GEOLOGY OF THE HAT CREEK COAL BASIN

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Introduction

Several hundred millions of tonnes of sub-bituminous coal have been outlined by recent drilling in the upper section of Hat Creek Valley 22 kilometres west of the village of Cache Creek (Fig. 1). Current exploration, sponsored by the British Columbia Hydro and Power Authority is directed towards defining these reserves more clearly with a view to the possible installation of a thermal power plant.

This report is intended as an outline of the geology of the Hat Creek basin based mainly on field observations during June and July 1975.

PHYSIOGRAPHY AND GLACIATION

The valley formed by the headwaters of Hat Creek, site of the coal deposit, is a northerly trending topographic and structural depression 22 kilometres long and 3 to 5 kilometres wide. It is an open basin bounded by the rugged Clear Range on the west and Cornwall Hills on the east. Relative relief is marked by slopes rising from Hat Creek, near Marble Canyon at the north end of the valley, at an approximate elevation of 820 metres (2,700 feet), to the encircling ridges and peaks in excess of 2000 metres (6,500 feet) above sea level.

It appears that the valley was overridden by two and possibly several Pleistocene ice sheets (*Plate 1*). The most recent advance originated in the Coast Mountains and moved easterly at 117 degrees, according to average striae measurements, depositing much gravel and clay. Except for the coal beds now exposed at the north end of the valley, bedrock is rarely seen on the valley floor. Reconnaissance drilling shows that the average till cover and glacial outwash ranges from 10 to 100 metres thick, averaging about 50 metres.

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The soils of Hat Creek valley are characteristically clay-rich and have unusual swelling properties when water saturated. This swelling tendency suggests the presence of montmorillonite - a clay formed by the decomposition of glassy volcanic rocks.

The consequence of this clay-rich mantle is evident throughout the valley resulting in poor ground water drainage and a number of large landslips.

History

The presence of an important coal deposit on Hat Creek has been known for many years. It was first reported by G.M. Dawson of the Geological Survey of Canada in 1877 and again in 1894.

The first attempt to work the deposit was in 1893 by a rancher, George Finney, who supplied coal to local residences and the village of Ashcroft. During the period

1895 to 1925 the property was operated by a number of companies including the Hat Creek Coal Co., the production being small and intermittent. The total development to 1925 amounted to three shallow exploration shafts, two tunnels driven 35 metres and 50 metres from the west side of Hat Creek, and seven drill holes - altogether testing an area of about 45 hectares located approximately 1½ kilometres south of Marble Canyon.

The property lay dormant until 1933 when it was secured by L.D. Leonard. In the period 1933 to 1942 a production of a few hundred tonnes a year was realized supplying local needs. No further work was done until 1957.

In 1957 the B.C. Electric Co. Ltd., through a subsidiary, gained control of the property. Eight holes were drilled at this time. The investigation continued in 1959 when some trenching and six additional holes were completed west of Hat Creek near the old workings.

Acquisition of B.C. Electric by the Province ended further exploration until mid-1974 when B.C. Hydro and Power Authority, a crown owned company, began the current program of systematic drilling. Twenty-five diamond drill holes and two rotary holes totalling 11,418 metres were completed in 1974 and 76 diamond drill holes totalling 22,556 metres in 1975. In addition, ground level magnetometer and gravity studies were undertaken covering the entire length of the valley.

General Geology

The geology of the Hat Creek area was described originally by Dawson, 1877 and 1894, and amplified later by MacKay, 1925, and Duffell and McTaggart, 1952. Recent studies include a number of private investigations by Dolmage Campbell and Associates for the British Columbia Hydro and Power Authority and work by Höy (this publication, pages to). The results of reconnaissance mapping by the writer in 1975 are shown on Figure 1 .

MacKay provides a good geological summary (p. A 219) :

"The oldest rock formation exposed near upper Hat creek and the one which apparently underlies all of the coal-basin is a thick series of compact grey limestones and argillites of Carboniferous age. These beds, termed by Dawson the Cache Creek group, have been folded and faulted and 3 miles to the west of upper Hat Creek are intruded by several large granitic stocks composed of granite, granodiorite, and diorite, so that much of the limestone has been converted into marble, hence the name Marble Canyon. The age of the intrusives is not definitely known, but they are thought to be Jurassic, the period of the Coast Range batholith intrusion.

