British Columbia Geological Survey
Geological Fieldwork 1990

BURNT RIVER MAPPING AND COMPILATION PROJECT (93 P/5, 6)

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KEYWORDS: Coal geology, Peace River, Burnt River, Gwillim Lake, Boulder Creek, Gates, Gething, structure, coal rank, coalbed methane.

INTRODUCTION

This study continues the 1:50 000-scale geologic mapping program in the Peace River coalfield. The study area is adjacent to the recently completed mapping of the Bullmoose and Kinuseo map sheets to the south (Kilby and Wrightson, 1987a, b, c; Kilby and Johnston, 1988a, b, c; Kilby and Hunter, 1990). The objective is to produce Open File maps of 93P/5 and the southwest half of 93P/6 to be released in early 1991 (Figure 5-7-1). These maps will display data collected in the field in June, July and August 1990, as well as substantial outcrop and borehole data from coal and gas exploration reports.

LOCATION

The study area encompasses approximately 1300 square kilometres in the Rocky Mountain Foothills of northeastern British Columbia. Located midway between Chetwynd and Tumbler Ridge, the area is predominantly tree covered with topography ranging in elevation from 600 to 1700 metres. Vegetation varies from alpine tundra (in the extreme southwest) to mature stands of pine and spruce.

The Burnt River map area is trisected at the confluence of Burnt and Sukunka rivers which provide the main drainage. The rivers follow U-shaped valleys carved during the Pleistocene glaciation. Geologically, the area is bounded by the Rocky Mountains just west of the southwest corner of 93P/5 and the outer foothills structure of the Gwillim Lake area to the east. Access to most of the area is provided by a network of cut lines, logging, drilling and well-site roads, all accessible from the major highways.

