr.

Shale, 30-40%, as above.
Siltstone, 60-70%, light brown to dark grey-brown, firm to hard, blocky, occasionally becoming sub-fissile.

2070 - 2082m
ROP: 2.3m/hr.

Shale, 60-70%, light to medium grey, predominately moderately hard, occasionally firm, occasionally hard, sub-fissile to fissile, occasionally slightly calcareous, locally with thin calcite veins.

Siltstone, 30-40%, light to medium grey, generally firm, locally moderately hard, blocky, slightly calcareous with occasional calcite veins and occasionally with disseminated pyrite. Locally silty.

July 30, 1979

Depth: 2210m

Gas Readings:

Ditch gas range: 3 - 52 units total gas
(C_1 with very slight C_2 and only occasional trace C_3.)
0 units petroleum vapors

Mud-Blender Cuttings Gas range: 8 - 37 units total gas
0 - 1 unit petroleum vapors

No Connection Gas.

Trip Gas: 2118m: 207 units total gas above background
41,463 ppm C_1
152 ppm C_2
23 ppm C_3
10 ppm IC_4
0 NC_4

2194m: 50 units total gas above background.
0 units petroleum vapors.

2082 - 2085m
Shale, 60%, as above.
Siltstone, 40%, as above.

2085 - 2103m
Shale, 60-70%, medium brown, firm, occasionally moderately hard, blocky to sub-fissile, locally silty, slightly calcareous. Trace of calcite veins and loose crystals.

Siltstone, 10-20%, as above.
Marl, 10-20%, light brown, soft, locally light grey-brown.
Pyrite, trace, massive.

2103 - 2115m
Shale, 60-70%, as above.
Siltstone, 30-40%, medium to dark grey, mottled with black specks, firm to hard, calcareous to very calcareous with trace calcite veins.

2115 - 2118m
Shale, 100%, as above.
Calcite, good trace, white crystals and veins in the shale.
Pyrite, slight trace, massive.

2118 - 2136m
Shale, 80-90%, as above.
Dolomite, 10-20%, dark grey to grey-black, speckled, hard to very hard, blocky, commonly angular fragments, locally silty, argillaceous, commonly with disseminated pyrite. Good trace calcite.

Marl, good trace, light brown, soft to only firm.

Pyrite, trace, massive and sometimes crystalline.

2136 - 2142m
Shale, 90%, medium to dark grey, firm, occasionally moderately hard, blocky to fissile, locally only sub-fissile, occasionally with trace of calcite veins.

Siltstone, 10%, light brown to dark brown, firm to hard, blocky, slightly calcareous to calcareous.

2142 - 2148m
Shale, 30%, as above.
Siltstone, 60%, as above.
Limestone, 10%, light to dark brown, hard, medium grained, crystalline, argillaceous.

2148 - 2154m
Shale, 10-20%, as above.
Siltstone, 60-80%, predominately as above, very calcareous, locally grading to a silty limestone.

Limestone, 10-20%, off-white to buff, occasionally light brown, firm to hard, crystalline, argillaceous, silty in part.

2154 - 2160m
Siltstone, 60-70%, medium to dark grey, hard, blocky, calcareous to very calcareous, locally dolomitic, commonly grading to a silty limestone.

Limestone, 30-40%, as above.

2160 - 2169m

Siltstone, 90%, as above.
Limestone, 10%, predominately medium to dark brown, very silty, argillaceous.

Shale, trace-20%, medium grey, firm, locally moderately hard, silty, only slightly calcareous.

2169 - 2178m

Siltstone, 75-90%, medium to dark grey, predominately firm to moderately hard, locally very hard, blocky to sub-fissile, locally becoming silty shale, locally with some disseminated pyrite.

Limestone, trace-25%.

2178 - 2184m

Shale, trace-10%, as above.

Siltstone, 50%, as above, but generally becoming a little softer.

Limestone, 40%, off-white to tan to light grey-brown, firm, locally soft, commonly argillaceous to very argillaceous. Silty locally grading to a very calcareous siltstone. Locally becoming marly.

2184 - 2187m

Shale, 30%, as above.
Limestone, 60%, as above.
Chert, 10%, translucent green-grey, smoky, hard to very hard, blocky, commonly with white calcite patches, locally with some disseminated pyrite.

2187 - 2193m

Shale, 70%, as above.
Limestone, 20%, predominately as above, commonly associated with the chert and locally very siliceous, grading to a chert.

Chert, 10%.

2193 - 2205m

Shale, trace-20%, medium grey, firm, blocky to sub-fissile, predominately non-calcareous.

Limestone, 50-60%, as above.

Chert, 30-40%, predominately medium brown, translucent with common white calcareous patches. Locally grading to a very siliceous limestone.

COLUMBIA ET AL KOTANEELEE YT I-48 July 31, 1979

Geological Samples Description Depth: 2257m

Background Ditch gas: 2205-2226m: 4 - 9 units total gas
0 units petroleum vapors
2226m: 800 units total gas
0 units petroleum vapors

-- 159,819 ppm C_1
358 ppm C_2
7 ppm C_3
142 ppm IC_4
0 NC_4

2226-2257m: 18 - 65 units total gas
0 units petroleum vapors

-- C_1, trace C_2, & occasional trace C_3.

Mud-Blender Cuttings gas: 3 - 25 units total gas
0 units petroleum vapors

2205 - 2210m
ROP: 2.5m/hr.

Limestone, 60%, off-white to light grey, occasionally light brown, firm to hard, crystalline, argillaceous, cherty in part, locally grading to a very calcareous chert.

Chert, 30%, medium brown, commonly with white calcareous patches, translucent in slices. Very hard, calcareous, closely associated with the limestone.

Shale, 10%, medium to dark grey, predominately firm, locally moderately hard, silty, blocky to sub-fissile, slightly calcareous.

2210 - 2213m
ROP: 1.6m/hr.

Limestone, 45-65%, as above.
Chert, 15-25%, as above, locally with disseminated pyrite.
Shale, 10-40%, as above.

2213 - 2216m
ROP: 2.6m/hr.

Limestone, 60%, as above.
Chert, 40%, as above.
Shale, good trace, as above.

2216 - 2221m
ROP: 1.5m/hr.

Limestone, 30-50%, as above, commonly very argillaceous, locally becoming marly.

Chert, 20%, predominately as above, commonly with disseminated pyrite, occasionaly crystals of pyrite. Locally grading to a siliceous limestone.

Shale, 30-50%, predominately as above, locally becoming light grey, very calcareous, marly.

2221 - 2229m
ROP: 1.4m/hr.

Shale, 60-75%, as above.
Chert, 20-30%, as above.
Limestone, good trace-20%.

2229 - 2235m
ROP: 2.5m/hr.

Limestone, 10%, as above.
Chert, 30%, as above.
Shale, 50-60%, as above.
Calcite, good trace-10%, white, crystalline, loose crystals and thin veins in the shale.

2235 - 2241m
ROP: 3m/hr.

Limestone, 30%, generally as above, but locally becoming increasingly light to medium brown, hard and cherty.

Chert, 30%, as above.
Shale, 20-40%, predominately calcareous to very calcareous.

Dolomite, trace-20%, medium to dark brown, locally grey-brown, hard to very hard angular fragments, commonly argillaceous, slightly silty and locally slightly siliceous.

2241 - 2247m
ROP: 3m/hr.

Limestone, 10-20%, as above, but becoming dark brown, dolomitic in patches.

Chert, 40-50%, black, occasionally translucent brown, very hard, calcareous, blocky angluar fragments, locally becoming slightly dolomitic.

Shale, 30%, as above.
Dolomite, 10%, as above.

2247 - 2252m
ROP: 2.4m/hr.

Chert, 10-20%, becoming increasingly dolomitic, commonly grading to a siliceous dolomite.

Shale, 50-70%, medium to dark grey, firm to hard, blocky, dolomitic, locally very dolomitic, also slightly cherty in part.

Dolomitic, 10-20%, as above, hard to very hard, locally cherty.

Limestone, 10%, predominately as above, also locally cherty.

COLUMBIA ET AL KOTANEELEE YT I-48 August 1, 1979

Geological Samples Description Depth: 2278m

Gas Readings: Ditch gas range: 13 - 32 units total gas
0 units petroleum vapors

Cuttings gas range: 7 - 14 units total gas
0 units petroleum vapors

Trip gas: 465 units at 2278m
C_1 - 92,140 ppm
C_2 - 38 ppm
C_3 - trace
IC_4 - 33 ppm
NC_4 -nil

2252 - 2259m
ROP: 2m/hr.

Shale, 40-50%, medium to dark grey, firm to hard, occasionally very hard, blocky, calcareous, dolomitic, cherty in part.

Dolomite, 50-60%, dark grey, hard to very hard, silty, argillaceous, locally calcareous, grading to a dolomitic limestone.

Calcimetry run: 0-14% calcite; 18-32% dolomite.

2259 - 2262m
ROP: 2m/hr.

Shale, 60%, as above.

Limestone, 30%, tan to light brown, locally off-white, soft to firm, argillaceous to very argillaceous, locally silty.

Dolomite, 10%, as above.

Calcimentry run: 32% calcite; 10% dolomite.

2262 - 2265m
ROP: 1.6m/hr.

Limestone, 50%, as above.
Shale, 30%, as above.
Dolomite, 20%, as above.

2265 - 2277m
ROP: 2m/hr.

Shale, 50-70%, as above.
Limestone, 20-30%, as above.
Dolomite, 10-20%, as above.
Calcimetry run: 25% calcite; 10% dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48 August 2, 1979

Geological Samples Description Depth: 2328m

2277 - 2283m
ROP: 1.5m/hr.

Shale, 90%, medium to dark grey, moderately hard, fissile to blocky, silty grading to siltstone, calcareous in part, calcite veins.

Dolomite, 10%, light to medium grey, microcrystalline, blocky, friable, silty grading to siltstone, calcareous.

Calcimeter run: 13% dolomite; 5% calcite.

Ditch gas range: 8 units total gas; 0 units petroleum vapors.

2283 - 2292m
ROP: 2.4m/hr.

Shale, 80%, as above.

Dolomite, 10%, as above.

Limestone, 10%, light to medium grey, microcrystalline, blocky, friable, silty grading to siltstone, dolomitic.

Calcimenter run: 12-14% dolomite; 13-14% calcite.

Ditch gas range: 5-9 units total gas; 0 units petroleum vapors.

2292 - 2304m
ROP: 3.4m/hr.

Shale, 90%, as above.

Limestone, 10%, as above.

Calcimeter run: 8% dolomite; 20% calcite.

Ditch gas range: 7-17 units total gas; 0 units petroleum vapors

2304 - 2319m
ROP: 3.1m/hr.

Shale, 30-40%, as above, non-calcareous.

Limestone, 30-50%, tan to light grey, friable to moderately hard, blocky, microcrystalline, locally very finely crystalline, silty grading to siltstone.

Siltstone, 20-30%, dark grey to black, hard, blocky, calcareous cement.

Calcimeter run: 7% dolomite; 32% calcite.

Ditch gas range: 2-178 units total gas; 0 units petroleum vapors.

2319 - 2322m
ROP: 3m/hr.

Shale, 60%, as above.
Siltstone, 20-30%, as above.
Limestone, 10-20%, as above.

Ditch gas range: 2-3 units total gas; 0 units petroleum vapors

Cuttings Gas range: 2 - 11 units total gas; 0 units petroleum vapors.

Connection Gas: 46 units at 2300m.

COLUMBIA ET AL KOTANEELEE YT I-48 August 3, 1979

Geological Samples Description Depth: 2373m

Gas Readings:

Ditch Gas range: 10 - 118 units total gas
0 units petroleum vapors

Cuttings Gas range: 4 - 10 units total gas
0 units petroleum vapors

Lithology:

2322 - 2334m
ROP: 3.8m/hr.

Shale, 60-70%, medium to dark grey, moderately hard, fissile grading to siltstone, non-calcareous.

Limestone, 10-20%, tan to light grey, moderately hard, sub-fissile, microcrystalline, silty. Trace of crinoids.

Siltstone, 10-30%, dark grey to black, moderately to very hard, blocky, calcareous cement.

Sandstone, trace, white to light grey, locally orange-brown, locally with black specks, very fine to fine-grained, high grain:matrix ratio, sub-angular to sub-rounded, tight, calcareous cement.

Calcimeter run: 12-16% calcite; 10-16% dolomite.

2334 - 2343m
ROP: 4m/hr.

Shale, 30-60%, as above.
Siltstone, 10-20%, as above.
Limestone, 20-50%, as above.
Sandstone, trace, as above.

Calcimeter run: 26% calcite.; 12% dolomite.

2343 - 2373m
ROP: 3.2m/hr.

Shale, 70-100%, as above.
Siltstone, 0-20%, as above.
Limestone, 0-10%, as above.
Sandstone, trace.
Calcite, trace.

Calcimenter run: 14-18% calcite; 7-10% dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48 August 7, 1979

Geological Samples Description Depth: 2481m

Trips at 2458 and 2473m, due to tight hole problesm.
Last trip gas at 2458m was 16,000 units total gas; 5 units petroleum vapors.

Last connection gas was 512 units total gas at 2480m.

2373 - 2442m 1.9 - 5.0m/hr.	Shale, 100%, medium grey, firm, fissile, occasionally silty, trace of calcite fracture fill, trace of massive and disseminated pyrite. Pyrite contains eliptical and concentrically grained inclusions and gives pyrite a botryoidal appearance, possibly oolitic or oncolitic, or may be fossils. Calcimeter run: 0-8% calcite; 2-11% dolomite. Ditch gas range: 40-540 units Cuttings gas range: 6-54 units.
2442 - 2451m 2.3m/hr.	Shale, 65-75%, as above. Limestone, 10-30%, off-white to light grey, inclusions as in the pyrite. Pyrite, 10-20%, as above. Calcimeter run: 12-30% calcite; 4-6% dolomite. Ditch gas range: 20-60 units Cuttings gas range: 14-29 units.
2451 - 2482m 0.6 - 2.5m/hr.	Shale, 80-100%, as above, locally waxy and striated. Pyrite, 0-20%, as above. Calcimeter run: 0-1% calcite; 2-8% dolomite. Ditch gas range: 40-288 units Cuttings gas range: 80-20 units.

COLUMBIA ET AL KOTANEELEE YT I-48 August 20, 1979

Geological Samples Description

Drilling "sidetrack" hole from 2393m

2393 - 2401m	Shale, 100%, light to medium grey, occasionally dark grey, soft to firm, occasionally hard, blocky, occasionally sub-fissile, predominately noncalcareous, occasionally becoming silty and slightly calcareous. Good trace of pyrite and trace of calcite.
2401 - 2429m	Shale, 100%, dark grey to black, firm to hard, blocky to sub-fissile with pyrite and calcite.
	Limestone, trace, dark brown, hard, blocky, argillaceous, silty grading to calcareous siltstone.
	Pyrite, trace, massive and disseminated.
	Calcite, trace, white to milky, crystalline.

Ditch gas range: 14 - 120 units

Cuttings gas range: 6 - 24 units

Last trip gas (at 2408m): 3,000+ units.

COLUMBIA ET AL KOTANEELEE YT I-48

August 21, 1979

Pulled out of hole, ran in and reamed to 2431m

August 22, 1979

Depth: 2440m

Lithology:

2430 - 2440m

Shale, 100%, medium to dark grey, sub-fissile to fissile, often silty, frequently coarse, firm to moderately hard, locally with calcite grains, locally calcitic.

Sandstone, poor trace, white with black lithic fragments, moderately hard, very fine, locally silty, sub-rounded, moderately well sorted with calcareous or dolomitic cement.

Pyrite, good trace (up to 4%).

ROP: 1.9m/hr.

Ditch gas range: 26 - 30 units.

Cuttings gas range: 13 - 18 units

Trip gas: 672 units at 2430m.

COLUMBIA ET AL KOTANEELEE YT I-48

August 27, 1979

Geological Samples Description

Depth: 2461.01m

Rig Status: Reaming

Gas Readings: Ditch gas range: 216 - 2850 units.
Cuttings gas range: 13 - 26 units
Last trip gas: 3,200+ units at 2457m

Large increases in gas:
2446m -- 640 units
2451m -- 2850 units
2452m -- 1056 units
2455m -- 330 units
2458m -- 1664 units
2461m -- 1280 units

Bad tight hole problems throughout, especially from 2450 to 2454m and at 2461m

2441 - 2450m
ROP: 1.94m/hr.

Shale, 100%, medium to dark grey, firm, sub-fissile to fissile, locally blocky, often silty, dolomitic, locally with calcite-filled microfractures.

Pyrite, good trace to very good trace, massive, framboidal accumulations with white and dark grey inclusions locally disseminated in the shale.

Calcite, trace to good trace, loose crystals, clear, locally filling microfractures in the shale.

2450 - 2461m
ROP: 1.32m/hr.

Shale, 80-85%, dark grey, rarely medium grey, hard, rarely firm, fissile to sub-fissile, locally blocky, locally silty, frequently dolomitic, often with calcite along microfractures and with disseminated pyrite.

Calcite, 10%, milky, occasionally clear as above.

Pyrite, 5-10%, as above.

COLUMBIA ET AL KOTANEELEE YT I-48 August 30, 1979

Geological Samples Description Depth: 2475m

Gas Readings: Ditch gas range: 144 - 704 units total gas
Cuttings gas range: 8 - 12 units total gas

Trip gas (at 2461m): 2,224 units total gas above background.
1 unit petroleum vapors above background.

2461 - 2476m
ROP: 0.6 - 1.1m/hr.

Shale, 90%, medium to dark grey, moderately hard to hard, commonly silty to very silty, sub-fissile, locally dolomitic, locally with disseminated pyrite, also locally with calcite filled micro-veinlets.

Pyrite, 10%, massive, framboidal, friable, locally hard with grey inclusions, also locally with very well rounded spheres.

2476 - 2475m
ROP: 0.5 - 1.2m/hr.

Shale, 85-90%, as above.
Pyrite, 5-10%, as above.
Calcite, 5%, clear to milking colored loose crystals.

COLUMBIA ET AL KOTANEELEE YT I-48 August 31, 1979

Geological Samples Description Depth: 2492m

Gas Readings: Ditch gas range: 160 - 3000+ units
Cuttings gas range: 9 - 22 units
Trip gas (at 2476m): 3200+ units
Connection gas (at 2479m): 3000+ units
(at 2488m): 3000+ units

ROP: 1.0 - 1.5m/hr.

2475 - 2479m Shale, 90%, medium to dark grey, occasionally light grey, moderately firm, occasionally moderately hard, blocky, predominately noncalcareous, occasionally very slightly calcareous with calcite and quartz veins associated with disseminated pyrite.

Limestone, 5%, medium to dark brown, hard, blocky, micro-crystalline, argillaceous, occasionally silty, dolomitic.

Pyrite, 5%, predominately disseminated, occasionally rounded pieces with calcareous core.

2479 - 2482m Shale, 95%, as above.
Pyrite, 5%, as above.

2482 - 2485m Shale, 90%, as above.
Calcite, 5%, as micro-veins with disseminated pyrite in the shale.
Pyrite, 5%, as above.

2485 - 2491m Shale, 100%, as above, with trace of pyrite and calcite.

COLUMBIA ET AL KOTANEELEE YT I-48 September 4, 1979

Geological Samples Description Depth: 2508m

Gas Readings: Ditch gas range: 216 - 360 units total gas (all C_1).

Cuttings gas range: 13 - 18 units total gas

Connection gas (up to 2499m): 2420 units total gas above background.

(at 2508m): 2248 units total gas above background.

Trip gas (at 2508m): 3200+ units total gas; nearly all C_1, with up to 260 ppm IC_4.

trace-4 units petroleum vapors.

2492 - 2497m
ROP: 0.7 - 1.0m/hr.

Shale, 100%, medium grey, firm, locally becoming moderately hard, blocky to sub-fissile, locally silty to very silty becoming a very argillaceous siltstone, predominately noncalcareous, locally slightly dolomitic, locally with calcite veinlets. Also locally with disseminated pyrite. Trace of crystalline calcite. Also good to very good trace of pyrite, which is predominately speckled, friable, granular or crystalline aggregate, locally crystalline, also occasionaly well rounded spheres of quartz cores, also appears as massive, hard chunks with grey, sub-rounded to rounded inclusions which are sometimes calcareous.

2497 - 2503m
ROP: 0.9 - 1.3m/hr.

Shale, 90-95%, as above.
Pyrite, 5-10%, as above.
Calcite, trace.
Sandstone, very slight trace, clear to off-white to light grey, very fine to silty with occasional fine grains, sub-angular to sub-rounded, moderately well sorted, very tight porosity, calcareous in patches.