Lying unconformably upon the limestone is a series of early Tertiary lake deposits, several thousand feet thick, consisting of a basal conglomerate overlain by brown to purplish weathering semi-indurated sandstones, shales, and clay, which in the upper part of the series carry thick seams of lignite. The sediments, which have been designated by Dawson the Coldwater group, are confined to the lower slopes of Hat Creek and it may be that the coal-basin is very limited in extent. From the divergence of dip observed in the tunnel sections and the volcanic outcrop 1,000 feet distant the Tertiary sediments appear to be unconformably overlain by Miocene volcanics consisting of basalt, breccias, and tuffs, the latter being in places fine-grained and showing distinct stratification as if laid down under water. These have also been subjected to folding and faulting parallel to the general axis of the valley, so that they now dip at angles up to 45°. The volcanics have their greatest development to the west of Hat creek, covering all of Clear Mountain range, where the vents were apparently located. Late Tertiary erosion has largely removed the volcanics from the valley area, but remnants of the extensive flows still occur on the east slope of the valley and on the west of Hat Creek close to the coal-outcrop."

The volcanic rocks, considered by Dawson to be all Tertiary age are now known to comprise a broader assemblage consisting of both Cretaceous and Tertiary lavas and breccias referred to as the Spences Bridge Group and Kamloops Group, respectively (Duffell and McTaggart, pp. 54 and 66).

SEDIMENTARY ROCKS

The sedimentary assemblage is known mainly from drilling because of poor bed rock exposure.

Examination of the drill core shows that the coal formation is ~~indeed~~ many ~~of~~ hundreds of metres thick as suspected from previous studies. Almost everywhere it appears to be overlain by a thick deposit of claystones and siltstones. Owing to the great combined thickness of the coal measures and covering rocks, often in excess of 600 metres, no drill holes have completely penetrated the sedimentary pile. The few deep holes that have gone below the coal have intercepted siltstone, sandstone, and conglomerate ~~beds~~. The thickness and lateral extent of this basal unit in the map-area remains uncertain.

The names Coldwater Beds, Hat Creek Coal Formation, and Medicine Creek Formation are applied to the lowest, middle, and upper sedimentary units, respectively, for informal use pending more detailed description.

Coldwater Beds

The use of the name 'Coldwater Beds' in this report is consistent with Dawson's original reference to the basal Tertiary sandstones and conglomerate but differs in so much as the coal formation and younger sedimentary rocks are here assigned to separate formations.

Typically the Coldwater beds consist of firmly indurated brown sandstones and conglomerates, about 1,372 metres thick, as found exposed along the lower section of Hat Creek northeast of the map-area. The clasts are commonly well sized and rounded and have a mixed provinence. A thin section study of 10 representative sandstone samples gives an average of chert and quartzite, 45 per cent (from the Cache Creek Group); quartz and feldspar, 35 per cent (from a granite source); and accessory greenstone, mica schist, and carbonate fragments.

The presence of Coldwater beds in the map-area is indicated by blocks of conglomerate in the glacial deposits near Hat Creek south of Marble Canyon and one small outcrop of conglomerate near Ambusten Creek three kilometres above the confluence of this stream with Hat Creek. From the results of drilling, Hole No. 43 penetrates what is believed to be some of the uppermost Coldwater beds. This is a thickness of about 90 metres of sandstone and conglomerate followed upward by 130 metres of claystone and sandstone to the base of the coal formation, (Fig. 2).

According to Dawson, the Coldwater beds are fluvial accumulations emplaced prior to the main phase of early Tertiary volcanism. Volcanic clasts in these rocks were probably derived from the basement formations, mainly the Cache Creek Group, and the fresher Cretaceous volcanic units which underlie much of the area.