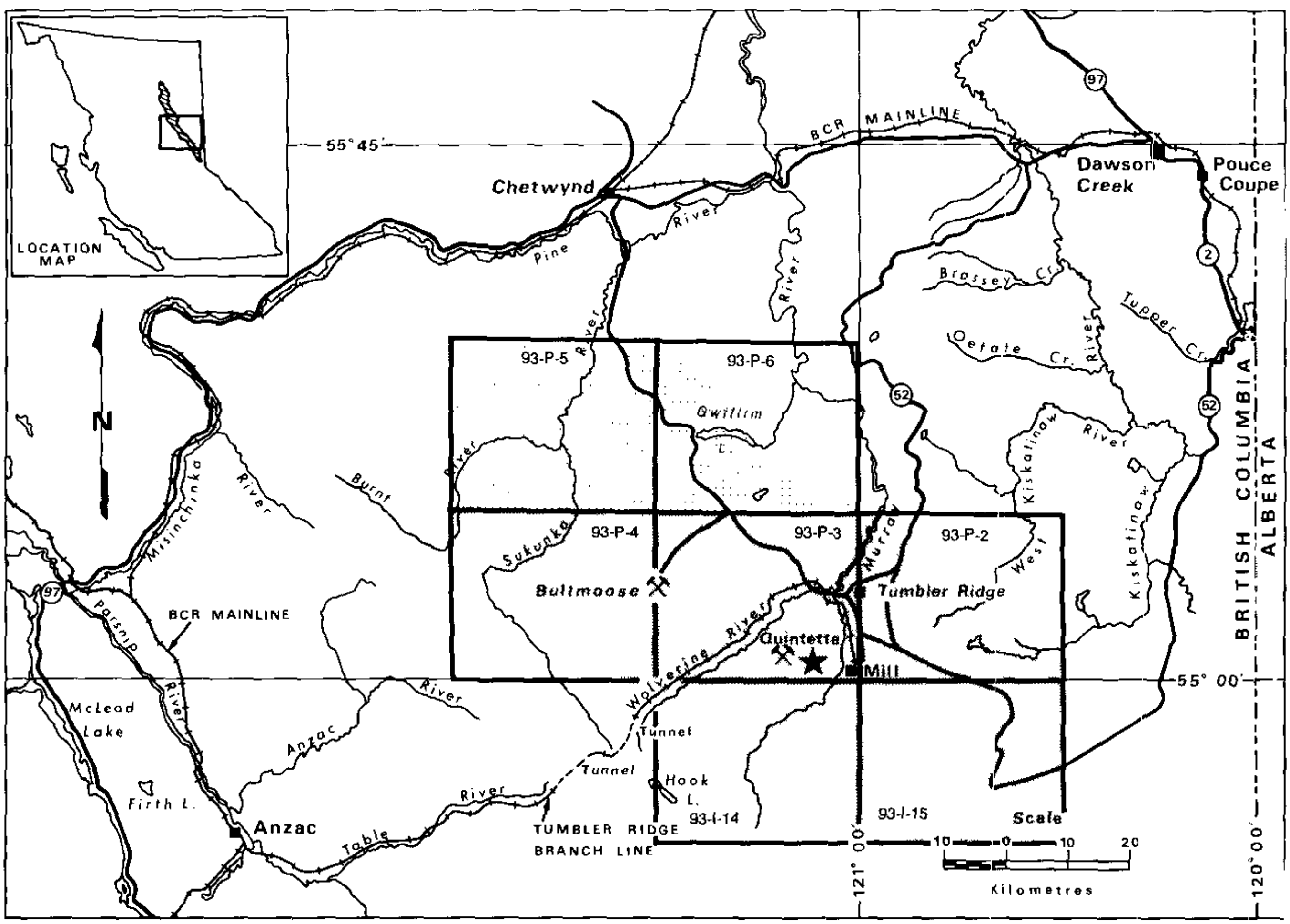


Figure 5-7-1. Location map. Dark stipple shows previous mapping, light stipple shows area of 1990 mapping.

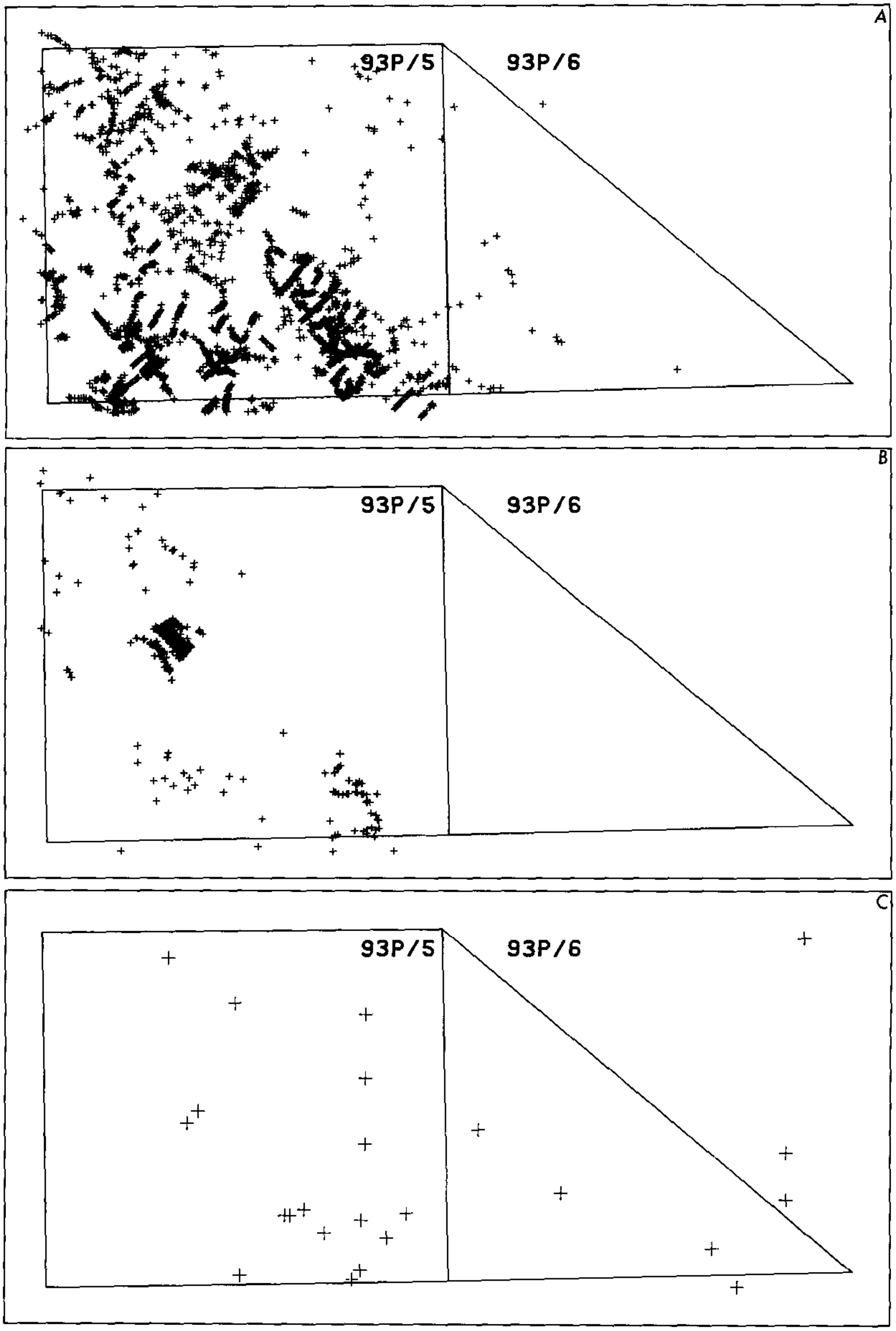


Figure 5-7-2. Locations of a) outcrops b) coal boreholes and c) petroleum exploration wells in Burnt River database.