2503 - 2508m
ROP: 1.1 - 1.4m/hr.

Shale, 100%, as above.
Pyrite, very good trace, as above.
Calcite, trace, as above.
Sandstone, slight trace, as above.

COLUMBIA ET AL KOTANEELEE YT I-48

Sept. 19, 1979

Geological Samples Description

Depth: 1971m
Launching Deviation

Gas Readings: Ditch gas range: 10-12 units
Cuttings gas range: 2-3 units
Trip gas: 288 units (at 1953m)

1953 - 1971m

Shale, 50-90%, grey to dark grey, fissile to blocky, becoming frequently pressured, showing splintery needles, hard to firm, occasionally dolomitic.

Marl, trace-30%, medium to light grey, soft, rarely silty.

Siltstone, trace-20%, dark grey to brown, firm to soft, rarely hard, blocky, calcareous.

Drilling Rate: Average 1.6m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 September 20, 1979

Geological Samples Description Depth: 1981m

Gas Readings: Trip gas: 200 units at 1971m
Ditch gas range: 4-5 units
Cuttings gas: 1 unit

1971 - 1981m
ROP: 1.2m/hr.

Shale, 70-80%, grey to dark grey, fissile to blocky, becoming occasionally pressured, splintery needles, hard to firm, occasionally dolomitic.

Siltstone, 20-30%, dark grey to brown, firm to soft, locally hard, blocky, calcareous.

Cement, 20-30%.

September 21, 1979

Depth: 1987m

Gas Readings: Trip gas: 664 units (at 1981m)
Ditch gas: 2 units
Cuttings gas range: 1-2 units.
Calcimetry: 83 (probably still contaminated with cement).
Calcium carbonate: 0
Dolomite: 9

1981 - 1987m
ROP: 1.4m/hr.

Shale, 100%, grey to dark grey, hard to firm, locally sub-fissile, occasionally pressured, dolomitic.

Siltstone, trace, dark grey to brown, firm to soft, locally hard, blocky.

COLUMBIA ET AL KOTANEELEE YT I-48

Sept. 27, 1979

Geological Samples Description

Depth: 2012m
Status: Drilling

Gas Readings: Ditch gas range: 7 - 10 units
Cuttings gas range: 1 - 4 units
Trip gas: 640 units at 1997m

1987 - 2007m Shale, 60-70%, medium to dark grey, moderately hard, frequently sub-fissile, micromicaceous, partly calcitic.

Siltstone, 30-40%, grey brown, hard, blocky, calcite with disseminated micropyrite.

2007 - 2012m Shale, 50%, as above.
Siltstone, 30%, as above.
Calcite, 20%.
Marl, brown to light grey, soft.

ROP: 0.5m/hr.

COLUMBIA ET AL KOTANEELEE YI I-48

Sept. 28, 1979

Geological Samples Description

Depth: 2041 m
Status: Tripping

Gas Readings: Ditch gas range: 5 - 21 units
Cuttings gas range: 1 - 7 units

2012 - 2022m

Shale, 50-60%, grey to dark grey, firm to hard, frequently sub-fissile, micromicaceous, partly calcitic, slightly dolomitic.

Siltstone, 40-50%, grey to brown, firm to hard, blocky, with disseminated pyrite, calcitic and slightly dolomitic.

Marl, trace.

2022 - 2041m

Shale, 30-50%, light grey to medium grey, occasionally to dark grey, moderately hard, locally firm, mostly brittle, mainly sub-fissile, moderately calcitic, trace of disseminated micropyrite.

Siltstone, 20-30%, brown to light grey, frequently speckled, firm to hard, blocky, calcitic, slightly dolomitic with micropyrite.

Marl, 30-50%, light grey to brown, soft, silty, calcitic.

Calcite, trace, white, milky, crystalline.

ROP: 0.7m/hr.

NOTE: Shale is becoming harder with depth, more sub-fissile and more silty.

COLUMBIA ET AL KOTANEELEE YT I-48

Sept. 29/79

Geological Samples Description

Depth: 2067.7m
Status: Drilling

Gas Readings: Ditch gas range: 22 - 33 units
Cuttings gas range: 3 - 11 units
Trip gas: 600 units at 2041m

2041 - 2061m

Shale, 30-70%, light to medium grey, occasionally dark grey, hard, brittle, fissile to sub-fissile, frequently blocky, frequently silty, calcitic and dolomitic cement.

Siltstone, 30-70%, grey, medium grey to brown, more black speckled, hard to firm, blocky, slightly calcitic, occasionally with disseminated micropyrite.

Marl, 0-10%, light grey to grey brown, soft, silty, calcareous.

Calcite, white, occasionally clear, hard and brittle, crystalline, occasionally has microfracture in-fillings in shale. Trace only. Pyrite usually disseminated or aggregate in shale and siltstone. Trace only.

ROP: 2.0m/hr.

Sept. 30/79

Depth: 2115
Status: Drilling

Gas Readings: Ditch gas range: 12 - 110 units
Cuttings gas range: 8 - 18 units
Trip gas: 400 units at 2115m

2067.7 - 2115m

Shale, 50-80%, grey to dark grey, firm, hard, blocky to sub-fissile, with calcitic and dolomitic cement.

Siltstone, 10-30%, grey to dark grey, firm to hard, blocky to sub-fissile, also with calcitic and dolomitic cement.

Marl, light grey to white, soft and rounded, silty and argillaceous, trace to 20%.

Also a trace of white crystalline calcite.

ROP: 4.4m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

Oct. 1/79

Geological Samples Description

Depth: 2146
Status: Drilling

Gas Readings: Ditch gas range: 28 to 210 units
Cuttings gas range: 6 - 15 units
Trip gas: 890 units at 2125m

2115 - 2146

Shale, trace to 30%, dark grey to grey, firm to hard, blocky to sub-fissile, silty and micromicaceous, with calcitic and dolomitic cement.

Siltstone, 60-90%, grey, firm to hard, blocky, argillaceous, with calcitic and dolomitic cement.

Dolomite, 0 - 20%, dark grey to black, speckled, hard, argillaceous and silty.

ROP: 2.6 m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 2, 1979

Geological Samples Description

Depth: 2162m
Status: Drilling

Gas Readings: Ditch gas range: 28 - 60 units
Cuttings gas range: 6 - 10 units
Trip gas: 1920 units at 2155.5m

2146 - 2162

Siltstone, 60%, grey to dark grey, firm, occasionally hard, blocky to brittle, sub-fissile, slightly to moderately calcitic.

Limestone, 40%, white, light grey, grey to brown, frequently black speckled, firm to hard, blocky to brittle, frequently sacchariodal, mostly micritic, argillaceous, impure calcilutite, crystalline, occasionally fossiliferous with mainly micro-fossils.

Corals and bryozoa at 2160m.

A trace of calcite.

ROP: 2m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 2, 1979

Geological Samples Description

Depth: 2185m
Status: Drilling

Gas Readings: Ditch gas range: 25 - 45 units
Cuttings gas range: 6 - 10 units
Trip gas: 44 units @ 2160m - 44 units @ 2180m

2162 - 2185

Siltstone, 70-90%, grey to dark grey, firm, occasionally hard, blocky to brittle, sub-fissile, slightly to moderately calcitic, becoming locally very calcareous, grading locally to a very silty limestone.

Limestone, 10-30%, off-white, grey, becoming more grey with increasing depth, frequently black speckled and mottled, firm to moderately hard, crystalline, argillaceous, locally silty, grey to calcareous siltstone.

Calcite trace, shell trace, poor to a reasonable trace of Marl.

ROP: 1.1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 3, 1979

Geological Samples Description

Depth: 2201
Status: Running in hole

Gas Readings: Ditch gas range: 17 - 48 units
Cuttings gas range: 4 - 8 units
Connection gas: 64 units @ 2189m

2185m - 2201m Limestone, 40-70%, white, light grey, brown, buff, frequently mottled brown, hard, fairly firm, very brittle, moderately calcareous, occasionally dolomitic, becoming cherty locally, grading to siltstone.

Siltstone, 15-40%, light grey to grey, firm, becoming hard locally, blocky to sub-fissile, moderately calcareous, grading to limestone locally.

Shale, 0-20%, light to dark grey, hard, brittle, sub-fissile, becoming fissile in part, poorly calcareous, locally slightly dolomitic.

Chert, 5-10%, brown, buff, light grey, smokey or clear, hard, very brittle, mostly angular, occasionally conchoidal, occasionally saccharoidal, frequently with white calcareous inclusions.

Calcite, white, crystalline, hard, brittle, frequently as vein fillings. Zero to very good trace.

ROP: 1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 4, 1979

Geological Samples Description

Depth: 2218m
Status: Tripping out

Gas Readings: Ditch gas range: 12 - 40 units
Cuttings gas range: 3 - 4 units
Trip gas: 15 - 36 units @ 2201
Connection gas: 25 units @ 2213m

2201 - 2218 Limestone, 70-80%, off-white, light brown, grey, firm, really hard, locally crumbly, crystalline, siliceous in part, locally argillaceous, locally dolometic.

Chert, trace-10%, smokey brown, brown, hard, angular, with calcareous inclusions.

Siltstone, 10-20%, grey to dark grey, firm to moderately hard, blocky, calcareous, occasionally very calcareous.

Shale, 0-10%, medium to dark grey, firm, occasionally soft, blocky, locally sub-fissile, non-calcareous.

ROP: 1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 5 - 9, 1979

Geological Samples Description

Depth: 2269m
Status: Reaming to bottom

Gas Readings: Ditch gas range: 10 - 61 units (over whole interval)
Cuttings gas range: 4 - 15 units (over whole interval)
Last trip gas: 17 - 28 units @ 2233m

2218 - 2228 Limestone, 20-30%, off-white, light brown, grey occasionally dark brown, firm, locally hard, locally crumbly, crystalline, very siliceous in parts, frequently argillaceous, occasionally dolomitic.

Siltstone, 40-50%, dark grey, dark brown, firm to hard, blocky, calcareous to very calcareous, grading to very argillaceous limestone in parts.

Shale, 30%, grey, firm, rarely hard, locally soft, blocky, noncalcareous.

Chert, trace, brown to dark brown, occasionally black, hard to very hard, angular, associated with calcite and limestone.

2228 - 2235 Limestone, 30-50%, as before

Siltstone, 20-30%, as before

Shale, 20%, generally as before, associated with calcite microveining.

Dolomite, 10%, very dark brown, hard, blocky to angular, argillaceous, siliceous in parts.

Chert, trace to 10%, as before

2235 - 2247 Limestone, 40-50%, as before

Chert, 10%, as before

Siltstone, 10%, as before

Shale, 10-20%, as before

Dolomite, 10-20%, medium to dark brown, hard, occasionally very hard, angular, occasionally blocky, microcrystalline, argillaceous, siliceous with calcite microveining.

2247 - 2253 Limestone, 20%, as before

Shale, 40-50%, medium to dark grey, moderately soft to *firm, occasionally moderately hard, blocky to subfissile,* slightly micromicaceous, noncalcareous.

Dolomite, 30-40%, as before, with trace of chert and a trace of calcite.

2253 - 2265 Dolomite, 50-60%, dark grey to grey brown, black, hard, locally very hard, brittle, angular, siliceous in parts, rarely with calcite inclusions.

Limestone, 20-30%, as before

Shale, 10-20%, as before

2265 - 2269 Dolomite, 40%, as before

Shale, 30%, as before

Limestone, 30%, as before, with trace of pyrite.

ROP: .57 to 4.29m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 10, 1979

Geological Samples Description

Depth: 2280m

Status: RIH with dyna drill

Gas Readings: Ditch gas range: 43 - 92 units
Cuttings gas range: 10 - 11 units
Last trip gas: 3000+ units @ 2269m

2269 - 2271 Shale, 60%, medium to dark grey, occasionally light grey, firm to moderately hard, blocky to subfissile.

Siltstone, 20%, medium to dark grey, firm to moderately hard, blocky, non to moderately calcareous, dolomitic with calcite veining with pyrite.

Limestone, 10%, tan to dark brown, firm, blocky, crystalline, argillaceous, dolomitic, silty.

Calcite, 10%, white, coarsely crystalline, associated with siltstone and limestone.

2271 - 2280 Shale, 60-70%, as before, becoming slightly calcareous.

Siltstone, 20%, as before, dolomite trace to 10%, dark grey to brown, occasionally mottled, hard, angular, calcareous in parts.

Calcite, 10%, as above,

ROP: 1.2 to 1.94m/hr.

COLUMBIA ET AL KOTANEELEE YT I-43

October 11, 1979

Geological Samples Description

Depth: 2292m

Status: RIH with dyna drill

Gas Readings: Ditch gas range: 48 - 74 units
Cuttings gas range: 6 - 12 units
Last trip gas: 2300 units @ 2280m

2280 - 2283m Siltstone, 50%, dark grey, firm to moderately hard, occasionally hard, calcareous to very calcareous, grading to argillaceous limestone.

Shale, 40%, medium grey, occasionally light grey, firm to moderately hard, subfissile, silty in parts.

Marl, 10%, light to medium brown, soft, calcareous, silty in parts.

Limestone, calcite and dolomite, trace.

2283 - 2292m Marl, 30-40%, as above.

Shale, 20-40%, as above.

Siltstone, 20-40%, as above.

Trace calcite, white, coarsely crystalline, associated with silstone and a trace of limestone.

ROP: 5 to 1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

Geological Samples Description

to 14

October 12, 1979

Depth: ~~2310~~ 2312m

Status: Running in hole with new bit

Gas Readings: Ditch gas range: 45 - 102 units
Cuttings gas range: 4 - 12 units

2292 - 2298m Marl, 20-30%, light grey to grey brown, soft, very calcareous, locally grading to shale.

Shale, 50%, light to medium grey, firm to moderately hard, subfissile, silty in parts.

Siltstone, 20-30%, dark grey, firm to moderately hard, blocky, calcareous, dolomitic, with occasional calcite veins, with a trace of pyrite and a trace of calcite.

2298 - 2310m Marl, 10-20%, as above.

Shale, 40-50%, as above.

Siltstone, 10-30%, medium to dark brown, firm to moderately hard, occasionally hard, blocky, calcareous, occasionally very calcareous, grading to silty limestone.

Limestone, 10-30%, off-white to light brown, light grey, crumbly to moderately hard, fine to coarsely crystalline, occasionally chalky, argillaceous, slightly dolomitic, occasionally with a trace of fossils.

ROP: .51 to 3.53m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 16, 1979

Geological Samples Description

Depth: 2357m

Status: Drilling

Gas Readings: Ditch gas range: 52 - 74 units
Cuttings gas range: 8 - 18 units
Last connection gas: 20 @ 2352m

2312 - 2357m Shale, 40-80%, grey to grey brown, firm, blocky to subfissile, calcite and dolomite cement, silty.

Siltstone, 10-20%, grey to grey brown, firm, blocky, calcite and dolomite cement, locally sandy.

Limestone, 0-30%, grey to brown, hard to firm, brittle, microcrystalline and silty.

Dolomite, 0-10%, dark grey to black, hard to brittle and silty.

Marl, 0-20%, light grey to buff, calcitic, soft and silty to argillaceous.

ROP: 2.25m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 17, 1979

Geological Samples Description

Depth: 2371m

Status: Drilling

Gas Readings: Ditch gas range: 58 - 68 units
Cuttings gas range: 8 - 10 units
Last trip gas: 2375 units @ 2361m

2357 - 2371 Shale, 50-70%, grey, firm to hard, blocky to subfissile, calcite and dolomite cement, silty with trace of pyrite.

Siltstone, 10-30%, grey to brown, firm, blocky to subfissile, calcareous cement, locally sandy.

Marl, 10%, brown, soft, silty and calcareous.

ROP: 1.27m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 13, 1979

Geological Samples Description

Depth: 2390m

Status: Drilling

Gas Readings: Ditch gas range: 40 - 70 units
Cuttings gas range: 6 - 7 units
Last trip gas: 1800 units @ 2376m
Last connection gas: 65 @ 2388m

2371 - 2390 Shale, 50-90%, grey to grey brown, firm to hard, blocky to subfissile, micromicaceous, with calcite and dolomite cement.

Siltstone, 10-50%, grey, firm to hard, blocky to subfissile, calcite and dolomite cement, locally sandy.

Marl, 0-10%, brown to grey, soft, argillaceous and silty, calcareous.

ROP: 1.46m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 20, 1979

Geological Samples Description

Depth: 2416m
Status: POOH

Gas Readings: Ditch gas range: 60/0 - 90/0 units
Cuttings gas range: 6/0 - 22/0 units
Last connection gas: 100/0 units at 2398m

2390 - 2416m Shale, 60-90%, grey to brown, blocky to sub fissile, firm to hard, calcite, dolomitic cement, micromicaceous, silty.

Siltstone, 10-40%, grey, blocky, firm to hard, argillaceous, calcite, dolomitic cement.

Pyrite, 0-10%, massive and occasionally disseminated and frequently nodular.

ROP: 1m/hr.

October 21, 1979

Depth: 2416m
Status: Circulating

Gas Readings: Last trip gas: 300/5 units at 2416m.

October 22, 1979

Depth: 2426m
Status: Drilling

Gas Readings: Ditch gas range 40/0 - 70/0 units
Cuttings gas range: 6/0 - 10/0 units

2416 - 2426m Shale, 70-80%, grey to brown, hard to soft, brittle, fissile to sub-fissile, non calcareous.

Siltstone, 10-20%, grey to grey-brown, firm to hard, blocky.

Pyrite, 10%, disseminated and massive, frquently crystalline.

ROP: 0.8m/hr.

COLUMBIA ET AL KOTANEELEE YT I-43

October 23, 1979

Geological Samples Description

Depth: 2429m
Status: Drilling

Gas Readings: Ditch gas range: 40 units (stable)
Cuttings gas range: 6 units (stable)
Last trip gas: 603 units at 2426m

2426 - 2429m Shale, 80%, grey to grey-brown, hard, occasionally firm, brittle, fissile to sub-fissile, very poorly to noncalcareous, very slightly dolomitic locally, with disseminated pyrite locally.

Siltstone, 10%, grey to grey-brown, firm to hard, blocky to brittle, sub-fissile, non to very poorly calcitic with disseminated pyrite locally.

Pyrite, 10%, mostly massive, large chunks frequently, angular, occasionally well developed crystals, frequently with black pyritized fossil fragments as inclusions, also disseminated micropyrite inclusions.

ROP: 1.42m/hr.

October 24, 1979

Depth: 2438m

Gas Readings: Ditch gas range: 40-70 units
Cuttings gas range: 5 - 8 units

2429 - 2438m Shale, 80%, grey, occasionally dark grey, firm, occasionally moderately soft, blocky to sub-fissile, occasionally fissile, noncalcareous with disseminated pyrite.

Siltstone, 15%, grey, firm, blocky, noncalcareous with pyrite.

Pyrite, 5%, massive and disseminated, frequently with black fossiliferous inclusions.

COLUMBIA ET AL KOTANEELEE YT I-48 October 25, 1979

Geological Samples Description Depth: 2443m

Gas Readings: Ditch gas range: 44 - 48 units
Cuttings gas range: 11 - 13 units
Last trip gas: 1644 units

2438 - 2443m Shale, 90-95%, medium to dark grey, firm, occasionally moderately hard, blocky to sub-fissile, occasionally fissile, noncalcareous with pyrite with calcite filled microfractures.

Siltstone, trace-10%, grey, firm, blocky, noncalcareous.

Pyrite, trace-5%, massive, occasionally disseminated, occasionally well rounded, occasionally tube-like with calcareous inclusions, occasionally with black fossiliferous inclusions.

ROP: 1.42m/hr.

October 26, 1979

Depth: 2450m
Status: Drilling

Gas Readings: Ditch gas range: 40-78 units
Cuttings gas range: 31-32 units
Last trip gas: 1856 units (at 2443m)

2443 - 2445m Shale, 90%, dark grey, hard to firm, blocky to sub-fissile, occasionally fissile, noncalcareous with pyrite disseminations and calcite filled microfractures.

Pyrite, 10%, massive and disseminated with ringed fossil inclusions, frequently with a calcite core.

Calcite, trace.

2445 - 2448m Shale, 70%, as above, becoming harder.

Limestone, 20%, white to off-white, occasionally light grey-brown, firm, blocky with numerous rounded inclusions, frequently concentric ringed (possibly oolitic).

Pyrite, 10%, generally as above, mostly massive, associated also with limestone concentric ringed structures.