Hat Creek Coal Formation

The name Hat Creek Coal Formation is applied to the coal measures. The principal exposures are along a 400-metre section of Hat Creek about 1½ kilometres south of Marble Canyon (Plate 2). This area, which includes the original coal discovery, is referred to as No. 1 Reserve. A second coal deposit, the No. 2 Reserve, discovered by recent drilling, is centred about eight kilometres to the south near the mid-point in the valley, (Plate 3).

The general stratigraphy of the coal formation, especially in the area of No. 1 Reserve, is known from detailed studies of drill core. The formation, comprising somewhat more than 425 metres of strata, consists of three principal seams. These are well displayed in Hole No. 44 which is approximately perpendicular to bedding representing what is thought to be a complete section

The uppermost seam, about 160 metres thick, constitutes more than 1/3 of the total formation. It is a relatively impure sequence of alternating coal, seat earth, and siltstone and sandstone lenses. Calculations based on density measurements indicate that total impurities amount to about 28 per cent by weight of the seam.

The middle and lower seams are comparatively thin, 50 metres and 70 metres thick respectively, and are separated by zones of sandy siltstone, conglomeratic sandstone, and a few thin coaly bands. These seams are relatively clean having an estimated 23 per cent impurities.

The lower half of the lowest seam has the largest apparent volume of clean coal, a thickness of about 30 metres with only about 14 per cent impurities.

The character of the coal has been the subject of much research. MacKay provides a good general description (P. A 327):

> "Hat Creek coal has a dark brown to black colour and a dull resinous lustre. Hand specimens of the clean coal show alternating layers and lenses of bright and dark material, which range in thickness from microscopic size to several inches. The bright layers represent that part of the coal derived from wood and the dull portions the parts made up of debris. On drying, the coal breaks with a conchoidal fracture into small, irregular blocks, which on exposure to the weather further disintegrate, yielding very little lump. The coal does not soil the fingers on handling. On firing, it steams and sweats until the excess moisture is driven off, after which it burns with a bright-yellow flame. Parts of the coal are characterized by small lenses, globules, and irregular-shaped masses of light-yellow semi-transparent fossilized amber or retinite. Much of the coal shows highly polished slickensided surfaces, whereas other parts are made up of small angular fragments of amorphous coal partially or completely surrounded by a calcareous mud. Much

> of the coal is thus rendered valueless. Carbonated tree-trunks occur in several horizons and these in some instances have been converted into ironstone."

The rank of the coal according to the ASTM system is subbituminous "B". It has a gross rating of about 6000 Btu/lb at the 20 per cent moisture level. A ~~recent~~ B.C. Hydro investigation of the 1974-75 drilling (McCullough 1975. p. 7) reports the mean composition of coal as follows (20% moisture, 25% ash): carbon, 37.72 per cent; oxygen, 12.93 per cent; hydrogen, 2.94 per cent; nitrogen, 0.92 per cent; sulphur, 0.41 per cent; chlorine, 0.02 per cent. The composition of the ash is given in the accompanying table of chemical analyses (No. 3).

The sedimentary rocks intercalated with the coal vary in grain size from claystones to pebble conglomerates. Of the few thin sections of this material examined by the writer there is a surprisingly large proportion of fresh volcanic ~~rock~~ clasts and only a few quartz and feldspar grains derived from pre-Tertiary granitic rocks.

Thin cream coloured bands, conspicuous at a number of horizons in the coal seams, are thought to be altered ash layers from contemporaneous volcanism. Chemical analyses of a sample of this material (No. 1 , Table of Chemical Analyses) gives oxide values similar to 'tonsteins' of volcanic origin (Price and Duff, 1969). A peculiar yellow tonstein exposed above the coal measures on the south side of Dry Lake gulch (No. 3, Table of Chemical Analyses) was found to consist of approximately 60 per cent (molecular) kaolinite and 40 per cent montmorillonite.