SERIES	GROUP	MAP SYMBOL	FORMATION	THICKNESS IN METRES	LITHOLOGY
QUATERNARY		Q AL	QUATERNARY	?	Alluvial deposits; sands and gravels
UPPER CRETACEOUS		uKW	WAPITI	1000	Nonmarine interbedded conglomerate, sandstone, mudstone and coal
	SMOKY	uKP	PUSKWASKAU	210	Concretionary grey marine shale; coarsens upward to marine sandstone (Chungo)
		uKB	BAD HEART	10	Marine and nonmarine quartz sandstone
		uKM	MUSKIKI	65	Grey marine shale; rust weathering; concretionary
		uKC	CARDIUM	40	Marine and nonmarine sandstone; conglomerate in upper part
		uKK	KASKAPAU	750	Dark grey marine shales; interbedded sandstone and shale in lower part
		uKD	DUNVEGAN	475	Marine and nonmarine sandstone, shale and coal
	FORT ST. JOHN	uKCR	CRUISER	150	Dark grey marine shale with sideritic concretions; some sandstone.
LOWER CRETACEOUS		KGO	GOODRICH	150	Fine-grained, crossbedded sandstone; shale and mudstone
		KHA	HASLER	300	Silty dark grey marine shale with sideritic concretions;siltstone in lower part
		KBC	BOULDER CREEK	120	Fine-grained, well-sorted sandstone; massive conglomerate; nonmarine sandstone and mudstone and coal
		KH	HULCROSS	100	Dark grey marine shale with sideritic concretions
		KG	GATES	130	Fine-grained, marine and nonmarine sandstones; conglomerate; coal; shale and mudstone
		KM	MOOSEBAR	130	Dark grey marine shale with sideritic concretions; glauconitic sandstone and pebbles at base
	BULLHEAD	KGE	GETHING	375	Fine- to coarse-grained, brown, calcareous, carbonaceous sandstone; coal, carbonaceous shale, and conglomerate
		KCD	CADOMIN	40	Massive conglomerate containing chert and quartzite pebbles and sandstone
JURASSIC	MINNES	JKM	UNDIFFERENTIATED	1700	Thinly to thickly interbedded, shale, sandstone, siltstone and coals.

Figure 5-7-3. Stratigraphic table (modified after Stott, 1982).

DATA

Mapping was aided by surface and subsurface data from several sources. The complete database includes 3084 outcrop locations with orientation data, 325 coal company boreholes and associated maps, and 23 petroleum company exploration wells (Figure 5-7-2). Outcrop and coal-borehole data were obtained from assessment reports on file with the Geological Survey Branch. Gas-well data was created by analysis of geophysical logs available through the Petroleum Resources Division of the Ministry of Energy, Mines and Petroleum Resources. Microcomputers are being used for the storage and manipulation of these data. A standardized format has been established for all the surface and subsurface information so that it may be released in conjunction with the Open File maps. The geological maps are also stored digitally in the form of CAD files.

In several areas with limited access or outcrop, mapping has been based on air-photo interpretation and the information contained within this database.

STRATIGRAPHY

The Foothills of the map area are underlain by Upper and Lower Cretaceous strata with progressively older formations exposed southwestward. This succession is predominantly an alternating series of marine and nonmarine clastic sediments with dark grey marine shales (Figure 5-7-3). This represents several transgressive-regressive cycles depositing a complete succession of over 4500 metres thickness. Triassic carbonates of the Rocky Mountain Front Ranges are exposed southwest of the Burnt River map area. Fieldwork during 1990 covered all formations from the Puskwaskau Formation to the Minnes Group. Coal occurrences were noted in the Boulder Creek, Gates and Gething formations as well as the Minnes Group. Regionally, coal is also present in the Dunvegan, Cardium and Wapiti formations. The major coal-bearing sequence of the map area is the lower Gething. Regional stratigraphy of the Cretaceous sequence has been extensively described by Stott (1967, 1968, 1973, 1982), by Kilby and Wrightson (1987a, b, c) and Kilby and Johnston (1988a, b, c).