ROP: 1m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

October 29, 1979

Geological Samples Description

Depth: 2491m
Status: Drilling

Gas Readings: Ditch gas range: 20 - 3200+ units total gas
3205 units petroleum vapors
-- 20 - 60 units up to 2468m.
-- sharp increase to 960 units (with 4 units petroleum vapors) at 2469m.

Cuttings gas range: 17 - 50 units

Last trip gas: 768 units (with 4 units petroleum vapors) at 2466m.

Connection gasses: 3200+ (with 3 units petroleum vapors) at 2476m.

3000 units (with 5 units petroleum vapors) at 2486m

2448 - 2491m Limestone, trace-40%, light grey, white, mottled black, hard to firm, blocky to angular, silty, mostly micritic, occasionally oolitic-like, becoming highly argillaceous with grey, silty laminations. Occasionally fossiliferous with brachiopod fragments, occasionally with pyrite di :minations.
(Only trace to good trace below 2463m)

Calcite, trace-10%, white, milky, rarely clear, frequently as vein fill.
(Steady 5% or more below 2469m)

Shale, 55-100%, light to dark grey, occasionally grey-brown, firm, becoming hard and brittle locally, rarely soft, sub-fissile, locally blocky, non to very slightly dolomitic.

Siltstone, trace-30%, dark grey, grey-brown, firm to hard, blocky, poorly calcareous, rarely moderately calcareous, locally slightly dolomitic.
Below 2478m: sandy siltstone, grey, occasionally white mottled, black speckles, hard to firm, crumbly, slightly calcareous.

Pyrite, trace-10%, disseminated and massive, frequently well crystalline.

ROP: 1.18m/hr. (average)
0.72 - 2.07m/hr. (range)

COLUMBIA ET AL KOTANEELEE YT I-48

October 31, 1979

Geological Samples Description

Depth: 2511m
Status: Drilling

Gas Readings: Ditch gas range: 11 - 4000 units.
Cuttings gas range: 11 - 39 units.

2491 - 2499m

Shale, 55-60%, medium to dark grey, firm, occasionally moderately soft, blocky to sub-fissile, occasionally silty and slightly calcareous with disseminated pyrite and calcite filled microveins.

Siltstone, 30-40%, grey to grey-brown, firm, blocky, slightly calcareous.

Calcite, trace-5%, white, occasionally crystalline.

2499 - 2508m

Shale, 80-90%, as above, with occasional pyrite filled veins.

Siltstone, 10%, dark grey, firm to moderately hard, occasionally brittle, blocky to sub-angular, moderately calcareous, moderately dolomitic.

Pyrite, trace-10%, massive and disseminated.

Calcite, trace.

2508 - 2511m

Shale, 100%, as above.

Siltstone, trace, as above.

Pyrite, trace.

Calcite, trace.

ROP: 1 m/hr. (average)

COLUMBIA ET AL KOTANEELEE YT I-48

November 1, 1979

Geological Samples Description

Depth: 2515m

Gas Readings: Ditch gas range: 11 - 592 units
Cuttings gas range: 11 - 19 units

2511 - 2515m Limestone, 40%, dark grey to grey-brown, firm to moderately hard, angular to blocky, microcrystalline, locally silty, very argillaceous, moderately to very dolomitic.

Dolomite, 30%, dark grey-brown, firm to hard, occasionally brittle, angular, microcrystalline, moderately calcareous, argillaceous, locally silty, occasionally grading to dolomitic siltstone.

Shale, 30% medium to dark grey, firm to moderately hard, blocky, associated with traces of calcite and pyrite.

Average ROP: 1.05m/hr.

November 2, 1979

Depth: 2535m

Gas Readings: Ditch gas range: 80 - 1,280 units
Cuttings gas range: 14 - 27 units

2515 - 2520m Shale, 60-65%, medium to dark grey, firm, occasionally moderately hard, blocky to sub-angular, non calcareous with occasional small calcite veins, occasionally silty.

Dolomite, 30-40%, grey to grey-brown, moderately hard, sub-angular, microcrystalline, argillaceous, occasionally slightly calcar ous, locally silty, no visible porosity.

Pyrite, trace-5%, massive and disseminated.

Calcite, trace, white to translucent, coarsely crystalline.

Sandstone, very poor trace.

2520 - 2532m Shale, 80-90%, generally as above, locally becoming silty.

Dolomite, 10-20%, generally as above, locally becoming more calcareous, occasionally grading to Limestone.

Limestone, off-white to light grey, argillaceous, dolomitic, locally silty.

Pyrite, trace.

Calcite, trace.

2532 - 2535m Shale, 90%, as above.

Pyrite, 5%.

Calcite, 5%.

Dolomite, trace.

Average ROP: 0.67m/hr.

November 5, 1979

Depth: 2577m

Gas Readings: Ditch gas range: 40-1440 units
Cuttings gas range: 11-22 units

2535 - 2544m Shale, 80-95%, dark grey to black, firm, sub-angular to blocky, non calcareous, associated with pyrite.

Dolomite, 5-15%, light brown to grey, moderately hard, sub-rounded to blocky, microcrystalline.

Limestone, trace-10%, light brown, soft to firm, microcrystalline, argillaceous.

Pyrite, trace-5%, massive and disseminated, locally with well rounded black inclusions.

Calcite, trace, white to translucent, coarsely crystalline.

2544 - 2553m Shale, 85-95%, as above.

Pyrite, 5-10%, as above.

Calcite, trace-5%, as above.

Dolomite, trace.

Limestone, trace.

2553 - 2571m Shale, 70-80%, medium to dark grey, firm, occasionally moderately soft, blocky, non calcareous, associated with pyrite and calcite.

Limestone, 15-30%, dark grey-brown, firm to moderately hard, occasionally friable, blocky, occasionally angular, argillaceous to very argillaceous, dolomitic in parts, microcrystalline, no visible porosity.

Pyrite, trace-10%, massive, abundant well rounded inclusions. (possibly fossil replacements).

Dolomite, trace.

Calcite, trace.

2571 - 2577m Shale, 90-100%, generally as above, becoming more fissile and splintery.

Dolomite, trace-5%.

Limestrone, trace-5%.

Average ROP: 0.62m/hr.

Note: Samples are fairly poor over this interval due to the hole cleaning badly and abundant shale cavings.

November 6, 1979

Depth: 2601m

Gas readings: Ditch gas range: 6 - 960 units
Cuttings gas range: 6 - 16 units.

2577 - 2583m Shale, 100%, medium to dark grey, firm, occasionally moderately soft, blocky, associated with pyrite and calcite. Traces of pyrite, calcite, dolomite and limestone.

2583 - 2592m Limestone, 70-80%, medium to dark grey to light brown, moderately hard, blocky to sub-angular, microcrystalline, occasionally dolomitic, occasionally argillaceous, with traces of pyrite.

Shale, 20-30%, grey to dark grey, firm, occasionally moderately soft, massive to fissile, associated with pyrite and calcite, possibly fossile replacement. Traces of calcite and dolomite and good traces of pyrite. Pyrite occurred in minute balls and massive aggregates.

2592 - 2601m Limestone, 55-65%, medium grey-brown to off-white, firm to moderately hard, occasionally argillaceous, blocky to sub-angular, microcrystalline and very dolomitic.

Shale, 35-45%, medium grey to dark grey, firm, occasionally soft, fissile, associated with pyrite. Good traces of dolomite, pyrite, calcite and marl. Marl is grey-brown, argillaceous, silty, calcareous.

Average ROP: 0.67m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 November 7, 1979

Geological Samples Description Depth: 2610m

Gas Readings: Ditch gas range: 6 - 38 units
Cuttings gas range: 6 - 12 units

2601 - 2604m Limestone, 55%, light grey-brown to off-white, firm to moderately hard, argillaceous in part, blocky to sub-angular, microcrystalline, occasionally dolomitic.

Shale, 45%, grey to dark grey, firm, occasionally soft, fissile, associated with pyrite.

Good traces of dolomite, traces of pyrite, calcite and marl.

2604 - 2607m Shale, 55%, as above.

Limestone, 45%, as above.

Traces of marl and pyrite, and poor trace of calcite.

2607 - 2610m Shale, 60%, light grey to grey-brown, firm to moderately hard, blocky to sub-angular, occasionally associated with pyrite.

Limestone, 20%, grey to grey-brown, mottled, firm to hard, sub-angular, microcrystalline.

Dolomite, 10%, grey to grey-brown, sub-rounded to blocky, micro-crystalline.

Marl, 10%, light grey to brown, very argillaceous, silty, calcareous.

Pyrite, trace.

Average ROP: 0.82m/hr. (9m in 24 hrs. due to reaming).

COLUMBIA ET AL KOTANEELEE YT I-48

November 16, 1979

Geological Samples Description

Depth: 2630m

Status: Drilling

Gas Readings: Ditch gas range: 64 - 500 units
Cuttings gas range: 7 - 26 units
Trip gas: 3,200 units (1 unit P.V.) at 2610m
2,800 units (2 units P.V.) at 2618m
Pick up gas: 268 units at 2629.5m

2610 - 2630m Shale, 60-90%, grey, occasionally grey-brown, rarely black, firm, occasionally hard, blocky, rarely sub-fissile, silty, slightly calcareous in part, rarely dolomitic with pyrite disseminated in part. Many caving from above.

Siltstone, 10-40%, light grey to grey, rarely light brown, frequently black speckled, hard to firm, blocky, rarely brittle, occassionally moderately calcareous with trace of calcite, locally grading to a sandy siltstone.

Sandy Siltstone: description as for siltstone above. 0% to good trace.

Pyrite, poor trace to trace, mostly massive and frequently vein material, with frequent framboidal sections, replacing coal, with calcite circle centers, to generally disseminated throughout the shale section with increasing depth.

Calcite, 0% to trace, mostly milky crystals or vein material.

2610 - 2625m

Limestone, very poor trace to trace, grey-brown, white-brown, grey, highly argillaceous, sub-fissile.

Dolomite, very poor trace to trace, grey to black, rarely grey-brown, very argillaceous, frequently silty.

Average ROP: 0.85m/hr.
Formation becoming softer.

COLUMBIA ET AL KOTANEELEE YT I-48

November 17, 1979

Geological Samples Description

Depth: 2653m

Status: Drilling

Gas Readings: Ditch gas range: 7 - 165 units.
Cuttings gas range: 5 - 12 units.

Connection gas: 40 units at 2631m
232 units at 2640m

Trip gas: 2750 units at 2651m

2630 - 2653 Marl, trace-70%, light brown-grey, rarely grey-yellow, soft, frequently firm, silty, slightly dolomitic, grading to siltstone. Marl is probably ground siltstone.

Siltstone, trace-55%, light grey to grey, often yellow-grey, rarely white-brown, frequently speckled, firm to hard, blocky, locally sandy, slightly calcareous, grading to sandy siltstone.

Sand Siltstone, 0-10%, yellow, yellow-grey, black speckled, firm, crumbly, blocky, noncalcareous.

Shale, 0-100%, grey to grey-brown, firm to hard, blocky, rarely sub-fissile, noncalcareous; much of the shale in the samples is undoubtedly cavings.

Calcite, 0-good trace.
Pyrite, 0-trace.

Average ROP: 0.72m/hr.

November 18, 1979

Depth: 2669m

Status: Drilling

Gas Readings: Ditch gas range: 80 - 1600 units
Cuttings gas range: 12 - 21 units
Pickup gasses: 1600 units (with trace petroleum vapors) at 2657m
3200 units (with trace petroleum vapors) at 2658m
3200+ units (with trace petroleum vapors) at 2659m
Trip gas: 3200 units at 2660m

2653 - 2669m Marl, trace-60%, as above.
Siltstone, 30-60%, as above, becoming more hard locally.
Shale, 10-60%, light to medium grey, soft to moderately firm, occasionally firm, blocky to sub-fissile, occasionally fissile, silty in parts.
Siltstone, trace-10%, as above, becoming harder locally.
Pyrite, 0%-trace locally.
Calcite, 0%-trace locally.

Average ROP: 0.67m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

November 19, 1979

Geological Samples Description

Depth: 2701m

Status: Drilling

Gas Readings: Ditch gas range: 16 - 160 units
Cuttings gas range: 3 - 9 units
Connection gasses: 960 units (trace petroleum vapors) at 2669m
20 units at 2695m

2669 - 2701m Marl, 10-30%, as above, becoming lighter and more sticky locally. (only up to 2685m).

Siltstone, 20-40%, very light to medium grey, very soft to firm, blocky, becoming sub-fissile, locally very argillaceous, noncalcareous occasionally slightly dolomitic, grading to shale.

Shale, 30-80%, grey, becoming lighter with increasing depth, soft to firm, sub-fissile to fissile, occasionally blocky, locally silty, very slightly dolomitic.

Pyrite, very poor trace to poor trace (absent after 2679m).

Calcite, very poor trace to very good trace locally.

Limestone, poor trace, very light grey to grey, spotted black, firm, crumbly, silty, occasionally sandy, detrital, with clasts of siltstone and shale (2673 - 2679m only).

Average ROP: 0.66m/hr.

November 20, 1979

Depth: 2721m

Status: Drilling

Gas Readings:
Ditch gas range: 49 - 240 units
Cuttings gas range: 3 - 9 units

2701 - 2709m Shale, 30-50%, light grey, occasionally medium grey, soft to firm, sub-fissile to fissile, occasionally blocky, very slightly dolomitic, occasionally silty.

Siltstone, 40-50%, light to medium grey, occasionally dark grey, moderately soft to firm, blocky to sub-fissile, predominately noncalcareous, occasionally slightly calcareous and dolomitic, grading to shale.

Marl, 10-20%, light grey, soft, silty.

Cont'd ..... /2

2709 - 2715m Shale, 30-40%, light to medium grey, moderately soft to firm, blocky, sub-fissile, locally fissile, slightly micro-micaceous, locally silty.

Siltstone, 60-70%, medium to dark grey, firm to moderately hard, occasionally moderately soft, blocky, occasionally sub-fissile.

Marl, trace, as above.

2715 - 2721m Shale, 70-90%, generally as above, becoming more calcareous and dolomitic.

Siltstone, 10-30%, generally as above, becoming slightly more calcareous.

Average ROP: 0.67m/hr.

November 21, 1979

Depth: 2754m

Status: Drilling

Gas Readings: Ditch gas range: 12 - 105 units
Cuttings gas range: 1 - 7 units

2721 - 2733m Shale, 80-90%, light grey, soft, occasionally firm, blocky to sub-fissile, locally slightly calcareous, slightly dolomitic, silty in parts, locally grading to claystone.

Siltstone, 10-20%, medium grey, occasionally dark grey, moderately soft to firm, blocky, non to slightly calcareous, grading to shale in parts.

2733 - 2754m Shale, 100%, generally as above, grading to claystone in parts.

Siltstone, trace, as above.

Pyrite, occasional trace.

Average ROP: 0.67m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

November 22, 1979

Depth: 2772m

Gas Readings: Ditch gas range: 4 - 320 units
Cuttings gas range: 1 - 3 units

2754 - 2757m Shale, 100%, light grey, soft, occasionally firm, sub-fissile to fissile, silty, occasionally slightly calcareous.

Calcite, trace.

Siltstone, trace.

2757 - 2769m Shale, 90-95%, as above.

Claystone, 5-10%, light grey to buff, soft to very soft, soluble, occasionally silty.

2769 - 2772m Shale, 100%, generally as above, becoming firmer in parts.

Average ROP: 0.62m/hr.

November 23, 1979

Gas Readings: Ditch gas range: 35 - 150 units
Cuttings gas range: 1 - 4 units

2772 - 2805m Shale, 100%, light grey, occasionally medium grey, moderately sot to firm, sub-fissile to fissile, non calcareous, locally grading to claystone, occasionally silty.
Also, good trace, darkbrown to grey, firm, blocky to sub-fissile, silty, occasionally slightly calcareous.

Claystone, trace, light grey to buff, soft to very soft, silty.

Average ROP: 0.63m/hr.

Depth: 2805m

COLUMBIA ET AL KOTANEELEE YT I-48 November 26, 1979

Geological Samples Description Depth: 2868m

Gas Readings: Ditch gas range: 52 - 700 units
Cuttings gas range: 2 - 9 units

2805 - 2814m Shale, 100%, predominately light grey, occasionally medium grey, moderately soft to firm, blocky, sub-fissile, non calcareous, occasionally slightly calcareous.

Siltstone, trace, light grey, firm, blocky, occasionally slightly calcareous.

2814 - 2823m Shale, 90-95%, as above.

Claystone, 5-10%, buff to light grey, very soft to soft, occasionally silty.

2823 - 2829m Shale, 100%, as above.

2829 - 2835m Shale, 90%, light to medium grey, occasionally dark grey, moderately soft to firm, blocky to sub-fissile, locally becoming fissile, predominately non calcareous, locally becoming silty and slightly calcareous.

Siltstone, 10%, medium to dark grey, occasionally black, firm, occasionally moderately soft, blocky, non to slightly calcareous, grading to silty shale in parts.

Limestone, poor trace, dark brown, firm to hard, blocky, silty, dolomitic.

2835 - 2850m Shale, 80-85%, generally as above, occasionally becoming more silty.

Siltstone, 15-20%, generally as above, becoming more calcareous in parts.

2850 - 2865m Shale, 70-80%, generally as above with frequent thin black laminations, possibly carbonaceous.

Siltstone, 20-30%, as above.

2865 - 2868m Shale, 90%, light to medium grey, firm, occasionally moderately sot, blocky to sub-fissile, frequently with thin black laminations, occasionally with small quartz veins, rarely with veins filled with a light green mineral, predominately non calcareous.

Siltstone, 10%, as above.

Average ROP: 0.67m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 November 27, 1979

Geological Samples Description Depth: 2895m

Gas Readings: Ditch gas range: 40 - 80 units
Cuttings gas range: 1 - 3 units

2868 - 2873m Shale, 90%, light to medium grey, firm, occasionally moderately soft, blocky to sub-fissile, frequently with thin black streaks, occasionally with quartz veins, rarely with veins filled with a light green colored mineral and some quartz, non calcareous.

Siltstone, 10%, medium to dark grey, occasionally light brown, firm to moderately soft, blocky, slightly calcareous.

2873 - 2895m Shale, 100%, light to medium grey, moderately soft to firm, blocky to sub-fissile, becoming more fissile, mineralization still present, possibly being chlorite.

Average ROP: 0.65m/hr.

Samples contain abundant cavings.

November 28, 1979

Depth: 2924m

Gas Readings: Ditch gas range: 60 - 80 units.
Cuttings gas range: 1 - 4 units.

2895 - 2904m Shale, 100%, light to medium grey, firm, blocky, sub-fissile, occasionally fissile, silty in parts, non calcareous. Occasional traces of mineralization.

Pyrite, trace.
Siltstone, trace.

2904 - 2912m Shale, 90%, generally as above, becoming slightly lighter and occasionally brown-grey.

Siltstone, 10%, medium grey to grey-brown, moderately soft, blocky, calcareous.

2912 - 2918m Shale, 90%, generally as above.

Claystone, 10%, light grey, very soft to soft, occasionally silty, non-fissile, non calcareous

2918 - 2920m Shale, 80%, as above.
Claystone, 20%, as above.

2920 - 2924m Shale, 70%, generally as above.
Claystone, 30%, generally as above.
Dolomite, poor trace, black, hard, brittle, microcrystalline.

Average ROP: 0.62m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48 November 29, 1979

Geological Samples Description Depth: 2940m

Gas Readings: Ditch gas range: 74 - 672 units
Cuttings gas range: 3 - 4 units

2924 - 2931m Shale, 80%, light to medium grey, firm to moderately hard, sub-fissile, occasionally fissile, silty in parts, associated with quartz veins.

Claystone, 20%, light grey to buff, soft, silty, non calcareous.

2931 - 2940m Shale, 90%, generally as above, with thin, black bands running through the shale.

Claystone, 10%, generally as above.

Average ROP: 0.7m/hr.

November 30, 1979

Depth: 2964m

Gas Readings: Ditch gas range: 52 - 144 units
Cuttings gas range: 1 - 3 units

2940 - 2945m Shale, 80%, light to medium grey, firm, occasionally hard, blocky to sub-angular, sub-fissile, occasionally fissile, non calcareous.

Claystone, 10%, light grey to buff, very soft to soft, silty, non calcareous.

Siltstone, 10%, grey to grey-black, hard to firm, blocky and slightly calcareous.

2945 - 2958m Shale, 90%, generally as above, with traces of green mineral (possibly being chrisolite), and traces of white calcite veins and clear quartz.

Claystone, 10%, as above.

Pyrite, trace.
Dolomite, trace.

2958 - 2961m Shale, 100%, light grey to grey, rarely black, hard, becoming softer, sub-fissile to fissile, occassionally silty, non calcareous and grading to claystone.