The origin of the Hat Creek coal remains mostly a matter of speculation. However, the inland isolation of the deposit and a general absence of marine or brackish water fossils suggests a limnic (continental) as opposed to a paralic (coastal) paragenesis. This conclusion is strengthened by other evidence such as the astonishing thickness of the seams. Also the coal beds appear to terminate laterally by lithification rather than digitation or splitting. The formation maintains more or less a constant thickness although the height of clean coal varys markedly over short distances passing into shaly coal then coaly shale.

The general dull lustre and massive character of the coal combined with some banding and conspicuous woody matter and resin suggests a mixed open moor, forest moor, and lacustrine facies. The lower and middle seams record a cycle of emergent moor through to submergent lacustrine and renewed emergent conditions. The large upper seam displays a history of what appears to be repeated destruction of vegetation by flooding accompanied by influx of clay and silt.

Medicine Creek Formation

The name Medicine Creek Formation is applied to a monotonous siltstone, claystone sequence overlying the coal. It is a remarkably homogeneous cream coloured unit having more or less a uniform density of about 1.8 gm/cm^3. Except for a few zones of laminated carbonaceous argillite, the rock is almost massive with only occassional vague expression of bedding planes.

Petrographically the rock consists of small angular quartz fragments, shredded mica, and clay. Chemical analysis of the rock (No. 4, Table of Chemical Analyses) differs slightly from average Mississippi River silt (Clarke 1924, p. 509). Calculations give a molecular composition of, quartz, 55 per cent; feldspar, 18 per cent; the remainder being equal proportions clay, mica, and water.

The total thickness of the formation is unknown because of erosion of the upper beds, however, it is certainly in excess of 600 metres, the true bedding intersection observed in Hole No. 54, (Fig. 2).

The abrupt contact with coal beds at the base of the formation indicates a sudden change in depositional conditions from moor facies to lacustrine. The sharp contact is a marker horizon recognizable throughout the coal measures .

VOLCANIC ROCKS

The sedimentary formations are confined geographically and stratigraphically by major volcanic units. The easily eroded coal and shales occurring mainly on the floor of the valley are virtually surrounded by resistant volcanic rocks on the valley slopes and ridge crests. The older Spences Bridge Group underlies a broad region to the west and south of the sedimentary rocks, and younger volcanic rocks of the Kamloops Group fringe the basin mainly on the east and northwest.

The Spences Bridge Group

The Spences Bridge Group, where examined by the writer along the western boundary of the map-area, conforms to the descriptions of Duffell and McTaggart. This is a thick sequence of gently dipping lavas and pyroclastic rocks of mainly dacitic and andesitic composition.

The rocks are mostly massive, brittle, and grey or light greenish grey. In thin section they are characterized by rectangular phenocrysts of plagioclase mixed with a few subhedral pyroxene grains, 1 to 2 mm. in diameter, and set in a matrix of very small aligned feldspar microlites and fine magnetite dust. The normative composition of an analysed dacite sample ~~of Chemical Analysis)~~ shows; quartz, 15 per cent; feldspar, 80 per cent, and 5 per cent combined pyroxene and magnetite (No. 5, Table of Chemical Analyses).

The age of these rocks is considered to be Lower Cretaceous (Aptian) based on plant fossils (Duffell and McTaggart, p. 55).

Somewhat younger volcanic rocks, also mapped as part of the Spences Bridge Group by Duffell and McTaggart, are exposed near the south boundary of the map-area. These are mostly basaltic lavas ~~recently~~ dated as Upper Cretaceous (whole rock K/Ar analysis, 88.3 ± 3.7 m.y.).

The rocks are petrographically distinctive being charged with feldspar crystals 1 to 4 mm in diameter. In thin section fresh labradorite phenocrysts are embedded in a groundmass of randomly arranged plagioclase microlites and interstitial magnetite, pyroxene, and a small amount of what appears to be serpentinized olivine. The normative mineralogy based on chemical analysis of a typical sample ([redacted]) gives; quartz, 1 per cent; feldspar, 75 per cent; pyroxene, 20 per cent; and magnetite, 4 per cent (No. 6, Table of Chemical Analyses).

Kamloops Group

The volcanic rocks of the Kamloops Group defined as Miocene and earlier Tertiary (Duffell and McTaggart, p. 64) are considered partly cogenic but mostly younger than the sedimentary formations. Tuff bands intercalated with the coal represent the oldest Tertiary volcanism in the area. These were followed by eruption of rhyolite locally and emplacement of a thick deposit of andesite and dacite lava, breccia and lahar - referred to here as the Finney Lake Beds. The youngest episode of volcanism is represented by a few small outliers of olivine basalt lava.

Rhyolite Formation

Duffell and McTaggart (p. 67) note the occurrence of porphyritic rhyolite near the town of Ashcroft as;

> "one of the earliest phases of Tertiary volcanism in the district."

The rhyolite rests directly on Jurassic shales and is overlain locally by basalt.

In the Hat Creek area rhyolite is found on hillocks below and immediately to the west and north of White Rock Bluff. These exposures are lava and bedded pyroclastics. The age of the formation determined from K/Ar analysis of biotite is 49.9 $\pm$ 1.4 m.y., Middle Eocene.

Thin section studies indicate that much of the lava is holocrystalline. Phenocrysts of quartz, sanidine, plagioclase, and biotite, 1 to 3 mm in diameter, constitute about one per cent of the rock. Except for quartz which is commonly corroded these crystals are euhedral in outline and dispersed throughout a microcrystalline groundmass which, according to norm calculations, is composed of quartz, 35 per cent; sanidine, 20 per cent; oligoclase, 40 per cent; ferromognesian minerals (biotite and magnetite), 5 per cent.

A larger outlier of rhyolite is centred in the Trachyte Hills immediately east of the northeast extremity of the map-area. This is a massive non-porphyritic, cream coloured lava, undoubtedly the remnant of a lava dome, similar chemically to the White Rock Bluff rhyolite occurrence (see Nos. 9 and 10, Table of Chemical Analyses). The dome, which forms a topographic high at the north end of the Cornwall range, rests unconformably on inclined Coldwater beds.

Finney Lake Beds

The Finney Lake Beds comprise by far the greatest part of the Kamloops Group in this area. The formation consists of andesite and dacite lava flows and coarsely bedded volcaniclastic deposits.

The maximum development of the formation appears to be just east of Finney Lake where a thickness of approximately 290 metres of mainly volcaniclastic rocks have been intersected in Hole No. 47, (Fig. 2). Similar beds composed of lahar with admixtures of sandstone and conglomerate are well exposed along the lower section of Medicine Creek just above the main road and in the area to the south along the east side of the valley almost to White Rock Bluff. Outcrops of the same rock can also be found scattered along the west side of the valley from the region south of Marble Canyon to beyond Park Lake.

Lahar beds predominate in the volcaniclastic pile. They consist of rounded and subangular blocks ranging to several feet in diameter suspended in a mud matrix - the manifestation of chaotic rubble flows (Plate 4). The fragments are an assortment of light grey dacite, dark andesite, and dark grey to light cream coloured obsidian and perlite clasts.

The interbedded sandstones and conglomerates are compositionally similar to the lahars appearing to be the washed and sorted, stream-worked equivalent. In thin sections, the sandstones consist almost entirely of volcanic clasts; fragments usually charged with feldspar microlites, accompanied by a small amount of chert and quartz.

The main lava deposits, source of much of the volcanic rubble, flank the valley on the east and west sides.

Dacite flows are best exposed on the low cliffs that extend south to Medicine Creek, from a point about one mile east of the entry of Hat Creek into Marble Canyon. Typically this is a fine grained, non-porphyritic, light grey and brittle rock that tends to cleave into thin subparallel plates. A whole rock K/Ar determination gives an age of 49.1 $\pm$ 1.8 m.y., Middle Eocene - only slightly younger than the rhyolite formation.

The andesitic volcanic rocks are stratigraphically and compositionally gradational with the dacites. Commonly andesites are dark grey, and like the dacites, they are fine-grained, brittle rocks. Arc fusion analysis of eight samples of aphanitic lava show a range in refractive index of artificially prepared glass from 1.507 to 1.555, the average 1.535 marking an even division in the frequency of andesite and dacite samples.