Claystone, trace.
Quartz, trace.

2961 - 2964m Shale, 90%, generally as above. Traces of pyrite and quartz, both found in veins associated with the shale. Some quartz found separately as round crystals.

Claystone, 10%.

December 3, 1979

Gas Readings: Ditch gas range: 64 - 1440 units
Cuttings gas range: 1 - 5 units

2964 - 2978m Shale, 90%, light grey to grey, occasionally dark, hard, sub-fissile, occasionally fissile, blocky, associated with tiny pyrite veins and quartz veins.

Claystone, 10%, light grey, firm to soft, blocky, non calcareous.

Dolomite, trace.

Quartz, trace, appears separately as small, round to sub-angular grains and in veins associated with the shale.

2978 - 2981m Shale, 80%, generally as above.

Claystone, 20%, generally as above, light grey, blocky, soft, slightly calcareous. Very poor trace of fluorescence, possibly due to contamination.

Calcite, poor trace.

Quartz, poor trace.

2981 - 2984m Shale, 90%, generally as above, becoming more porous and coarser grained.

Claystone, 10%, generally as above, becoming slightly calcareous.

Calcite, trace.

Quartz, trace.

2984 - 2990m Shale, 100%, generally as above.
Claystone, trace, generally as above.
Calcite, trace, generally as above.
Quartz, trace, generally as above.

2990 - 2996m Shale, 90%, medium grey, firm, becoming harder and coarser grained, occasionally soft, blocky, with trace veins of green mineral.

Claystone, 10%, generally as above.

Dolomite, trace.
Quartz, poor trace.
Sand, trace.

2996 - 2999m Shale, 80%, generally as above.

Claystone, 15%, generally as above.

Limestone, 5%, off-white to brown, firm to moderately hard, microcrystalline, blocky, very calcareous.

Pyrite, poor trace.

29999 - 3002m Shale, 95%, as above.
Claystone, 5%, as above.
Dolomite, good trace, white, milky, crystalline, vein fill.

3002 - 3011m Shale, 100%, generally as above.
Pyrite, poor trace, generally as above.
Dolomite, trace, generally as above.

3011 - 3030m Shale, 95%, generally as above, associated with a poor trace of a green mineral vein.

Claystone, 5%.
Quartz, good trace.
Dolomite, trace.
Pyrite, very poor trace.

Average ROP: 0.92m/hr.

December 4, 1979

Depth: 3064m

Gas Readings: Ditch gas range: 68 - 200 units
Cuttings gas range: 2 - 3 units
Connection gasses: 280 units at 3035m
288 units at 3044m
730 units at 3053.5m
90 units at 3063m

3030 - 3064m Shale, 80-95%, grey to light grey, occasionally dark grey, firm to hard, rarely soft to firm, sub-fissile to fissile, rarely blocky, mostly noncalcareous, rarely slightly calcareous, occasionally slightly dolomitic.

Claystone, 5-20%, light grey, soft, silty, noncalcareous, grading to Marl below 3060m.
Marl, 10%, light grey to brown, soft, sticky, amorphous, argillaceous, rarely silty, highly calcareous, grading to claystone.

Quartz, very poor trace, clear, rarely milking, crystalline.

Dolomite, trace, white, milky, vein fill, frequently associated with the green asbestos-like mineral, possibly chrisolite.

Calcite, poor trace to trace, white, vein fill.

Pyrite, very poor trace, disseminated throughout the shale.

ROP: 0.7m/hr.

COLUMBIA ET AL KOTANEELEE YT I-48

December 5, 1979

Geological Samples Description

Depth: 3080m
Status: Drilling

Gas Readings: Ditch gas range: 52 - 400 units
Cuttings gas range: 2 - 4 units
Last trip gas: 2880 units at 3075m

Average ROP: 0.63m/hr.

3064 - 3080m

Shale, 90-100%, grey to light grey, frequently black, firm to hard, brittle, fissile to sub-fissile, locally very slightly calcareous, slightly dolomitic.

Marl, 0-30%, light grey-brown, soft, sticky, amorphous, argillaceous, rarely silty, highly calcareous.

Quartz, very poor trace, clear, crystalline (absent below 3069m).

Dolomite, trace, white, crystalline, probably vein fill, (absent below 3069m).

December 6, 1979

Depth: 3104m

Gas Readings: Ditch gas range: 104 - 410 units
Cuttings gas range: 1 - 15 units
Connection gasses: 150 units at 3082m
190 units at 3090m
500 units at 3101m

Average ROP: 0.55m/hr.

3080 - 3104m

Shale, 90-100%, dark grey to black, locally light grey, locally hard, becoming firm to moderately soft, occasionally brittle, fissile, locally sub-fissile, becoming blocky occasionally, frequently silty, non becoming slightly calcareous, slightly dolomitic becoming slightly to moderately dolomitic with a trace of disseminated pyrite locally.

Siltstone, trace to good trace, dark grey-black, speckled, moderately soft, blocky, slightly to moderately calcareous. (Up to 3090m and from 3099 - 3102m).

Marl, 10%, dark grey-brown, soft, silty, moderately calcareous. (3088 - 3090m and 3103 - 3105m).

COLUMBIA ET AL KOTANEELEE YT I-48

December 7, 1979

Geological Samples Description

Depth: 3141m

Status: Drilling

Gas Readings: Ditch gas range: 104 - 1248 units
Cuttings gas range: 1 - 8 units
Connection gasses: 3200 units at 3110m (with trace petroleum vapors).
1456 units at 3119m
480 units at 3129m
2550 units at 3138m

Average ROP: 0.78m/hr.

3104 - 3141m

Shale, 50-80%, black to light grey, soft to firm becoming firm to hard, blocky becoming sub-fissile to fissile, locally silty, slightly to moderately calcareous in places, mostly poorly or non calcareous, locally slightly dolomitic, grading to siltstone in part.

Siltstone, trace - 30%, light grey, locally dark grey, rarely black speckled, firm to hard, locally soft, blocky, sandy, moderately calcareous, locally slightly dolomitic becoming sandy siltstone, locally sub-angular to sub-rounded, rarely fine, sand.

Marl, trace - 20% throughout, grading to dark brown, soft, locally sticky, locally very silty, moderately to highly calcareous, grading in part (below 3126m) to limestone.

Limestone, trace - 40% below 3126m. Brown to dark grey, white to grey locally, soft to firm, rarely firm to hard, argillaceous to very argillaceous locally, silty grading to marl.

Pyrite, very poor trace to poor trace locally, disseminated in the shale.

December 10, 1979

Depth: 3202m
Status: Drilling

Gas Readings: Ditch gas range: 104 - 3200 units
Cuttings gas range: 1 - 25 units
Connection gasses: 2304 units at 3148m
3000 units at 3157m
3200+ units at 3176m
well over 3200+ units at 3186m (with 1 unit petroleum vapors).
2010 units at 3195m
Last trip gas: 2560 units at 3163m

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Average ROP: 0.83m/hr.

3141 - 3202m

Shale, 40-50% (up to 3150m), light grey, firm to hard, fissile to sub-fissile, very poorly calcareous, possibly grading to siltstone below 3150m.
Below 3150m: 60-100%, light grey to black, occasionally grey to light grey, firm to hard, locally soft to firm, blocky to sub-fissile, occasionally fissile, noncalcareous, locally dolomitic.

Siltstone, trace - 30%, light grey, soft to firm, blocky, noncalcareous, locally slightly dolomitic, rarely calcareous.

Sandy siltstone, 3141 - 3150: good trace.
3180 - 3189: 10%.
Black to dark grey, firm to hard, crumbly, very fine, sub-angular to sub-rounded sand, very slightly dolomitic.

Marl, 3141 - 3174: 10-30%, grey to brown, soft, occasionally sticky, silty, moderately to highly calcareous.

Limestone, 3141 - 3167: trace - 20%, off-white to light grey, becoming grey to grey-white, locally brown to light brown, soft to firm, becoming firm to hard, blocky, crumbly, silty, sandy, locally argillaceous.

Dolomite, 3174 - 3195: very poor trace to 10%, white, milky, occasionally clear, becoming locally mottled grey with silty impurities, mostly vein-fill, frequently associated with parallel veins of pyrite, becoming locally crumbly.

Pyrite, disseminated throughout the shale, rarely nodular, frequently in veins, often running parallel to dolomite veins.

COLUMBIA ET AL KOTANEELEE YT I-48

December 11, 1979

Geological Samples Description

Depth: 3217m
Status: Drilling

Gas Readings: Ditch gas range: 88 - 280 units
Cuttings gas range: 4 - 14 units
Trip gas: 3,200 units at 3205m
Connection gas: 480 units at 3204m
2,240 units at 3214m

Average ROP: 1m/hr.

3202 - 3217m Shale, 100%, predominately dark grey to black, locally grey to light grey, soft to firm frequently hard, blocky to sub-fissile, frequently silty, frequently dolomitic with small white inclusions of microcrystalline dolomite and occasional trace of disseminated pyrite.

Siltstone, trace to good trace.

Dolomite, trace to good trace.

December 12, 1979

Depth: 3256m
Status: Drilling

Gas Readings: Ditch gas range: 100 - 800 units
Cuttings gas range: 4 - 7 units
Connection gasses: 3200 units at 3223m
3200 units at 3233m
1050 units at 3242m
3200 units at 3255m (with 1 unit petrolum vapors.

Average ROP: 0.55m/hr.

3217 - 3256m Shale, 100% (80% below 3252m). Dark grey, black, dark grey-black, occasionally grey to light grey, firm becoming hard to very hard below 3243m, slightly to very silty becoming silty locally, with small, white inclusions of crystalline dolomite locally, locally a very poor trace of disseminated pyrite.

Siltstone, 20% below 3252m. Dark grey, black speckled, hard, brittle, slightly dolomitic, grading to a silty shale portion.

COLUMBIA ET AL KOTANEELEE YT I-48 December 13, 1979

Geolgocal Samples Description Depth: 3270m

Gas Readings: Ditch gas range: 200 - 752 units
Cuttings gas range: 6 - 8 units
Connection gasses: 3200 units at 3262m

Average ROP: 0.58m/hr.

3256 - 3270m Shale, 80-90%, dark grey, black, dark brown-black, occasionally medium to light grey, hard occasionally very hard, brittle, silty to very silty, rarely with small white inclusions of dolomite, grading to siltstone.

Siltstone, 10-20%, dark grey, black speckled, hard, brittle, slightly dolomitic, occasionally grading to shale.

COLUMBIA ET AL KOTANEELEE YT I-48 Date: December 23 - 27, 1979

Geological Samples Description

Gas Readings: Ditch gas range: 3270 - 3300m, 40 - 104 units
3330 - 3333m, 20 - 48 units
3333 - 3348m, 5 - 10 units

Cuttings gas range: 3270 - 3276m, 14 - 18 units
3276 - 3330m, 32 - 68 units
3330 - 3348m, 4 - 18 units

December 23, Depth: 3271m
December 24, Depth: 3298m

3270 - 3294m Shale, 100%, dark grey, firm to hard, blocky to sub-fissile, slightly calcareous and dolomitic, occasional calcite veins.

December 25, Depth: 3324m

3294 - 3309m Shale, 80 - 90%, dark grey to dark grey brown, hard, occasionally very hard, blocky to sub-fissile, silty to very silty, slightly to moderately calcareous, grading to siltstone.

Siltstone, 10 - 20%, dark grey, mottled, firm to hard, blocky, moderately to very calcareous and moderately to very dolomitic.

3309 - 3312m Shale, 70%, as above.

Siltstone, 30%, generally as above becoming very dolomitic with numerous small, white crystalline inclusions of dolomite.

December 26, Depth: 3331m

3312 - 3333m Shale, 100%, dark grey, hard, occasionally very hard, blocky to sub-fissile, occasionally silty, non to slightly calcareous and dolomitic with a good trace of pyrite and a trace of siltone.

December 27, Depth: 3348m

3333 - 3339m Dolomite, 40 - 50%, very light grey to medium grey, occasionally off-white, mottled, moderately soft to firm, occasionally moderately hard, occasionally friable, sucrosic texture, blocky, coarsely crystalline, argillaceous to very argillaceous, locally silty with frequent inclusions of massive and disseminated pyrite.

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COLUMBIA ET AL KOTANEELEE YT I-48 - Dec. 23 - 27/79 - continued

3333 - 3339m - continued

December 27, Depth 3348m

Shale, 35 - 40%, as above.

Claystone, 10 - 20%, medium brown, moderately soft, occasionally firm and occasionally calcareous and grading to Marl.

Pyrite, trace to 5%, massive and disseminated, frequently with good crystalline form.

3339 - 3342m Siltstone, 50%, medium brown, soft, rounded, grading to claystone.

Dolomite, 10%, as above.

Shale, 25%, as above

Claystone, 15%, as above with a trace of pyrite.

3342 - 3345m Shale, 50%, as above.

Claystone, 25%, as above.

Dolomite, 20%, as above.

Pyrite, 5%.

3345 - 3348m Claystone, 40%, light grey, occasionally medium grey, soft, globular, silty, occasionally becoming firm and grading to shale.

Shale, 50%, light to medium grey, moderately soft to firm, blocky to sub-fissile, occasionally silty.

Pyrite, 10%, massive and disseminated associated with shale, dolomite and siltstone.

Siltstone, trace, light to medium grey, occasionally dark grey, firm, grading to shale.

Dolomite, trace, as above.

COLUMBIA ET AL KOTNAEELEE YT I-48

Date: December 28, 1979

Depth: 3363m

GEOLOGICAL SAMPLES DESCRIPTION

Gas Readings: Drilling rate range: 67 to 92 minutes per meter
Average: 77 minutes per meter

Ditch gas range: 5 units to 8 units

Blender range: 1 unit to 4 units

Average ROP: 0.78m/hr.

3348 - 3350m Shale, 50%, light to medium grey, moderately soft to firm, blocky to sub-fissile, occasionally silty.

Claystone, 40%, light grey, occasionally medium grey, soft, globular, silty, occasionally becoming firm grading to shale

Pyrite, 10%, massive to disseminated associated with shale and dolomite.

Dolomite and siltstone, good trace of each.

3350 - 3359m Shale, 40%, as above.

Dolomite, 20%, as above.

Claystone, 35%, as above.

Siltstone, good trace, dark grey to black, very hard, blocky and noncalcareous.

3359 - 3363m Shale, 75%, dark grey to black, firm, blocky to sub-fissile, very silty, occasionally calcitic and dolomitic.

Dolomite, 15%, white to off-white, very soft to firm with a pitted texture.

Siltstone, 5%, dark grey to black, very hard, blocky, noncalcareous being occasionally calcareous with calcite veins present.

Claystone, 5%, as above.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: December 31, 1979
Depth: 3438m

Geological Samples Description

Gas Readings: Drilling rate range: 20 to 71 minutes per meter
Average: 38 minutes per meter

Ditch gas range: 7 units to 72 units with petroleum vapors showing 3 units at 3436m

Cuttings gas range: 2 units to 11 units

Average ROP: 1.58m/hr.

3363 - 3378m Shale, 75%, medium to dark grey, soft to firm, blocky to sub-fissile, very silty, occasionally calcitic and dolomitic.

Dolomite, 15%, white to off-white, very light grey, soft to moderately soft, crumbly, sucrosic to pitted texture.

Claystone, 10%, light grey to grey to dark grey, soft, occasionally hard, blocky, noncalcareous, occasionally calcareous, calcite veins present.

Trace of siltstone and trace of calcite.

3378 - 3384mm Shale, 80%, generally as above, with shale becoming very silty.

Dolomite, 10%, generally as above.

Good trace of siltstone.

3384m - 3993m Shale, 95%, generally as above.

Siltstone, 5%, light to medium grey, firm, occasionally very soft, blocky, grading to shale.

Trace of calcite and trace of pyrite.

3393 - 3432m Shale, 100%, generally as above, becoming harder.

Trace of dolomite, trace of siltstone, trace of pyrite and trace of calcite.

3432 - 3438m Shale, 90%, becoming more brittle.

Dolomite, 10%, medium grey, off-white, firm, occasionally soft, blocky and microcrystalline.

Trace of calcite and trace of pyrite.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 2, 1980

Depth: 3484m

Geological Samples Description

Gas Readings: Drilling rate range: 12 to 77 minutes per meter
Average: 37 minutes per meter

Ditch gas range: 20 to 176 units with petroleum vapors showing 2 units at 3441m

Average ROP: 1.62m/hr.

3438 - 3447m Shale, 90%, medium to dark grey, firm, brittle, blocky, occasionally sub-fissile, occasionally silty, noncalcareous.

Dolomite, 10%, medium grey, off-white, firm, occasionally soft, blocky, microcrystalline, occasionally white, dolomitic crystals occur.

Traces of claystone, calcite and pyrite.

3447 - 3471m Shale, 100%, as above, becoming moderately hard, occasionally very hard, silty, occasionally dolomitic.

Traces of dolomite, calcite and siltstone.

3471 - 3484m Shale, 85%, medium grey, occasionally dark grey (80% hard, 20% firm), occasionally soft, blocky, occasionally sub-fissile, silty, associated with calcite and pyrite.

Dolomite, 15%, as above.

Traces of calcite and pyrite.

(Please note that interval of very hard compacted [illegible]le was observed from 3458m to 3465m)

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 3, 1980

Depth: 3516m

Geological Samples Description

Gas Readings: Drilling rate range: 22 to 57 minutes per meter
Average: 39 minutes per meter

Ditch gas range: 6 to 38 units

Cuttings gas range: 4 to 6 units

Average ROP: 1.54m/hr.

3484 - 3486m Shale, 50%, medium grey, firm to occasionally moderately hard, blocky, sub-fissile, silty, calcareous and dolomitic.

Dolomite, 50%, grey to whitish grey, hard, occasionally soft, blocky and microcrystalline.

Traces of siltstone, pyrite and calcite.

3486 - 3489m Shale, 25%, light to medium grey, grading to siltstone, occasionally calcareous.

Dolomite, 75%, generally as above.

Trace of pyrite.

3489 - 3492m Shale, 20%, generally as above.

Dolomite, 60%, generally as above.

Siltstone, 20%, light grey, firm to moderately hard, fissile, occasionally blocky, noncalcareous.

Trace of calcite and pyrite.

3492 - 3498m Dolomite, 70%, generally as above.

Siltstone, 30%, generally as above.

3498 - 3504m Dolomite, 80%, medium grey to off-white, speckled, firm to moderately hard, blocky, grading to limestone and microcrystalline.

Siltstone, 20%, light grey to light brown grey, firm, brittle, silty and noncalcareous.

Good trace of shale.

Trace of limestone.

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COLUMBIA ET AL KOTANEELEE YT I-48 - January 3, 1980 - continued

3504 - 3507m Shale, 5%, generally as above.

Dolomite, 80%, generally as above.

Siltstone, 15%, generally as above.

3507 - 3510m Shale, 5%, generally as above.

Dolomite, 75%, generally as above.

Siltstone, 20%, generally as above.

Trace of pyrite.

3510 - 3513m Shale, 20%, becoming more fissile.

Dolomite, 60%, generally as above.

Siltstone, 20%, generally as above.

3513 - 3516m Shale, 40%, light grey, firm, becoming softer, fissile, noncalcareous.

Dolomite, 50%, medium to dark grey, occasionally black, blocky, firm to moderately hard.

Siltstone, 10%, light grey, brown, firm but soft, silty and noncalcareous.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 7, 1980

Depth: 3627m

Drilling rate range: 9 - 80 minutes per meter

Average ROP:
3534-3569 - 2.0m/hr.
3569-3601 - 2.73m/hr.
3601-3607 - .95m/hr.
3607-3617 - 3.33m/hr.
3617-3620 - 6m/hr.
3620-3627 - 1.5m/hr.

Gas Readings:

Ditch gas range: 5 units to 26 units

Cuttings gas range: 2 units to 9 units

Geological Samples Description

3534 - 3564m Shale, 80 - 90%, light to medium grey, occasionally dark grey, moderately soft to firm, blocky, occasionally sub-fissile, occasionally very lightly dolomitic, locally silty.

Dolomite, 10 - 20%, dark grey to black, mottled, with white dolomite crystals, firm to hard, blocky with occasional trace of pyrite, also some dolomite was white, soft to very soft, amorphous.

3564 - 3591m Shale, 95%, dark grey, occasionally medium grey, moderately hard, occasionally moderately soft to firm, blocky to sub-fissile, locally becoming fissile, occasionally associated with calcite veins with a trace of pyrite.

Dolomite, 5%, as above.