Chemical analyses of representative samples of lava are given in the accompanying table (Nos. 7 and 8). Significant differences are noted in the normative mineralogy comparing the results for andesite and dacite, respectively: quartz, 2 percent and 20 percent; potassium feldspar, 10 percent and 20 percent;

plagioclase, 75 percent and 55 percent; and ferromagnesium minerals, 13 percent and 5 percent.

The contact relationships of the Finney Lake Beds are generally obscured because of poor exposure, however, the available evidence suggests the presence of an important unconformity at the base of the formation. The nature of the contact with older Tertiary rocks is 10 kilometres north of the northeast part of the map-area where dacite lavas are found resting on Coldwater Beds, and in the area west of White Rock Bluff where volcaniclastic rocks are unconformable on inclined Medicine Creek mudstones and the coal formation. The contact relations with pre-Tertiary rocks are viewed in the area immediately west of Bedard Lake where andesite lavas directly overlie Cache Creek limestone and south of Blue Earth Creek where dacite lavas are unconformable on feldspathic basalt flows of the Spences Bridge Group.

The occurrence of a thin zone of coal and carbonaceous shale in the Finney Lake Beds near the bottom of Hole No. 47 (Fig. 2) is in keeping with the discovery of logs and wood splinters in the lahar deposits. It is believed that the area had developed a rolling terrain with marshy low lands and wooded slopes at the time of volcanic eruption. Destruction of vegetation was apparently consequent of the partial infilling of the low areas with volcanic debris - mostly mud slides.

The volume and lateral extent of the coaly member in this formation is not thought to be great.

Olivine Basalt

Olivine basalt lava, the youngest formation in the Kamloops Group, occurs in three small areas. The largest exposure is on the crest of a low ridge immediately east of the No. 2 Coal Reserve. Two smaller outliers are in the northeast part of the map-area centred about 2½ and 5 kilometres north of Medicine Creek

The rocks are fresh, dark grey or black, and speckled with small olivine crystals. In thin-section the olivine forms both diamond-shaped and partially rounded grains, ¼ to 2 mm. in diameter, scattered throughout a matrix composed of tight ophitic growths of pyroxene and plagioclase, accessory magnetite, and a small amount of interstitial glass. The normative mineralogy, calculated from analysis of a typical sample of lava shows; plagioclase, 57 per cent; pyroxene, 26 per cent; olivine, 15 per cent; and magnetite, 2 per cent. (No. 11, Table of Chemical Analyses). Whole rock K/Ar analysis of this sample gives a Middle Miocene age of 13 m.y.

Younger volcanic rocks are not observed in the region, except perhaps for a few ash bands in the Pleistocene tills. Bands of reddish soil, conspicuous at several points in the valley near coal seams, appear to be ash layers from burnt coal. A breccia exposed on the south embankment overlooking Dry Lake, described by MacKay 1925 as a volcanic dyke (plate facing p. A 320), is probably only pseudo scoria, an example of the cindery residue of burnt coal. Analysis of this rock proves it is unlike any other volcanic rock, having a composition unusually enriched in alumina, iron oxide, and lime (No. 12, Table of Chemical Analysis). There is evidence suggesting that much, if not all of the exposed coal in the Hat Creek valley has been superficially burnt in prehistorical times.

Structure

The Hat Creek basin is similar to a number of Tertiary grabens and half-graben structures scattered across central and southern British Columbia. As a narrow intermontane depression bounded by steep faults, it resembles the Bowron River basin near Prince George. In thickness of volcaniclastic, lacustrine, and fluvial beds, the Hat Creek section is comparable to the White Lake deposits near Penticton. It is only in thickness and volume of coal that the Hat Creek basin is outstanding.

The general structure of the basin is simple. The central zone of the valley, underlain mainly by coal and sedimentary formations, has been down-dropped forming a graben. This has been achieved principally by downward movement on a series of north-south tension faults trending subparallel to the direction of regional maximum stress, the walls of this graben having been offset locally by northwest and northeast-striking conjugate shear faults (Fig. 3). An important system of easterly trending gravity faults cutting across the basin appears to be of more recent origin being superimposed on the main graben structures.

A study of minor fractures throughout the map-area shows a general concurrence in orientation with important faults (Fig. 4). The strongest joint development striking about 035 degrees and a weaker system striking 165 degrees, both dipping steeply, coincide roughly with the shear directions. Other fractures striking about 080 degrees and weaker sets at 125 degrees are subparallel to cleating in the coal and cross faults.

The detail structure of the coal measures is known only from the drill holes and a few outcrops and old tunnels. The available information is mostly on No. 1 Reserve, reconnaissance drilling in the area of No. 2 Reserve being incomplete.

According to drill results, using the base of the Medicine Creek Formation as a marker, the average bedding in the area of No. 1 Reserve is believed to dip southerly at about 25 degrees. Some divergence of bedding attitude noted locally is probably due to faulting accompanied by ~~the development of~~ minor folds. For example strata exposed on Hat Creek and the outlet of Dry Lake dip southeasterly, having attitudes of 040° - 45° SE and 075° - 47° SE respectively, whereas farther south on the west bank, dips to the southwest are most commonly recorded. MacKay (p. A 320) has described the local disruption of beds viewed in one of the old tunnels in this area (now collapsed);

> " -- the beds are folded into two synclines which are separated by a compressed and faulted anticline. The axes of these folds strike 170 degrees and plunge 10 degrees south ."

Figure 5A is a conceptual model of the No. 1 Reserve area. A central panel, bounded on the east and west by major north-south gravity faults, is segmented internally by a series of minor east-west reverse faults. The pattern of movement within the panel, of slices on the north moving down relative to adjacent slices on the south, has resulted in a net decrease in the southerly dip of the coal formation. The overall result of faulting on the coal formation is a gently southerly plunging trough or syncline-like structure.

The structure of No. 2 Reserve is thought to be relatively straight forward. The deposit is a sinuous 3.5 kilometre long band of coal paralleling the valley and the axis of a large gravity anomaly (Fig. 2). Drilling shows that the coal formation is inclined 20 to 30 degrees dipping westerly under the Medicine Creek mudstones, the strike of the beds paralleling major north-south gravity faults. The repetitive effect of the north-south faults across the graben is a trap-door-like downward rotation of beds on the west and a net increase in the westerly dip of the coal measures (Fig. 5B). The repetitive faulting and resulting steep dip of the coal also explains the coincidence of the large negative gravity anomaly with the No. 2 Reserve.

In general, the history of the Hat Creek basin is one of downfaulting. The evidence suggests that elements of the graben structure probably prevailed from the time of the Coldwater stream deposits, to the emplacement of the coal measures, lake sediments, and the final period of volcanic eruption.
The controlling factors in the development of the thick coal

accumulations were unlike sea-level coastal conditions, and required maintenance of a high water table and a marshy environment over a long time interval. The water level in the basin was probably governed by a spillway which may have been influenced by the Fraser River fault system, known to have been active in the Tertiary, or possibly volcanic eruption affecting drainage.

Coal Potential

The investigation of the coal measures is difficult because of down dip burial of the coal under younger formations and the displacement of beds by faulting. Nevertheless it is estimated that No. 1 Reserve alone consists of approximately 117 hectares of potentially extractable near surface coal, the coal formation ranging from 150 to 300 metres thick. Calculations based on data from 21 drill holes indicates slightly more than 200 million tonnes to base elevation of 760 metres. Additional calculations on fewer drill penetrations suggest that about twice this tonnage can be realized by extending mining downward to base elevation of 600 metres.

The calculation of tonnage for No. 2 Reserve awaits further drilling results to establish the extent of the zone . There seems to be general consensus, however, that the volume of coal here well surpasses the No. 1 deposit. The quality also appears to be superior with only 15 to 25 per cent clay admixture.

The subsurface extent of the coal measures can be roughly judged from the gravity contours on Figure 2.

A tabulation of the results of drilling to July 20th, 1975, accompanies this report.

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