3591 - 3603m Shale, 100%, dark grey to grey black, moderately hard to hard, blocky to sub-fissile, locally fissile, noncalcareous, occasionally slightly silty.

Trace of pyrite.

3603 - 3606m Shale, 100%, predominantly as above, also light grey, occasionally medium grey, moderately soft to firm, blocky to sub-fissile, non to slightly dolomitic, with occasional small, black, carbonaceous streak.

Good trace of massive and disseminated pyrite.

3606 - 3615m Shale, 100%, dark grey to grey black, hard, occasionally firm to moderately hard, blocky to sub-fissile, occasionally fissile, micromicaceous, non to very slightly dolomitic, with occasional trace of white dolomite crystalline inclusions associated with a good trace of pyrite.

3615 - 3624m Shale, 85 - 95%, as above.

Dolomite, 5 - 15%, light grey to white, moderately soft, medium crystalline to microcrystalline, associated with pyrite.

3624 - 3627m Shale, 100%, as above.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 10, 1980

Depth: 3647m

Drilling rate range: 10 - 40 minutes per meter
Average: 24 minutes per meter
Average ROP: 2.5m/hr.

Ditch gas range: 18 - 30 units
Cuttings gas range: 3 - 6 units

Geological Samples Description

3627 - 3647m Shale, 100%, dark grey to black, firm to hard, blocky to sub-fissile, slightly to moderately micromicaceous, slightly dolomitic, silty in parts.

Trace of pyrite.

Slight trace to 2 or 3% dolomite, light to medium grey, blocky, hard, occasionally moderately soft, argillaceous.

Trace of pyrite and trace of calcite.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 14, 1980

Depth: 3665m

Drilling rate range:	28 - 33 minutes per meter
Average:	30 minutes per meter
Average ROP:	2m/hr.
Ditch gas range:	12 - 29 units
Cuttings gas range:	3 - 11 units

Drilling rates were between 3652 and 3660m and from 3660 to 3665 were coring.

Geological Samples Description

3652 - 3655m	Shale, 100%, dark grey to very dark grey to black, hard to very hard, slightly micromicaceous, blocky, locally with subconchoidal fracture, with white dolomite crystalline inclusions in parts, dolomite frequently showing good crystalline form, locally possible fossil replacement.
3655 - 3665m	Dolomite, 90 - 100%, light to medium grey, firm to hard, blocky with 50% of the sample consisting of white dolomite crystals showing good crystal form associated with shale and microcrystalline dolomite.
	Trace of quartz crystals.
	Trace of black low density material with a conchoidal fracture and a trace of chert.

COLUMBIA ET AL KOTANEELEE YT I-48

Date: January 18, 1980

Depth: 3684m

Drilling rate range:	12 - 33 minutes per meter
Average:	23 minutes per meter
Average ROP:	2.61m/hr.
Ditch gas range:	40 - 52 units
Cuttings gas range:	0 - 4 units

Geological Samples Description

3672.1 - 3681m	Dolomite, 80%, light to medium grey to white to off-white, firm to hard, blocky, microcrystalline, occasionally silty and shaly.
	Quartz, 15%, clear to transparent to translucent, very hard, crystalline, crystals well formed, occasionally massive, frequently associated with dolomite.
	Shale, 5%, medium to dark grey, hard, blocky, frequently silty.
3681 - 3684m	Dolomite, 85%, as above
	Quartz, 10%, as above
	Shale, 5%, as above
	Trace of sphalerite and trace of bitumen

COLUMBIA ET AL KOTANEELEE YT I-43

Date: January 21, 1980

Depth: 3741m

Drilling rate range: 12 - 60 minutes per metre
Average: 25 minutes per metre
Average ROP: 2.4m/hr.

Ditch gas range: 12 - 200 units
Cuttings gas range: 0 - 5 units

Geological Samples Description

3684 - 3690m	Dolomite, 85%, light to medium grey to white to off-white, firm to hard, blocky, microcrystalline, occasionally massive, occasionally silty and shaly.
	Quartz, 10%, white, transparent, translucent, very hard crystalline, crystals are well-formed, occasionally massive, frequently associated with dolomite.
	Shale, 5%, medium dark grey, hard, blocky, subfissile, frequently silty.
	Traces of limestone, sphalerite, bitumen.
3690 - 3696m	Dolomite, 80%, as above.
	Quartz, 10%, as above.
	Shale, 10%, as above, becoming more silty and dolomitic.
	Trace of sphalerite and trace of bitumen.
3696 - 3705m	Dolomite, 80%, as above.
	Shale, 20%, as above.
	Very good trace of quartz, trace of sphalerite.
3705 - 3724m	Dolomite, 100%, as above, becoming microcrystalline to crystalline, light medium grey dolomite associated with white dolomite, abundant white dolomite veins, generally large percentage of white dolomite present.
	Very good trace of shale, trace of quartz and trace of sphalerite.
3724 - 3741m	Core #4

COLUMBIA ET AL KOTANEELEE YT I-48

Geological Morning Report

Date: January 25/80
Present Depth: 3866m
Previous Depth: 3782.4m
Progress: 83.6m
Current Operation: Drilling

Drilling rate range: 7 - 56 minutes per metre
Average: 16 minutes per metre
Average ROP: 3.75m/hr.

Ditch gas range: 15 - 120 units
Cuttings gas range: 1 - 3 units

Connection gases: 10 units @ 3794m
6 units @ 3802m
60 units @ 3812m
30 units @ 3860m

Lost Circulation Zone: 3807 - 3813m

Lithology:

3784 - 3791m
3815 - 3825m } Samples lost due to bypassing the shaker
3835 - 3844m

All samples collected are extremely poor due to contamination by lost circulation material

3782.4 - 3866m Dolomite, 100%, white to dark grey. Mostly hard to very hard, silty to very silty.

Trace of creamy calcite.

Poor trace of quartz.

COLUMBIA ET AL KOTANEELEE YT I-48

Geological Morning Report

Date: January 26, 1980
Present Depth: 3905m
Previous Depth: 3866m
Progress: 39m
Current Operation: Drilling

Drilling rate range:	3866 - 3869m: 19 - 41 minutes per metre 3869 - 3905m: 7 - 19 minutes per metre
Average:	12 minutes per metre
Average ROP:	5m/hr.
Ditch gas range:	32 - 240 units
Cuttings gas range:	2 - 10 units
Last trip gas:	640 units at 3869m
Last connection gas:	30 units at 3901m

Lithology:

3866 - 3905m 39m	Dolomite, 100%, light grey to dark grey, white speckled, with vein dolomite, white, off-white and cream. Hard, brittle, angular, silty to very slightly sandy locally. Grading to dolomitic grey siltstone locally. Poor trace of calcitic limestone. Siltstone light grey to dark grey, black speckled, dolomitic grading to dolomite, trace to very good trace only. Sandy siltstone with fine, subangular to subrounded quartzose sand, light to dark grey, black speckled, very poor trace at 3900m only. Dolomitic and grading to siltstone and dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48

Geological Morning Report

Date: January 27, 1980

Present Depth: 3912.6m

Previous Depth: 05.0m

Progress: 7.6m

Current Operation: RIH for core #10

Drilling rate range:	23 and 24 minutes per metre
Ditch gas range:	80 units
Cuttings gas range:	7 units
Last trip gas:	320 units at 3910.4m
Partial lost circulation zone:	3912.6m

Lithology:

3905.0 - 3910.4m 7.6m	Dolomite, 100%, light grey to grey, occasionally dark grey, white cream, hard to very hard, brittle, angular, becoming very silty and slightly sandy locally, grading to siltstone and sandy siltstone locally. Siltstone, trace to very good trace, light grey to dark grey, black speckled, dolomitic, grading to dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: January 29/80
Present Depth: 3949m
Previous Depth: 3916m
Progress: 33m
Current Operation: Running E logs

Drilling rate range: 12 - 31 minutes per metre

Ditch gas range: 25 - 160 units

Cuttings gas range: 6 - 10 units

Last trip gas: 688 at 3916m

Last connection gas: 50 at 3921m

Lithology:

3916 - 3949m

33m

Dolomite, 100%, light grey to grey, white speckled, hard, brittle, angular, finely crystalline, locally silty. 30% of dolomite is white cream veined. Poor trace of siltstone, light grey to grey, black speckled, hard, brittle, crumbly, dolomitic and grading to dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: January 31, 1980
Present Depth: 3985m
Previous Depth: 3956.8m
Progress: 28.7m
Current Operation: Drilling

Drilling rate range: 13 - 23 minutes per metre

Ditch gas range: 14 - 40 units

Cuttings gas range: 2 - 4 units

Last trip gas: 460 units at 3957m

Connection gas: 20 units at 3968m
18 units at 3977m

Lithology:

3957 - 3969m

12m

Dolomite, 100%, light to dark grey, hard, becoming soft locally, fine to very fine crystalline, silty locally with trace of clear quartz.

At 3969m formation starts to become calcareous and by 3975m this has reached a poor to fair calcareousness.

3969 - 3985m

16m

Dolomite, 100%, mostly light grey to off-white, locally grey, firm to hard, occasionally soft, crumbly locally, brittle, finely crystalline, saccharoidal, locally silty, dolomitic but becoming fairly calcareous locally, also with a black bitumen mineral which is associated with white vein dolomite.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date:	February 1, 1980
Present Depth:	4034m
Previous Depth:	3985m
Progress:	49m
Current Operation:	Trip out

Drilling rate range:	6 - 51 minutes per metre
Average:	17 minutes per metre
Average ROP:	3.53m/hr.
Drilling exponent:	1.44 - 1.54
Ditch gas range:	20 - 100 units
Cuttings gas range:	2 - 4 units
Connection gases:	40 units @ 3996m 15 units @ 4005m 10 units @ 4024m

Lithology:

3985 - 4034m 49m	Dolomite, 100%, light grey to off-white, rarely grey, occasionally black speckled, firm to hard, occasionally soft, fine to medium crystallinity, saccharoidal, crumbly, locally silty, locally sub-fissile, dolomitic, but slightly calcareous, becoming fairly calcareous locally. Poor trace of clear quartz.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 2, 1980
Present Depth: 4040m
Previous Depth: 4034m
Progress: 6m
Current Operation: Coring

Drilling rate range: 20 - 85 minutes per metre

Ditch gas range: 32 - 64 units

Cuttings gas range: 2 - 5 units

Last trip gas: 830 units at 4037m

Lithology:

4034 - 4038m 4m	Dolomite, 100%, light grey to white, locally grey, hard to firm, occasionally soft, fine to medium crystallinity, occasionally medium to coarse crystallinity and euhedral; crumbly and locally silty.
4038 - 4040m 2m	Dolomite, 100%, light grey to white, grey to dark grey, hard, occasionally firm, fine to microcrystalline, rarely white, crystalline-veined dolomite, very slightly calcareous locally.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 3/80
Present Depth: 4046m
Previous Depth: 4040m
Progress: 6m
Current Operation: Trip out

Drilling rate range: 24 - 90 minutes per metre

Ditch gas range: 23 - 32 units

Cuttings gas range: 4 - 5 units

Last trip gas: 440 at 4043.6m

Last connection gas: 40 units at 4045.6m

Lithology:

4040 - 4046m 6m	Dolomite, 100%, light grey to white, grey to dark grey, hard, occasionally firm, fine to microcrystalline, rarely white, crystalline-veined dolomite, very slightly calcareous locally.

OLUMBIA FT AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 4, 1980
Present Depth: 4102m
Previous Depth: 4046m
Progress: 56m
Current Operation: Drilling

Drilling rate range: 10 - 25 minutes per metre

Ditch gas range: 20 - 100 units

Cuttings gas range: 3 - 5 units

Last trip gas: 560 at 4047m

Connection gases:
50 at 4054m
15 at 4064m
50 at 4073m
10 at 4082m
20 at 4093m
20 at 4102m

Lithology:

4064 - 4102m — Dolomite, light grey to dark grey, firm to hard, becoming locally soft, fine to medium crystallinity, occasionally microcrystalline, becoming slightly sacchroidal locally, occasionally silty, trace of black bituminous mineral.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 5, 1980
Present Depth: 4124m
Previous Depth: 4102m
Progress: 22m
Current Operation: Drilling

Drilling rate range:	17 - 24 minutes per metre
Drilling exponent:	1.44 - 1.5
Ditch gas range:	18 - 24 units
Cuttings gas range:	1 - 3 units
Connection gases:	30 units at 4111m 30 units at 4120m

Lithology:

4102 - 4110m 8m	Dolomite, 100%, grey, rarely mottled black, rarely dark grey, fine to medium crystallinity, very rarely with coarse white veined dolomite, hard, frequently firm, occasionally soft and crumbly, silty locally, locally calcareous.
4110 - 4124m 14m	Dolomite, 100%, white to light grey to grey to dark grey, occasionally black speckled, tight, locally subfissile becoming sacchroidal locally, micro-crystalline to fine to medium crystalline, firm to hard, rarely soft, frequently silty, slightly to fairly calcareous locally.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 6, 1980
Present Depth: 4126m
Previous Depth: 4124m
Progress: 2m
Current Operation: Drilling

Drilling rate range: 21 - 28 minutes per metre
Drilling exponent: 1.49 - 1.5
Ditch gas range: 20 units
Cuttings gas range: 3 units

Lithology:

4124 - 4126m 2m	Dolomite, 90%, white to light grey to grey to dark grey, occasionally black speckled, tight, locally subfissile becoming sacchroidal locally, micro-crystalline to fine to medium crystallinity, firm to hard to very hard, rarely soft, frequently silty, slightly to fairly calcareous locally. Dolomite, 10%, light grey to smokey, very hard, brittle, conchoidal fracture, noncalcareous.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 7, 1980
Present Depth: 4152m
Previous Depth: 4126m
Progress: 26m
Current Operation: Drilling

Drilling rate range:	12 - 24 minutes per metre
Average:	19 minutes per metre
Average ROP:	3.16m/hr.
Ditch gas range:	48 - 80 units
Cuttings gas range:	2 - 4 units

Lithology:

4126 - 4140m 14m	Dolomite, 100%, medium to dark grey, firm to hard, occasionally soft, fine to medium crystalline becoming coarser crystalline, approximately 20% is white crystalline dolomite occasionally occurring in vein form, with a trace of siltstone.
4140 - 4146m 6m	Dolomite, 100%, light to dark grey, occasionally white, fine to medium crystalline, hard to occasionally soft, blocky, sucrosic textured white crystalline dolomite occurred in vein form with a trace of bitumen.
4146 - 4152m 6m	Dolomite, 100%, generally as above, becoming moderately hard, becoming more sucrosic, silty, with about 30% white crystalline dolomite rarely in vein form, with a trace of bitumen and siltstone.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 8, 1980
Present Depth: 4165m
Previous Depth: 4152m
Progress: 13m
Current Operation: Drilling

Drilling rate range:	13 - 21 minutes per metre
Average:	16 minutes per metre
Average ROP:	3.75m/hr.
Ditch gas range:	40 - 78 units
Cuttings gas range:	1 - 3 units

Lithology:

4152 - 4165m 13m	Dolomite, 100%, light to dark grey, occasionally white, fine to medium crystalline, moderately hard, occasionally soft and silty, sacchroidal texture. Approximately 30% white crystalline dolomite occasionally in vein form with a trace of bitumen and a trace of siltstone.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 9-10, 1980
Present Depth: 4228m
Previous Depth: 4165m
Progress: 63m
Current Operation: Drilling

Drilling rate range: 13 - 26 minutes per metre
Average: 19 minutes per metre
Average ROP: 3.16m/hr.
Ditch gas range: 12 - 50 units
Cuttings gas range: 1 - 3 units

Lithology:

4165 - 4188m 23m	Dolomite, 100%, light to dark grey, friable, moderately hard, fine to medium crystalline, sacchroidal texture.
4188 - 4205m 17m	Dolomite, 100%, trace of siltstone, light to dark grey, frequently white, firm to moderately hard, fine to medium crystalline with sacchroidal texture and slightly calcareous.
4205 - 4228m 23m	Dolomite, 100%, light to medium grey, hard to occasionally soft, fine to medium crystalline, sacchroidal texture, crumbly, occasionally silty. Approximately 10% white dolomite with a trace of soft, black bitumen. White dolomite occurs in veins.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 11, 1980
Present Depth: 4313m
Previous Depth: 4228m
Progress: 85m
Current Operation: Drilling

Drilling rate range:	10 - 22 minutes per metre
Average:	15 minutes per metre
Average ROP:	4m/hr.
Ditch gas range:	20 - 38 units
Cuttings gas range:	1 - 4 units

Lithology:

4228 - 4242m 14m	Dolomite, 100%, light grey to dark grey, moderately hard, occasionally soft, silty, crumbly, fine to medium crystalline, sacchroidal texture, trace of siltstone.
4242 - 4263m 21m	Dolomite, 100%, generally as above, becoming more silty.
4263 - 4293m 30m	Dolomite, 100%, predominantly medium to dark grey, occasionally white, fine to medium crystalline, friable to moderately hard with a trace of bitumen.
4293 - 4313m 20m	Dolomite, 100%, generally as above with increasing amounts of white dolomite and sacchroidal texture.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 12/80
Present Depth: 4343m
Previous Depth: 4313m
Progress: 30m
Current Operation: Drilling

Drilling rate range:	9 - 20 minutes per metre
Average:	13 minutes per metre
Average ROP:	4.62m/hr.
Ditch gas range:	25 - 260 units
Cuttings gas range:	1 - 2 units

Lithology:

4313 - 4317m 4m	Dolomite, 100%, mainly medium grey, rarely white, occasionally dark grey, micro to medium crystalline, mainly moderately hard, occasionally friable, sucrosic texture, slightly calcareous.
4317 - 4329m 12m	Dolomite, 100%, light medium grey, occasionally white and dark grey, micro to medium crystalline, friable to hard. Trace of bitumen, occasionally sucrosic texture.
4329 - 4343m 14m	Dolomite, 100%. 90% light to medium grey, micro to medium crystalline, medium hardness. 10% white blocky dolomite. Trace of very fine light brown calcareous siltstone.

COLUMBIA ET AL KOTANEELEE YT I-48

Morning Geological Report

Date: February 13/80
Present Depth: 4413m
Previous Depth: 4343m
Progress: 70m
Current Operation: Drilling

Drilling rate range:	17 - 22 minutes per metre
Average:	12.5 minutes per metre
Average ROP:	4.8m
Ditch gas range:	14 - 25 units
Cuttings gas range:	1 - 2 units

Lithology:

4343 - 4344m 1m	Dolomite, 100%, mainly light to medium grey, micro to medium crystalline with occasional sucrosic texture, occasionally white dolomite, micro to medium crystalline, blocky, with a trace of bitumen, trace of soft, brown siltstone.
4344 - 4356m 12m	Dolomite, 100%, mainly medium to dark grey, micro to medium crystalline, medium hard, trace white, medium to coarsely crystalline, moderately hard, occasionally with sucrosic texture.
4356 - 4386m 30m	Dolomite, 100%, medium grey dolomite, micro to medium crystalline, moderately hard, occasionally white, blocky, trace of siltstone, good trace of bitumen.
4386 - 4397m 11m	Dolomite, 100%, light grey to grey, white to off-white, occasionally dark grey, friable to hard, blocky, fissile, sucrosic and occasionally speckled, micro to medium crystalline, trace bitumen, soft, black and blocky.
4397 - 4413m 16m	Dolomite, 100%, white, off-white, light grey to creamy to occasionally dark grey, medium hard to hard, blocky, occasionally fissile, sucrosic and speckled, micro to medium crystalline, poor trace of bitumen, poor trace of calcium, white, creamy, soft, blocky, occasionally subrounded.

COLUMBIA ET AL KOTANEELSE YT I-48

Morning Geological Report

Date: February 14, 1980
Present Depth: 4429.4 m
Previous Depth: 4413.0 m
Progress: 16.4 m

Drilling rate range: 20 - 22 minutes per metre

Average: 21 minutes per metre

Average ROP: 2.86 m/hr

Ditch gas range: 14 - 16 units

Cuttings gas range: 1 - 2 units

Lithology:

4413 - 4415 m 2m	Dolomite, 100%, white to off-white, light grey to creamy, occasionally dark grey, hard to very hard, sucrosic, occasionally speckled, micro crystalline to crystalline, poor trace of pyrobitumen as well as poor trace of calcite.
	At this point a depth correction from 4415.0 to 4424.4 m was made. Started coring

S E C T I O N C

ENGINEERING SUMMARY

I

BIT RECORD

ENGINEERING SUMMARY

BIT RECORD

BIT NO.	MAKE	TYPE	M	HRS.	KdaN (1000x)	RPM	KPa	SPM	COND.
1	HTC	3AJ	108	61.50	3	50	1500	60	621
2	HTC	3AJ	48	27.50	4	60	2000	50	850
3	HTC	3AJ	16	12.25	6	60	5000	50	850
4	SEC	M4NJ	4	7.75		60	3500	60	880
5	SEC	H7J	15	14.25	5-7	70	5000	60	860
6	SEC	H7D	13	11.50	4-5	60	5000	60	751
7	SEC	S8J	41	9.00	9	60-80	4000	60	431
8		H.)	13	9.75	5		1200	60	53
9		H.O	22	18.25	3	65	1500	60	640
10	HTC	OSC1G	7	9.00	2-3	55	5500	60	
11	HTC	OSC1G	2	15.50	2-4	40	5500	60	
12	SEC	H7J	11	13.75	10-15	50	8500	92	431
13	STC	4JS	91	64.25	15	50	8500	50-52	321
14	STC	4JS	119	85.25	15	50	5000	39-42	521
15	REED	S62J	93	71.50	10	55	800	60	511
16	REED	S62J	84	76.00	10-18	50	800	65	640
17	REED	S62J	70	66.75	15-20	50	8000	60	840
18	REED	S62J	35	29.25	15-20	50	6600	40-44	840
19	REED	Y72	26	24.75	15-20	50	7000	64	411
20	SEC	H8J	36	54.75	15-20	35-45	4000	40-44	281
21	STC	4JS	57	55.75	18	40-45	8000	44-48	631
22	REED	S62J	60	51.25	15-17	40-45	10000	46-52	740
23	STC	4JS	49	47.25	11-12	40-45	10000	46-52	531
24	REED	S62J	78	49.25	8-10	40-45	10500	42-54	451
25	REED	S63J	21	22.25	6-8	50	9000	60	531
26	REED	FP62	79	39	8-10	42-45	8000	52	841
27	STC	F5	86	66	6-8	45	9000	48	321
28	SEC	S86F	113	67.25	6-8	50	9000	52	221
29	REED	FP62	86	49	8-10	50	12000	52	221
30	REED	S84F	102	34	15	50	14000	50	831
31	STC	F2	274	125	15	65	1200	52	811
32	SEC	S84F	111	53	20	65	12000	52	311

BIT RECORD CONT'D

BIT NO.	MAKE	TYPE	M	HRS.	KdaN (1000x)	RPM	KPa	SPM	COND.
33	SEC	M44N	89	39.25	25	75	12000	52	481
34	REED	S21G	101	42.25	27	65	12000	44	881
35	SEC	S34F	77	28.75	20	55	12000	56	841
36	REED	FP63	85	44.75	20	55	12000	56	831
37	SEC	S84F	94	33.25	20	55	12000	54	831
38	REED	FP52	87	31.25	20	45	12000	56	221
39	REED	FP52J	22	23	22	45	12000	56	111
40	REED	S21G	LEFT IN HOLD CEMENTED OFF						
41	REED	S21G	USED AS A FISHING BIT						
42	STC	SDGH	18	14.25	4-12	TURBO	6000	47	681
43	STC	SDGH	20	12	4-12	TURBO	6000	47	681
RR41	REED	S21G	13	7.50	10	TURBO	12000	66	231
44	REED	S13G	15	11.25	5-15	75	9000	54	621
45	STC	SVH	5	4	10-12	75	9000	54	521
46	SEC	M4NGJ	12	16.75	10	70	10000	52	311
47	HTC	XV	LEFT IN HOLE						
48	HTC	XV	18	20.75	2	DYNA			311
49	HTC	XV	10	31	2	DYNA			111
RR49	HTC	XV	6	10.25	2-3	75	6000		121
50	SEC	S44	10	6.25	2-3	75	9000		121
52	SEC	M44N	0	17.75	2-3	75	6000		241
53	HTC	XV	44	27.75	20-25	70	13500	50	221
54	SEC	S44	84	34.75	18-20	70	11000	50	481
55	HTC	XiG	29	17.50	18-20	70	11000	52	651
RR39	REED	FP52J	47	38.75	16-18	60	12000	55	651
56	SEC	M84F	16	13.50	10-12	400	11000	60	681
57	HTC	XDV	13	13	10-16	60	9000	55	831
58	HTC	XDV	3	4.50	5	400	10000	53	621
59	REED	FP52J	36	22	5-7	400	11000	56	880
60	SEC	S86F	11	7	20	50	14000	50	111
61	HTC	XDV	12	5.75	12-15	400	9000	57	321
62	SEC	S86F	8	11.75	5-12	400	7000	57	881

BIT RECORD CONT'D

BIT NO.	MAKE	TYPE	M	HRS.	KdaN (1000x)	RPM	KPa	SPM	COND.
63	SEC	DMN	9	10.50	22	65	9000	55	661
64	STC	3JS	47	24	20	70	12000	52	221
65	SEC	DJS	15	12.75	20	70	12000	52	251
66	SEC	DMM	40	21.50	20-25	75	9000	56	361
67	HTC	XV	9	10.75	10	70	10000	59	531
68	REED	S31G	12	18.75	10-15	70	10000	58	351
69	REED	S31G	6	7.50	10-15	70	10000	56	541
70	SEC	DMN	23	26.75	17-18	50	9000	56	561
71	SEC	DMN	33	33.25	22	50	9000	56	561
72	SEC	DMN	15	13.50	20	50	9000	56	671
73	REED	S21G	35	26	20	50	9000	56	611
74	STC	F2	61	35.75	18	50	10000	58	111
75	HTC	OSC3	USED TO CLEAN OUT HOLE						
76	REED	S21G	USED AS A FISHING BIT						
77	STC	3JS	7	11.50	20	50	8500	58	111
RR76	REED	S21G	41	29.50	20	55	13000	56	431
78	SEC	DSS	50	33.50	22	55	12000	58	351
79	SEC	DSJ	52	34	20	65	13000	57	181
80	SEC	DSS	67	43.50	22	65	9000	57	481
81	SEC	DSS	19	12.50	22	65	13000	57	211
82	REED	S21G	88	60	19	65	12000	57	261
83	REED	S21G	55.25	65	19	65	12000	57	581
84	REED	S21G	77	51.50	21	55	12000	57	581
85	REED	S21G	88	65	21	55	12000	57	451
86	HTC	XV	42	38.75	21	55	12000	57	431
87	HTC	J22	65	41.75	23	55	12000	57	831
90	REED	FP63	61	37.75	18	45	10500	48	221
91	HTC	J33	33	44.75	19	45	12000	46	221
92	SEC	M44L	63	35.75	15	45	12000	46	721
93	SEC	M44L	12	11.50	18	60	9500	48	721
94	REED	FP52	82	57.25	18	60	9500	48	321
95	SEC	M44L	48	30.25	15	45	9500	48	721
96	REED	FP52	59	29.75	17	50	9500	48	NO CONES
97	STC	3JS	19	7.50	14	45	10000	48	721

BIT RECORD CONT'D

BIT NO.	MAKE	TYPE	M	HRS.	KdaN (1000x)	RPM	KPa	SPM	COND.
98	SEC	M891F	5	4.50	14	45	10000	48	111
RR98	SEC	M891F	8	4.50	10	45	10500	48	221
1	CHRIS	MC28	5	18.50	10	60	10000	54	GOOD
2	CHRIS	MC23	3	7.25	10	60	12000	54	DAMAGED
RR 1	CHRIS	MC28	3.50	11	10	60	10500	50	
98	SEC	M891F	0	7.25	10	60	9500	48	311
99	HTC	J55	12	6.50	18	50	7000	48	820
100	HTC	J55	10	4.50	15	42	6500	48	820
101	STC	F9	30	11.50	15	40	6500	48	711
3	CHRIS	MC20	17	18.75	15	70	6500	48	GOOD
4	CHRIS	MC20	18	3.75	14	70	11500	43	GOOD
RR 4	CHRIS	MC20	11	4.50	14	70	10500	43	GOOD
RR 4	CHRIS	MC20	7.75	4.50	12	65	5500	48	GOOD
102	REED	FP72J	84	23.25	15	45	5500	48	781
103	STC	F4	41	9	15	55	6000	48	611
RR 3	CHRIS	MC20	2	1.25	15	70	11500	42	GOOD
RR 3	CHRIS	MC20	3.50	2	12	70	11000	43	FAIR
104	REED	FP72J	34	11	15	55	5500	48	111
RR 3	CHRIS	MC20	7.50	6.50	16	65	10500	43	GOOD
RR104	REED	FP72J	28	8.50	16	45	5500	48	611
RR 3	CHRIS	MC20	1.50	1	15	60	5500	48	DAMAGED
RR 4	CHRIS	MC20	7	8.50	8	65	10500	40	OK
5	CHRIS	MC20	2.50	1.25	10	65	11000	40	DAMAGED
105	SEC	M88F	80	23	15	45	6000	48	881
106	REED	FP72	32	10.25	15	45	5500	45	431
RR 5	CHRIS	MC20	7	2.50	15	50	11500	43	GOOD
107	SEC	M88F	69	20.75	15	45	GOOD	47	221
108	HTC	J88	85	24.50	15	45	6500	43	271
109	HTC	J88	103	25.25	15	45	6500	43	231
RR05	CHRIS	MC20	5	1.50	11	65	11500	43	GOOD

II

DEVIATION SURVEY RESULTS

SURVEY DATA

DEPTH (m)	ANGLE^{O}	DIRECTION	DEPTH	ANGLE^{O}	DIRECTION
57	.50		742	3.875	N56W
85	1		761	5	
114	1.75		770	4.50	N57W
142	2.50		780	4.50	
167	2		798	4	N60W
176	2.50		810	4	
191	2		826	4	N50W
212	1.25		828	4	
222	1.50	N47W	847	4	N51W
230	1.75		867	4.375	
256	3	N33W	884	4.50	N52W
265	3		903	4.25	N53W
275	3	N35W	924	5.50	
290	3.25	N33W	932	5.50	N54W
310	3	N33W	941	4.25	
340	3	N34W	962	4.75	N54W
360	3.25	N39W	976	5.75	
375	3.25		990	4.75	N56W
398	3.50	N36W	1009	6	
416	3.50	N35W	1029	6.50	N57W
444	3.25	N35W	1047	7	N64W
466	3.75	N33W	1087	7.50	N66W
500	3.75	N36W	1115	7.75	N65W
518	3.75		1125	8	
537	3.75	N40W	1132	9	N72W ms
562	3.75	N39W	1154	8.25	N67W
576	3.75		1170	9.75	N74W ms
595	3.50	N47W	1182	8.25	
615	3.75	N49W	1230	11	N66W
632	3.25		1238	11.25	N67W
653	3.50	N51W	1256	11.25	N70W ms
672	3.75	N52W	1315	11.75	N69W
691	3.75		1353	12	N68W
713	4	N53W	1382	11.75	N64W
723	3.875		1400	11.25	N62W

SURVEY DATA

DEPTH (m)	ANGLE°	DIRECTION	DEPTH	ANGLE°	DIRECTION
1400	11.25	N62W	2270	5	N08W
1420	11.25	N60W	2280	6	N08W
1439	11.25	N55W	2300	5	N01W
1490	11.25	N52W	2320	6.25	N14E
1510	11.25	N52W	2339	6	N08E
1528	11.25	N80W	2348	6	N08E
1541	11.25	N75W	2355	6.25	N06E
1555	11.75	N75W	2364	6.25	N05E
1583	12	N82W	2375	5.75	N05E
1620	11.25		2416	5.50	N04E
1659	11.50		2424	4.75	N06E
1683	11	N89W ms	2436	4.25	
1797	11.50	N50W ms	2464	4.75	N03E
1826	11	N50W ms	2472	4.75	N02E
1855	12	N46W ms	2483	4.75	
1881	11.75		2512	4.75	N06E
1912	11	N50W ms	2541	4.50	N15E
1966	11.25	N45W	2569	5	N22E
2005	11	N37W	2588	5.25	N37E
2060	10		2617	5.50	N42E
2083	7.25	N37W ms	2659	7	N51E
2093	6.75	N38W	2676	7	N49E
2102	7	N34W	2711	6.75	N49E
2112	6.75	N38W	2760	7.50	N42E
2131	6	N35W	2853	9.50	N40E ms
2141	6	N34W	2967	8.50	N43E ms
2151	6	N34W	3107	6.25	N32E
2160	5.75	N39W	3135	6	N28E
2168	5.75	N34W	3163	6	N32E
2179	5.75	N33W	3252	5.75	N27E ms
2189	5.75	N34W	3313	6	N30E
2218	6	N14W	3559	6	N28E
2238	5.75	N07W	3415	6.25	N27E
2260	5.25	N10E	3620	9	

DEPTH (m)	ANGLE°	DIRECTION	DEPTH	ANGLE°	DIRECTION
3764	9				
3860	8.25	N44E			
4158	6				

S E C T I O N D

EQUIPMENT

SECTION D : EQUIPMENT

I THE LOGGING UNIT

An Exploration Logging Unit, number 120, was on location at the Kotaneelee YT I-48 wellsite for the duration of drilling operations with sample logging commencing at a depth of 300m on 11 April, 1979 and continuing to 4429.4m total depth, on 15 February, 1980.

Unit 120 was situated in a excellent position in close proximity to the shale shakers and rig floor. Power, water and compressed air were provided from the rig supply and a telephone link to the rig floor, engineer's office and living quarters were installed. It is a Standard Unit contianing the following equipment:

--Penetration Rate and Depth Recording System
--Combustible-Gas Detectors
--Cuttings-Gas Detectors
--Pump Stroke Counters
--Chromatograph for the Analysis of Gaseous Hydrocarbons
--Honeywell Multipoint Recorder
--Equipment for Oil and Gas Show Evaluation

In addition to this, the unit contains secondary equipment in the form of:

--Mud Monitoring System - Pit Volume Totalizer, Dual Mud Weight and Dual Mud Temperature Recorders
--Multisolution Shale Density Kit
--Autocalcimeter (for the latter part of the well)

The unit was manned by graduate geologists working on a two weeks on the rig and one week off schedule, with two men on the rig at one time,

each working a twelve hour tour, taking ditch samples at ten feet intervals and preparing a lithology log on a 1:600 scale upon which the following was recorded:

--Bit Data
--Drill Rates, in feet per hour, plotted every meter
--Lithology Percentages and Types
--Gas Readings Comprising:
- Continuous Ditch Gas in Gas Units
- Chromatographic Analysis in ppm
- Cuttings Gas in Gas Units
--Lithology Descriptions
--Information regarding casing depths, electric logs, mud reports, hole deviation, oil shows, core and drill stem test intervals and calcimetry results

A Pressure Log was also prepared on a scale of 1 cm: or approximately 1:2500, with plots of:

--Corrected Drilling Exponents (Dxc)
--Flowline Temperature ^{o}C
--Background, Connection and Trip Gases
--Mud Weight - pounds per gallon
--Shale Density - grams per cc
--Lithology

CUTTINGS SAMPLES:

Samples were collected at ten feet intervals and divided as follows:

1. 100 cc of unwashed sample was disintegrated with 500 cc of water in a blender to obtain a Cuttings Gas readings.

2. The rest of the sample was washed through an 8-mesh sieve, collected in a 170-mesh sieve, washed until clean and then dried, after which approximately 20 gm was placed in each of two plastic phials and kept at the wellsite.

3. About 0.5 kg of additional washed sample was placed in a small cloth bag and every one or two weeks the accumulated cloth bags sent to the Canadian Geological Survey Institute of Sedimentary and Petroleum Geology, 33rd Street N.W., Calgary, Alberta.

4. From the washed and sieved sample a quantity of cuttings was taken for examination and lithology analysis:

   a) under ultra-violet light to check for fluorescence caused by the presence of oil, as opposed to natural fluorescence of minerals, such as calcite.

   b) under a binocular microscope, after which the sample was described according to its rock type, colour, hardness, grain size, grain shape, sorting, cemetation, porosity, accessory minerals, show; using the standard Exploration Logging abbreviations.

In the event of the sample being calcareous and/or shaly, it could be used to obtain limestone and dolomite percentages and/or shale density values.

This examination procedure is also followed when a core is being described.

II POWER AND AIR SUPPLY FOR LOGGING UNIT:

AC POWER

The main power requirement for the unit is 115 volt, 60 cycles per second, 30 amps provided via a two conductor neoprene cable from the rig generator. This is routed through the main circuit breaker assembly and master switch with one part going to the unregulated portion of a circuit breaker box to provide power for the unit compressor, agitator motor and a set of unregulated AC power outlets along the inside of the unit, and another part going to a regulated AC "shorting plug" and being fed to circuit breakers supplying power for the fluorescent lights and regulated AC power outlets in the unit and the DC power supply.

There is also a 220 volt power supply used to run the air conditioning, heater or auxiliary equipment such as core-processing apparatus.

DC POWER

This is provided by the conversion of part of the sometimes widely varying AC power into a very stable DC power or 5.8 volts used for the gas detectors and other instruments where a stable power supply is very necessary.

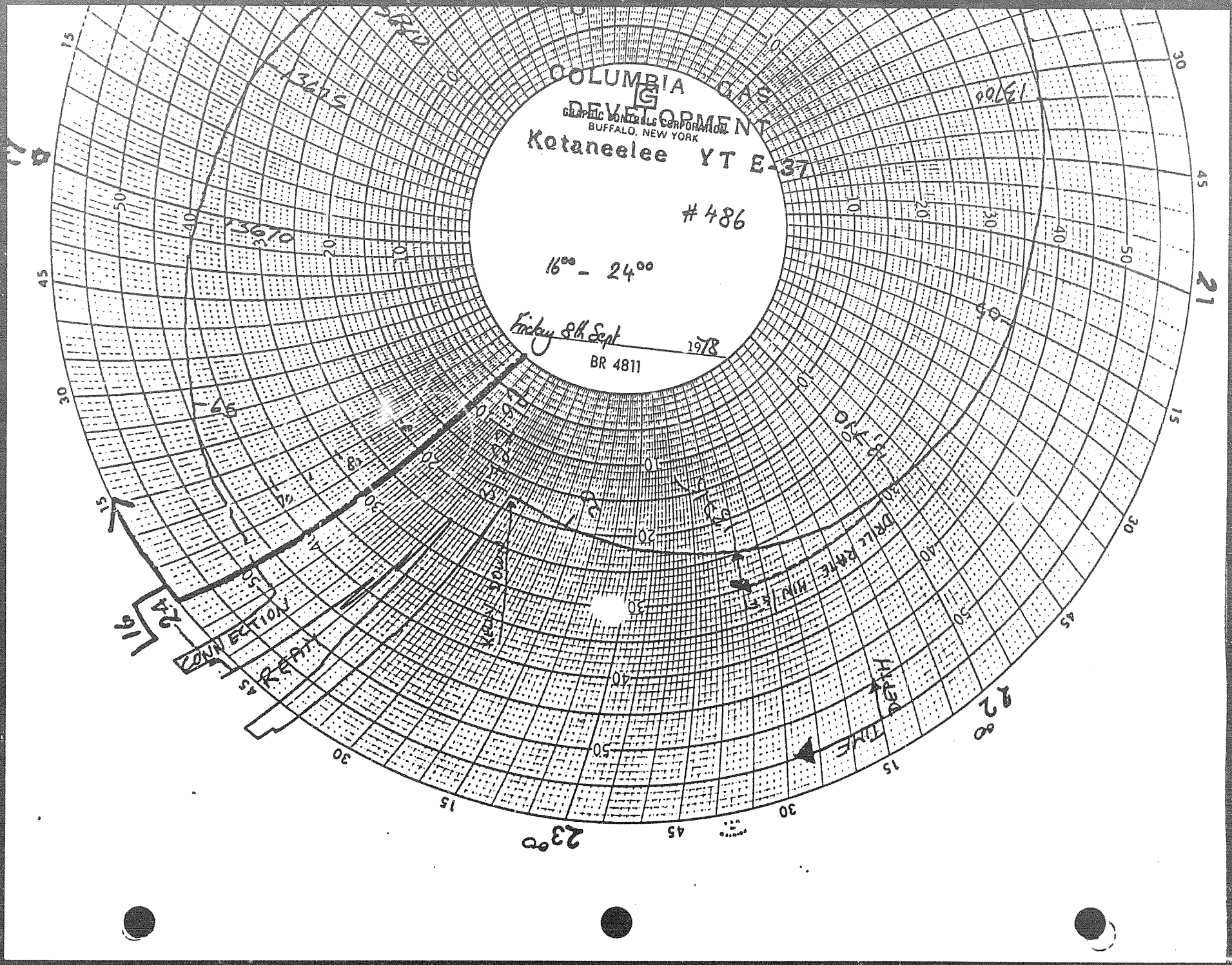
AIR

A 120 psi air system is used in the unit and this is provided by the rig air supply or by the unit compressor. To prevent any surges in air supply from damaging equipment, regulators are installed in the line and an air filter is used to remove water and oil from the air. Once through the filter, the air is distributed via a manifold to various air lines in the unit, bristol tank to pressure up the bristol system and fill the hose with water, mud filter press used to obtain filtrate and filter cake readings from a mud sample, a blow off hose in the backroom of the unit.

III VACUUM SYSTEM:

The Exploration Logging Vacuum System provides a means of drawing gas from the mud in the ditch and passing it through filament chambers in the gas detectors for measurements of the concentrations of the combustible gases in the mud. A continuous steady vaccum of four to five inches of mercury and a total sample gas flow of 30 to 40 standard cubic feet per hour is provided by a twin-cylinder vaccum pump with one cylinder operating for the ditch gas system and the other providing the vacuum for the cuttings gas detector.

The outside part of the system consists of a gas trap partially immersed in the ditch so that mud passes through it continually. In the gas trap is a ½ horse-power, 115 volt explosion proof agitator motor which agitates the mud causing the release of any gas which may have been held in suspension. The gas trap has an efficiency of up to 70% depending on mud properties such as viscosity, the speed of agitation and the


COLUMBIA GAS
DEVELOPMENT
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
Kotaneelee YT E-37
#486
16⁰⁰ - 24⁰⁰
Friday 8th Sept 1978
BR 4811
341 SE
301 S
166
CONVECTION
REFL
HEAT FLOW
DRILL RATE
TIME
HEAT
21
12
23
24
16
17

IV PENETRATION RATE RECORDING SYSTEM Cont'd

chart, produces a curve which indicated the amount of time taken to drill each foot, with increasing rate of penetration showing on the chart as increasing gradient of the curve.

It is necessary to know the length of each single drill pipe as itis added to the drill string so that each kelly down depth is known and consequently, during the drilling of each signle to kelly down, the depth at any moment can be interpolated.

Advantages

1. It is a reliable, easy-to-maintain system.
2. Once it is calibrated and the span of the pen movement on the chart adjusted correctly, it should not normally need to be recalibrated.
3. The clockwork chart drive means that it is not affected by a loss of power to the logging unit or by variations in the frequency of the rig power.

Disadvantages

1. In cold weather operation such as the Yukon winter, antifreeze must be added to the water in the system and because the density of antifreeze is not the same as the density of water, the pen mechanism must be recalibrated.
2. Hoses are subjected to a lot of wear and tear while attached to the kelly hose and swivel and occasionally break or are work through and leak, causing loss in hydrostatic pressure within the system and hence anomalous chart readings, although it is a matter of only a few minutes to repair the hose.
3. Care must be taken not to allow air bubbles to enter the system as these will upset the calibration due to subnormal hydrostatic head.

V HOT WIRE GAS DETECTOR

This has been used for many years in the petroleum industry and has proven itself to be simple, very reliable, easy to use and maintain, and easy to calibrate. It uses a Wheatstone Bridge circuit to detect and register changes in the resistivity of a platinum-coated filament, as it is heated by the combustion of gas, compared to the resistivity of a reference filament which is igniting just air. The hot wire detector is divided into two identical parts, one using a detector voltage of 2.2 volts for measuring the amount of all combustible gases in the sample mixture (the total gas detector), and the other using a voltage of 1.1 volts to detect all combustible gases except methane (the petroleum vapour detector). The filaments are calibrated to record 50 units of total gas (1 Exploration Logging gas unit - 200 ppm total gas) when a mixture of 1% methane in air is passed into the filament chamber.

V HOT WIRE GAS DETECTOR Cont'd

The disadvantage of the hot-wire detector is that it only has a linear response to gas concentrations if all the gas is burning uniformly in the chamber. There is a critical concentration of gas above which explosive combustion will occur in the filament chambers and any of the following percentage of gases in the sample mixture will cause this.

Methane	7%
Ethane	4%
Propane	2.7%
Butane	2.3%
Pentane	1.8%

If the concentrations increase above this figure, pulsating explosions will result until sufficient oxygen is used up to cause complete cessation of combustion in the filament chambers. At the following concentrations the filament is inert and will not register any further increase in concentrations.

Methane	56%
Ethane	32%
Propane	22%
Butane	18%
Pentane	14%

As the gas concentration increases it is necessary to dilute the mixture being drawn into the filament chamber by introducing air into it. As long as the total flow into the chamber remains at two standard cubic feet per hour (scfh) it is possible to dilute the mixture up to one-twentieth of its initial concentration, i.e. 1.9 scfh of air with 0:1 scfh of gas sample before it becomes impossible to retain any vestige of accuracy in the results. Even at 1/20 attenuation the accuracy is poor and it is therefore essential to maintain the minimum attenuation possible at all times.

ATTENUA. FACTOR	SAMPLE FLOW (scfh)	AIR FLOW (scfh)	TOTAL FLOW (scfh)	GAS PERCENTAGE	GAS UNITS
x1	2	0	2	0- 2%	0- 100
x2	1	1	2	2- 4%	100- 200
x4	0.5	1.5	2	4- 8%	200- 400
x8	0.25	1.75	2	8-16%	400- 800
x20	0.1	1.9	2	16-40%	800-2000

The gas readings are indicated both on meters scaled from 0 to 100 units and also on the Honeywell Recorder as a 0 to 100 scale print out with total gas readings printed as a continuous red line and petroleum vapour readings as a continuous black line.

VI CHROMATOGRAPH

The chromatograph provides a method of determining the concentrations of gaseous hydrocarbons within the gas sample taken from the ditch. A sample of the gas is drawn into a column containing an inert material which effects a separation of the various hydrocarbons due to their differences in solubility, enabling methane, the least soluble, to separate out first followed by the others in order of their molecular weights and increasing solubilities, i.e. ethane, propane, butane, pentane and the heavier hydrocarbons. Each gas in turn then passes into a filament chamber where combustion occurs causing a change in the resistivity of the platinum-coated filament. As with the hot-wire detector, the Wheatstone Bridge circuit detects this change and it is registered as a series of peaks on a chart recorder with each peak representing a hydro-carbon concentration.

The column is divided into two sections and after butane has passed through the separation section, a back flush pressure is applied to this part of the column to expel the hydrocarbons heavier than butane, which take longer to pass through the separating column, so that sampling can proceed at regular intervals. The sampling cycle for the hydrocarbons from methane to butane takes five minutes after which time another sample of ditch gas is drawn into the separating column and the process continues. However, it is possible to prevent the back flush pressure being applied and therefore obtain a reading for pentane, hexane, etc. although, as the pentane peak appears on the chart about four or five minutes after butane, and the heavier gases a proportionately longer time after pentane, for practical purposes during drilling the cycle time of five minutes for results of methane, ethane, propane and butane concentrations is usually sufficient.

Again it is possible to attenuate the signals in the event of high hydrocarbon concentrations, although instrument attenuation is by electrical means, reducing the strength of the signal going to the chart recorder. Because the gas going into the filament chamber cannot be diluted with air it is necessary to recalibrate the filaments every few days, or more frequently in the event of high gas concentrations, due to a decrease in the sensitivity of the filaments. Calibration is done using a methane, ethane, propane, butane, pentane, air mixture of known concentrations and will give a value in parts per million of each hydrocarbon per division of the recorder chart. This value when multiplied by the attenuation value and the number of chart divisions of a peak gives the total parts per million concentration for that particular gas.

Saturation of the filament occurs when methane concentration exceeds approximately 100,000 - 110,000 ppm (10-11% methane) depending on filament sensitivity and again the minimum possible dilution factor must be used, as accuracy of results decreases with increasing dilution.

VII CUTTINGS GAS DETECTOR

The "microgas" system is a duplicate of the hot-wire gas detector, being able to determine concentrations of total gas and petroleum vapours in the gas released when 100 milliliter of unwashed ditch cuttings sample are disintegrated in 500 milliliter of water in a blender. After disintegration, the gas produced is drawn into the filament chambers and the total gas/petroleum vapours values read off on a 0 to 100 units meter. Attenuation is by the same method as the main ditch gas detector, using varying ratios of sample gas and air according to concentrations of gas in the sample.

Uses

1. It gives some indication of reservoir characteristics such as porosity and permeability and the proximity of the gas-oil contact depending on the amount of gas released compared to the oil show in the cuttings sample.
2. It can be used to check the efficiency of the mud degassing system by using drilling mud instead of cuttings in the blender and measuring the amount of gas in the mud both before and after the mud has been through the degasser.

For good standardization of results, of course, it is necessary to use the same amounts of cuttings and water each time and to ensure that the cuttings are not left exposed to the air for too long after being collected from the shale shaker. Occasional replacement of the cutter blades in the blender is required, the frequency depending on the abrasiveness of the rock sample, in order to achieve uniform disintegration over a fixed time period, usually twenty seconds.

VIII CALCIMETRY

Calcimetry is the determination of the types and percentages of carbonate minerals in a rock. The method normally used is based on a measurement of the amount of Carbon Dioxide released during the reaction of hydrochloric acid on a calcareous rock sample of known weight.

The Exploration Logging Autocalcimeter consists of an airtight pressure cell connected by polyflo tubing to a pressure transducer. The cell has two compartments, the larger of which contains a known weight, say 1 gram, of the crushed carbonate rock being analyzed, and the smaller one containing 0.ZN hydrochloric acid. The cell is sealed and tilted slightly to allow the acid to come in contact with the sample and carbon dioxide (CO_2) is immediately given off in direct proportion to the percentage of carbonate mineral in the sample. When calcite is the only carbonate mineral present, the following equation applies:

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$$

VIII Calcimetry

The ideal gas law equation is:

$$PV = nRT$$

P = Pressure
V = Volume
n = number of moles of gas
R = Gas content
T = Temperature (measured in degrees Kelvin: $0^{\circ}C = 273^{\circ}K$)

The reaction is exothermic, i.e. heat is produced during the reaction and the maximum increase in temperature due to the total reaction of one gram of 100% calcite is $4.59^{\circ}C$ in 10 milliliter of solution. Because the total system must be considered, i.e. gas phase and pressure cell, the temperature increase in only approximately $0.3^{\circ}C$, which would result in an error small enough to be neglected. Therefore, the temperature is considered to be constant during the reaction within the system. Rearranging the above equation gives us: $P = \frac{nRT}{V}$ and since we are dealing with a closed system, $\frac{RT}{V}$ is constant K.

Therefore, $P \propto nK$, i.e. the pressure produced during the reaction is directly proportional to the number of gram molecules (moles) of gas. Hence it is directly proportional to the number of moles of carbonate and also therefore to the weight of carbonate present.

If there is any variation in the laboratory ambient temperature it must be corrected by using the following equation:

$$\frac{OP}{RT} = \frac{CP}{CT}$$

where OP = observed percentage of carbonate
CP = correct percentage of carbonate
RT = laboratory ambient temperature during reaction ($^{\circ}K$)
CT = laboratory ambient temperature during calibration ($^{\circ}K$)

As the reaction proceeds and CO_2 is continually given off the pressure in the system increases and this pressure difference is measured by the transducer and relayed to a chart recorder. The information is recorded as a curve on a percentage scale and the relative percentages of each carbonate mineral are plotted on the lithology log in the cuttings gas column by the logging geologist.

The time taken for the reaction to reach completion is determined by the type of carbonate mineral present. Calcite, $CaCO_3$, releases CO_2 immediately and its fast reaction time will be shown on the percentage-time chart as an initial kick to the right which will indicate the amount of $CaCO_3$ present in the sample. Dolomite, $CaMg(CO_3)_2$, and Siderite, $FeCO_3$, have similar reaction speeds and the reaction is usually complete after five to ten minutes. Magnesite, $MgCO_3$, has a slower reaction speed than dolomite. See enclosed chart examples, (overleaf).

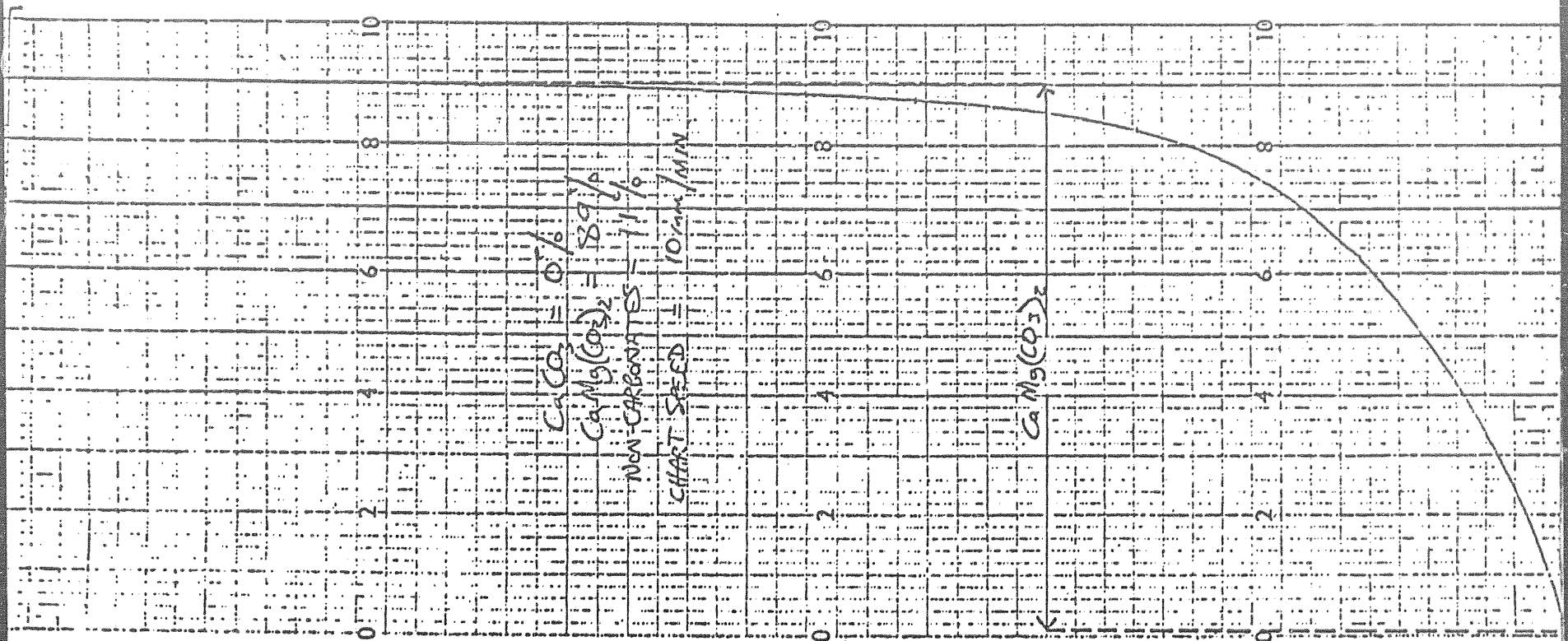
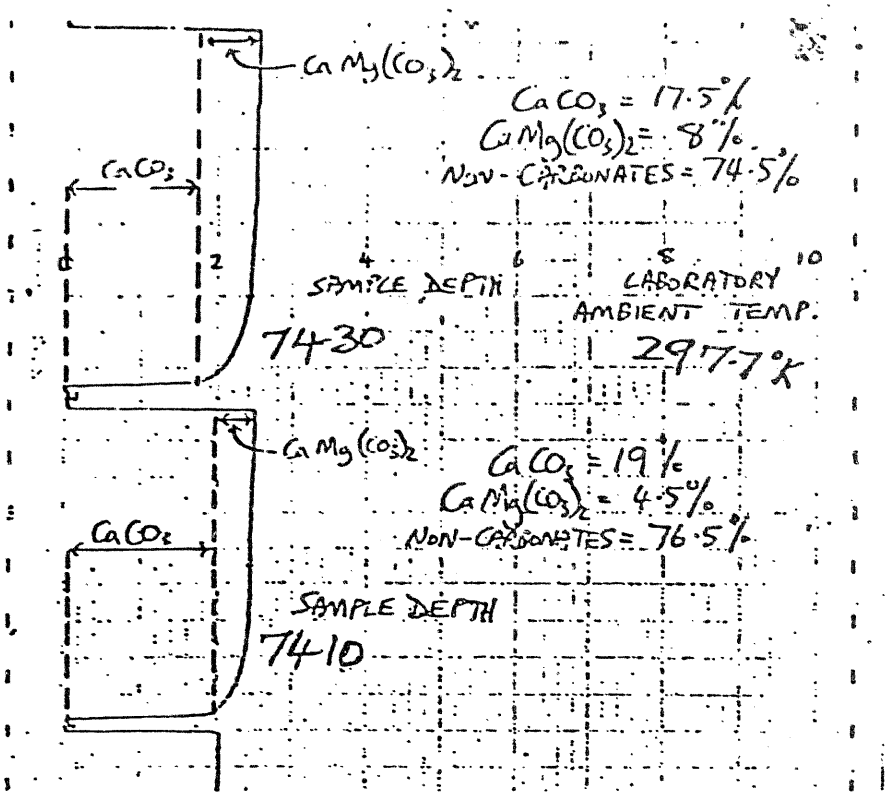


CHART No. SP-257 (0-10) ENVIRONMENTAL EQUIPMENTS LTD. 1/72



$CaCO_3$ = 17.5%
$CaMg(CO_3)_2$ = 8%
NON-CARBONATES = 74.5%

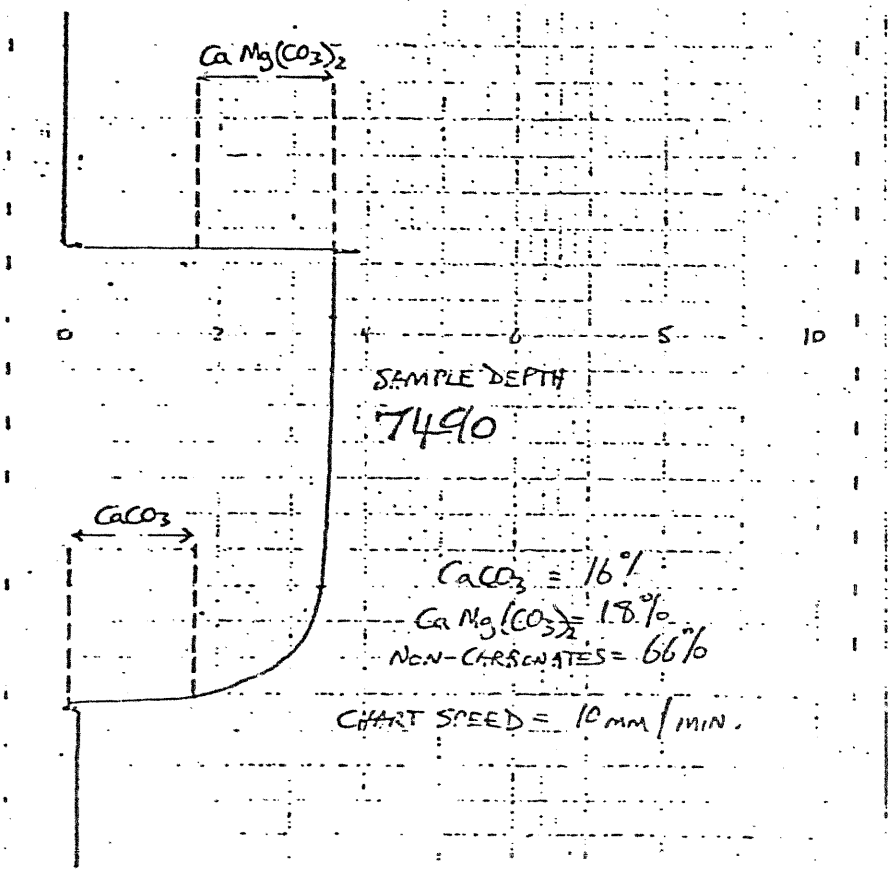
SAMPLE DEPTH
7430

LABORATORY AMBIENT TEMP.
297.7°K

$CaMg(CO_3)_2$
$CaCO_3$

$CaCO_3$ = 19%
$CaMg(CO_3)_2$ = 4.5%
NON-CARBONATES = 76.5%

SAMPLE DEPTH
7410



SAMPLE DEPTH
7490

$CaCO_3$ = 16%
$CaMg(CO_3)_2$ = 18%
NON-CARBONATES = 66%

CHART SPEED = 10 mm / min.

VIII CALCIMETRY Cont'd

Uses of Calcimetry

1. For the correlation of carbonate layers in stratigraphic studies.
2. In studies of environmental conditions during deposition.
3. For the identification of calcareous shales which may be associated with overpressured formations.

Advantages

1. It is a quick, simple and fairly accurate method of determining carbonate percentages.
2. The apparatus is relatively simple, reliable and easy to maintain.
3. It allows for the instant recognition of several types of carbonate.
4. Calibration is easy using 100% $CaCO_3$ and only needs to be done very occasionally.

Disadvantages

1. Readings are affected by even a slight change in laboratory ambient temperature and therefore constant monitoring of temperature is necessary.
2. It is important that only clean calcareous rock samples for the relevant depth are used and care must therefore be taken to ensure that cavings are not included if drill cuttings are used. Samples from a core will provide the most reliable readings.
3. Weighing of the crushed sample must be accurate.

Of course these drawbacks will apply to any scientific test so this method is really quite reliable, if it is used under controlled conditions.

IX MUD MONITORING SYSTEM

This is present in Unit 120 as secondary equipment in the form of Pit Volume Totalizer, Mud Weight and Mud Temperature measurements in and out of the hole.

1. Pit Volume Totalizer (PVT)

The basis pit level measurement is achieved using a float whose movement due to fluctuations in pit level provides a signal, via a potentiometer, the strength of which is directly proportional to the pit level. This signal is relayed to the Honeywell Recorder where the variations in float position, and hence pit level, are recorded as a blue line.

In Unit 120 a pit volume monitoring system is used in which the mud levels in a number of pits are monitored using a float pick-up unit in each pit and the signal from each pickup combined in the PVT to provide a digital readout and an input signal for the

multipoint recorder. The PVT has an alarm which can be set to sound immediately if any change in total pit volume of greater than ±1 barrel should occur.

2. Mud Weight

This is measured using a heavy steel ball which is totally immersed in the mud. As the mud density changes there will be a slight apparent change in the weightof the ball due to a change in the buoyancy factor. The ball is attached by steel cable to a transducer which translates any slight movement caused by an apparent alteration in the weight of the ball into an electrical signal transmitted to the logging unit. This signal is then represented both as a digital display of mud weight and as a printout on the Honeywell Recorder.

By placing a ball and transducer unit in the suction pit and another in the ditch, away from the effects of turbulence, a constant check of mud weight entering and leaving the borehole can be made, thus ensuring that a balanced mud circulation condition can be maintained during drilling.

3. Mud Temperature

Again this is measured by pickup units in both the suction pit and the ditch. A temperature probe is immersed in the mud and as the temperature varies, a signal is produced, via a transducer, which is relayed to the logging unit and the temperature of mud entering and leaving the borehole is thereby displayed both on a digital readout and on the Honeywell Recorder.

As a particular depth interval is drilled the mud temperature entering the hole is noted and when the samples representing that interval appear at the surface the flowline temperature is noted. A plot is made on the Exploration Logging Pressure Log of the flowline temperature and/or differential temperature, (flowline temperature minus suction tank temperature) in degrees Centigrade, in order to detect changes in geo-thermal gradient which may indicate an overpressured formation.

As there are many variables which may affect flowline temperature readings, such as lagtime, pump rate, lithology, length of flowline exposed to cooling conditions (especially relevant offshore where the marine riser must be taken into account) and any chemical treatment of the mud on the surface, this cannot be used on its own as a method for the prediction of overpressures. It can, however, be of some use when used in conjunction with other overpressure evaluation techniques such as d-exponent, shale density, shale factor and gas and borehole conditions.

X HONEYWELL MULTIPOINT RECORDER

The Honeywell Recorder is, in essence, a recording voltmeter and is used in the logging unit to record, via a printout on a stip chart, the measurements made by the gas detectors, pump stroke counters and secondary equipment such as pit volume totalizer, mud weight and mud temperature gauges. Each printout is colour-coded so it is possible to identify a certain reading immediately according to its colour.

Total Gas	= Red
Petrol Vapours	= Black
Pump Strokes	= Green
Pit Volume	= Blue
Mud Weight In/Out	= Brown
Mud Temperature In/Out	= Purple

When a signal is received from a detector it is amplified until it is large enough to turn a balance motor which drives a large aluminum gear and cable to reposition a printing carriage until it indicates the correct value. Since there are a number of voltages to be recorded, a rotary switch commutates the various input signals in a set sequence and the corresponding coloured point is printed on the chart.

The chart is driven at a constant speed of six centimeters per hour and has a scale from -10 to 0 to + 100 in 1-unit divisions. The recorder is calibrated for each detector separately, for example when the gas detector is showing a reading of 50 units Total Gas the recorder is calibrated to printout a red line at the +50 mark on the chart. If the total pit volume is 420 barrels the recorder can be calibrated to print a blue line at the +60 mark and this reading is multiplied by seven to obtain the correct pit volume measurement.

The Recorder is very reliable, needs little routine maintenance and it is possible for the logging geologist to repair most malfunctions which may occur. As such it is an integral part of the logg ng unit and is in operation continuously to allow for constant monitoring during drilling operations and also to provide a record of the pit volume during trips.

S E C T I O N E

COLUMBIA GAS DEVELOPMENT CANADA LTD. ET AL

PRESSURE REPORT

COLUMBIA GAS ET AL KOTANEELEE YT I-48

FEBRUARY 1980

SUBMITTED BY: M.A. Hodgetts
C.R. Lynden

I

INTRODUCTION TO PRESSURE THEORY

INTRODUCTION TO PRESSURE THEORY

I : TERMINOLOGY:

Basic understanding of pressure terms is essential to any discussion of pressure theory. The following is a list of terms:

(1) Hydrostatic Pressure:

$$P = 0.052 \times W \times D$$

where P = hydrostatic pressure, psi
W = fluid density, ppf
D = vertical depth, ft.
0.052 = constant of proportionality

(2) Equivalent Mud Weight:

$$We = \frac{Pp}{0.052 \times D}$$

where We = equivalent mud weight, ppg
Pp = formation pressure, psi

In abnormally pressured formations

$$We = Wf + \frac{Pe}{0.052 \times D}$$

where Wf = formation fluid density, ppg
Pe = pressure in excess of normal hydrostatic pressure, psi

With increasing penetration into an overpressured zone (increasing D), the extra mud weight required will decrease. Hence, if the mud weight is increased to balance formation pressure upon entrance of the zone, it will overbalance the formation pressure at greater depths within the zone.

In the event of a kick, with the mud weight being increased, sufficient pressure uphole may fracture the formation at the casing seat, due to the equivalent mud weight increasing uphole.

(3) Pressure Gradient:

$$\text{Pressure Gradient} = \frac{P}{D} = 0.052 \times W$$

Normal pressure gradients are: 0.433 psi/ft. (fresh water)
0.468 psi/ft. (saline water)

(4) Effective Circulating Density (E.C.D.)

E.C.D. is the total pressure effective at the bottom of the hole whilst circulating.

$$E.C.D. = Wo + \frac{\delta PA}{0.052 \times D}$$

where Wo = mud weight at surface (ppg)
δPA = annular pressure loss (psi)

I TERMINOLOGY Cont'd

Annular pressure losses are determined using the Power Model for the behaviour of a drilling fluid.

(5) Formation Pressure:

$S = \sigma + Pp$

where S = overburden pressure, psi
σ = rock grain pressure, psi
Pp = pore fluid pressure, psi

Pore (formation) pressure is the pore fluid pressure within any rock. Normally, this pressure will be quivalent to the hydrostatic pressure at the depth in question. A knowledge of environmental conditions is important, in order to understand the normality of any sequence. The Kotaneelee well was assumed to have a normal 0.435 psi/ft pressure gradient.

(6) Pressure Abnormalities:

If fluids are unable to communicate and equalize pressures, due to some form of restriction or barrier, an extra pressure will build up. If this pressure is positive, then the formation is said to be "overpressured". If negative, then the formation is said to be subnormally pressured.

Overpressured formations may be produced in several different ways, e.g. pressuring of a reservoir, communication between reservoirs at different depths, reservoir geometry and sub-compaction of claystones and shales.

(7) Formation Fracture Pressure:

The stress regime within a formation may be resolved into three perpendicular stress vectors, i.e. one vertical and two horizontal. Since overburden is usually the greatest of these three stresses, fractures are normally vertical. Cores taken in the Nahanni exemplified this.

The formation fracture pressure is the hydrostatic pressure which will open pre-existing fractures or initiate fracturing within the formation. Pressure integrity tests were held at the Kotaneelee well, although fracturing by the drilling fluid was very unlikely.

II : FORMATION PRESSURE INDICATORS

No pressure analysis plot, only pressure data plots, were made for the Kotaneelee well. However, ideas and recommendations concerning pressure phenomena were given using information gathered from the data.

The following is an explanation of each parameter which was monitored at the wellsite and plotted on the data log.

II FORMATION PRESSURE INDICATORS Cont'd

(1) Direct Pressure Measurement:

Formation pressures can be calculated from test results, or during a kick. The former was applicable to the Kotaneelee well, where test results gave a pressure of 9.4 ppg EMW for the Nahanni dolomite.

(2) Flowline Temperature:

The geothermal gradient for any normally pressured area is constant. However, across abnormally pressured formations the geothermal gradient is abnormally high. Since water has a lower thermal conductivity than rock matrix materials, higher water content in pressured rocks will reduce the thermal conductivity.

Measuring flowline temperatures is a practical way of determining temperature gradients. Care has to be taken in accounting for surface and treatments, flow rates, lithology, etc. Characteristically, temperature variations in and surrounding a pressure zone change dramatically. This can be detected at the flowline by a decrease or negative trend shift in temperature at the transition zone, followed by a sharp increase in temperature once the pressure zone has been entered.

(3) Rate of Penetration

Rate of penetration in a formation is controlled by several factors: force applied; rotary speed; tooth efficiency; differential pressure. With constant drilling conditions in a uniform lithology, rate of penetration would be controlled by formation compaction alone. Hence, there would be direct correlation of formation pressure to rate of penetration.

The drilling exponent or "d-exponent" is a formulation which tries to achieve a normalization of drilling factors so that the rate of penetration can be equated with formation compaction.

Jorden and Shirley modified Bingham's earlier work to give the following equation:

$$d = \frac{\log \frac{R}{60N}}{\log \frac{12W}{10^6}} \; B$$

where d = drilling exponent
R = rate of penetration ft/hr.
N = rotary speed, rpm
W = weight on bit, lb.
B = bit diameter, ins.

d is lithology specific.

II FORMATION PRESSURE INDICATOR Cont'd

Rehm and McClendon proposed a correction, taking into account the effects of mud weight.

$$dxc = d \times \frac{We}{ECD}$$

where dxc = corrected drilling exponent
We = normal pore pressure gradient-EMW (ppg)

DXC does not account for drilling hydraulics, tooth efficiency and matrix strength. Consequently, any major changes in these factors will be reflected in the dxc, e.g. tooth wear and change of bit type.

(4) Shale Density

Shale density is dependant upon matrix and fluid densities and porosity. In a normally pressured area, density will increase with depth as compaction increases and porosity decreases. If abnormally pressured shales are encountered then compaction is decreased and porosity increased, resulting in a lower shale density. A normal trend is first established as densities vary from area to area. Deviations from this trend, in the form of negative gradients will indicate an increase in pressure.

(5) Gas and Borehole Conditions

With a near balance condition, there will be a tendancy for the formation or fluids to enter the well. Kicks will occur if there are high permeabilities. If the permeability is low then large trip and connection gases will be seen, and if the fluid is unable to flow, the formation will tend to cave, e.g. sloughing shales.

Connection gases are a result of swabbing effects, and an indication that a near balance condition exists. Background gases are also a good indicator as to the nature of the balance. Gradual buildup of background gases, particularly in shales, suggests a near balance or slightly underbalanced condition exists. Also, communication fractures may give high background gas, whilst the general lithology itself is impermeable.

II

DATA COLLECTION AND INTERPRETATION

SECTION 1 : 300 - 1054m

This section was drilled with a mud weight of 900 - 950 Kg/m^3. No connection or Trip gases occurred. From 300m - 480m, the Dxc (corrected drilling exponent) data followed a normal trend with some scatter of data due to lithology variations - siltstone and limestone units will in massive Mattson sandstone.

From 480m - 669m, lost circulation was encountered and accurate mud weights were unattainable due to the large concentration of LCM in the mud system. This resulted in excessive Dxc data Scatter and an inability to reason an accurate trend line through this data.

From 669m - 900m, the Dxc follows a normally pressured trend. No connection or trip gases and a low, dead, background gas. This section was drilled with a 1080 Kg/m^3 mud weight.

From 900m to 1054m (casing point) a shift in trend was observed due to the change in lithology to siltstone and shale, but with still no connection or Trip gas activity.

Throughout this section, background gas rarely rose over 10 units.

Few shale density readings were taken due to the lack of a good clean shale. Those recorded vary between 2.46 and 2.58 g/cc.

340mm casing was set at 1054m. During the casing run, a waterflow was observed. A Pressure Integrity Test pressured the formation up to 1688 Kg/m equivalent mud weight.

SECTION II: 1054-3258m

A: 1054-1735

This unit comprises the lower part of the Mattson Sand which consists of massive sandstones with interbedded shales and siltstones. Below this is the Mattson Silt which is made up of-primarily-siltstones with interbedded sands, shales and carbonates. The Mattson Chert was encountered at 1497m.

This section was drilled using bulton bits. The rate of penetration was low, averaging between 20 and 40 minutes per meter. Bit runs were considerably longer than the next of the hole with a maximum of 274 meters in 125 hours. Tooth wear varied between 2 and 8 but bearing wear was consistently low between one and four. All bits were pulled in guage.

The Dxc data invoked a good trend but a great deal of scattering-due to lithology changes-was observed. Long bit runs aided this good trend.

The mud weight was progressively increased over this section from 1057 Kg/m^3 at 1735m.

The gas readings throughout this section were again low, rarely above 10 units. The first Trip Gas was encountered at 1074m and was 6 units. The first Connection Gas was recorded at 1357m. Trip Gases varied between 6 and 56 units, Connection Gases from 2 to 47 units.

Shale density values ranged from 2.51-2.61 g/cc and no abnormal trends were detected.

At 1364m, the pipe became stuck. Abundant cavings were also seen. This may well have been due to sloughing shale.

B: 1735 - 2615m

This section was drilled through the Mississippian Flett Formation. This comprises of massive limestones-the upper, middle and lower carbonate members-shales, siltstones and some thinner carbonate interbeds.

Severe hole problems whilst drilling this section resulted in two side tracks.

Forty six bits, in all, were used to drill this section.

From 1735 - 2450m, few problems were encountered. Good bit runs were associated with a rate of penetration hovering around 22 minutes per meter.

From 2450 - 2615, serious hole problems were encountered. Low penetration rates and short bit runs were the rule.

At 2508m, the drill string became stuck in the hole after encountering some tight hole problems. It was not possible to retrieve the Bottom Hole Assembly so the hole was plugged back and a new hold started at 2392m. After drilling this new hole for almost 50m, severe tight hole problems reoccurred. The pipe stuck at 2456m then again, this time stuck fast, at 2508m. It was not possible to retrieve the Bottom Hole Assembly. A second plug and sidetrack was required. An analysis of the geological information at hand indicated the existence of a high angle fault plane which the bit had followed both times causing the problems. It was decided that, in order to miss this zone of faulting, it would be necessary to plug back at least 500m and attempt to straighten up the hole. The second sidetrack hole was started at 1953m. This proved successful in circumnavigating the problem zone.

Mud weights were stable up to 2410m, ranging between 1160 and 1170 Kg/m^3. Weighting up to 1320 Kg/m^3 subsequently was attained, although the weight was lowered to around 1270 Kg/m^3 below 2525m.

The Dxc data plot exhibited a good trend from 1735m to 2270m, showing a normally pre-pressured sequence. Deviations due to the appearance of marls, carbonates and cherts were apparnet.

Due to short bit runs and tight hole problems, below 2270m, Dxc values became erratic.

Gas readings provided a useful indication for the major fault zones.

From 1735m to 2350m, background gas readings fell between 5 and 40 units, but with several peaks (2227m, 2314m) up to 900 units. Gas readings exhibited a steady increase from 2350m to 2450m, averaging about 70 units and rising over 200 units.

Ethane was present in small quantities below 2348m.

In all three holes, a marked increase in gas readings occurred around 2450m. This coincided with tight hole problems and sloughing shales as well as several pronounced gas 'cuts'. Gas readings here were occasionally off scale. On the first hole, at 2427m, propane was encountered and again between 2454m and 2480m. Iso-butane was also present between 2454m and 2462m on the first hole.

Connection gases ranged from 2 units in the upper part of the section to over 3200 units approaching the fault zone.

Trip gases range similarly from 22 to over 3200 units.

Flowline temperature readings became very erratic in the problem area due to the large number of trips.

Shale density values showed normal trend in the upper part of the section but values in the problem area are considered to be of poor quality due to the abundance of cavings occurring in the samples.

C: 2615 - 3258m

This section was drilled through the Besa River Formation. It consisted of thick shale sequences interbedded with siltstones and carbonate, and with a few marl and clay sequences. The section was drilled fairly slowly using both medium and hard tooth bits, and soft insert bits. The average rate of penetration was around 40 minutes per meter. Tooth and bearing wear varied from 1 - 8 in both cases.

Mud weights were gradually lowered from about 1300 Kg/m^3 to 1250 Kg/m^3 during the drilling of this section.

The Dxc plot showed a normally pressured sequence from 2615 - 3225m. There was a slight indication of an overpressured zone from 3225 - 3258m which was also accompanied by an increase of background gas.

The flowline temperature plot showed a normal trend increasing from 48^o at 2615 - 58^o at 3258m.

Shale densities showed a very slight normal compaction trend with valu ranging from 2.56 - 2.62 grams/cc. Sloughing shales were still a problem in this section of the hole resulting in this section of the hole resulting in poor sample quality especially in the upper part.

Background gas varied considerably throughout this section, generally the readings were quite high and on a number of occasions especially towards the bottom of the section the readings were in excess of 1000 units. Connection Gases varied from 5 - 3200+ units and Trip Gases from 440 - 3200+ units.

244mm casing was set al 3258m.

SECTION III 3288 - 4429.4m

This section was drilled through the lower Besa River, Horn River, Nahnni, Headless and Arnica formation. Due to two distinct lithological differences

The Dxc data plot shows a reasonable trendline but is affected markedly by lithology differences. The values seem to take a slight negative trend approaching the Nahanni formation. This may be due to an increase in dolomite cement of the rock at very slight over-pressure.

Mud weights were lowered from 1235 Kg/m^3 on drilling out to 1150 Kg/m^3, but around 3600m weighting up was again accomplished back to 1235 Kg/m^3, in anticipation of encountering abnormal pressure when approaching the Nahanni Formation.

The temperature plot showed a reasonable trend although the number of bit runs caused a number of shifts to the left.

The gas readings throughout this unit were considerably lower than the previous section, this is due to the major gas zones having been cased off. The gas ranged from 5 - 180 units although it rarely ranged from 4 - 480 units and Trip Gas values ranged from 200 - 2060 units.

Shale density values showed a normal compaction trend throughout the unit.

UNIT B 3648 - 4429.4m

This unit was drilled through the Nahanni, Headless and Arnica formations. The formation consisted of a fractured, brecciated vuggy dolomite. Sixteen cores were taken in this unit at various dpeths. The rest of the unit was drilled using medium hard and extra hard insert bits. Both tooth and bearing wear varied between one and eight due to the variable lenghts of bit runs.

Mud weights ranged from 1235 Kg/m^3 lowering to 1190 Kg/m^3 total depth.

Two areas of lost circulation were encountered - the first losing mud at a rate of 4m^3/hour, at 3765 - 3783m; and 3m^3 was lost in 20 minutes

at 3802m. Both times LCM was circulated. No problems (due to the bypassing of the shakers to retain the LCM were circulated to the surface between: 3783 - 3791m, 3815 - 3825m and 3839 - 3845m.

The Dxc plot shows a marked scattering over the first part of the unit, primarily due to the fractured, brecciated, nature of the dolomite. The plot showed a normal trend towards the bottom of the unit.

The temperature plot was broken up by the numerous trips involved in coring, but on some of the longer bitruns a normal trend was seen.

The gas readings varied from 10 - 250 units, the higher readings associated with the more fractured and vuggy dolomite. Connection gas readings ranged from 7 - 60 units and Trip Gas readings ranged from 120 - 1280 units.

Mud was being lost to the formation at 3770m at a rate of $4m^3$/hour. LCM was added to the system which proved successful in halting the lost circulation.