There are some significant stratigraphic variations found within several formations between the Burnt River area and previous geological investigations to the southeast. These are best illustrated by a comparison of the geophysical log traces for these formations (Figure 5-7-4). The figure shows three types of geophysical log. The gamma ray log (GR) measures the natural radioactivity of rock. Clay-rich rocks such as shales have a high gamma reading while clean sandstones, conglomerates and coal will move the curve to the left, reflecting their low radioactivity. The sonic tool

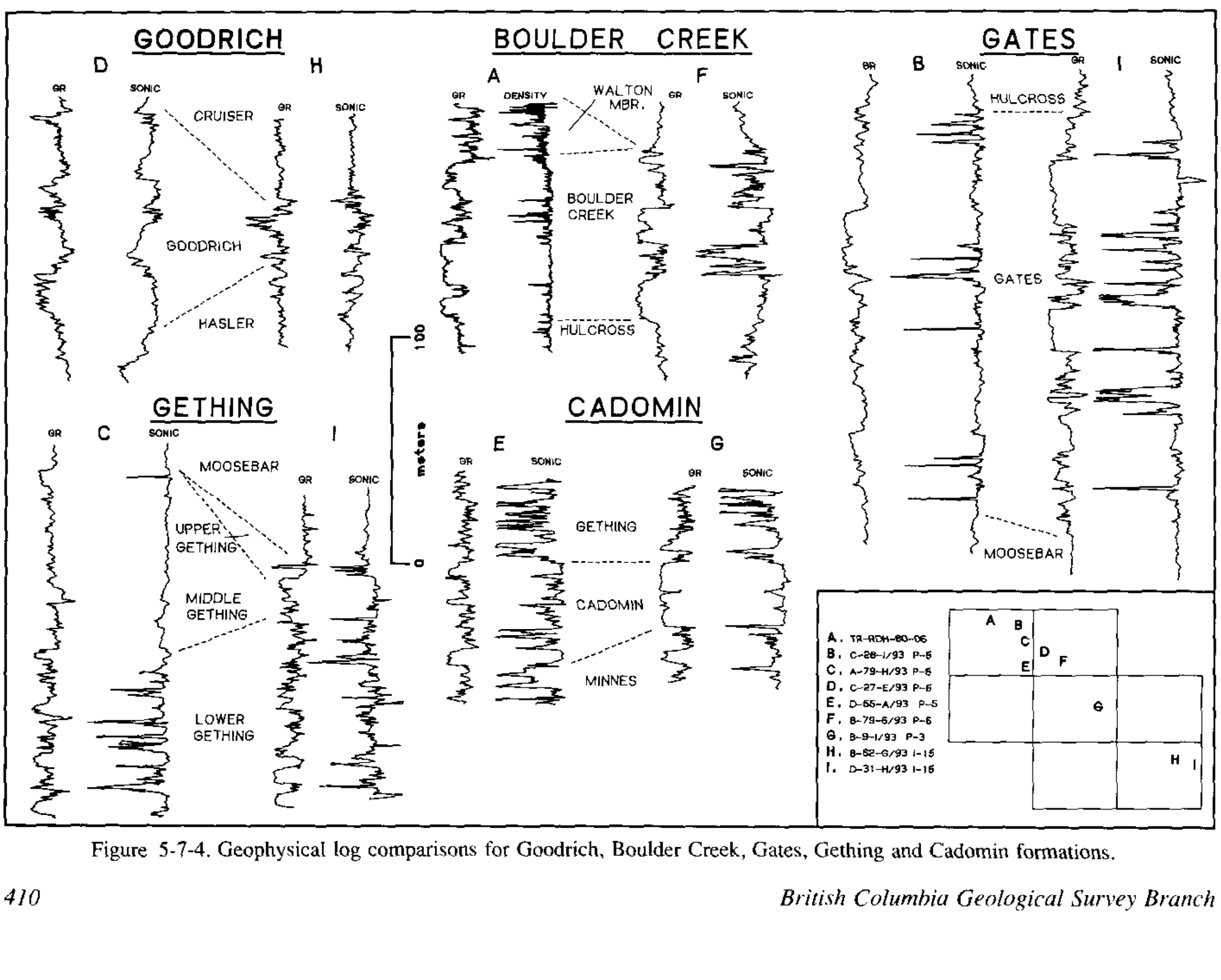


Figure 5-7-4. Geophysical log comparisons for Goodrich, Boulder Creek, Gates, Gething and Cadomin formations.

records the "interval transit time" for a sound wave to pass through a formation and return to the tool. The travel time is partly dependant on the density of the rocks. The low density of a coal seam will give a long travel time which appears as a strong kick to the left on the sonic log. The density tool emits gamma rays and counts the number which are scattered back to the tool. This is dependant on the number of electrons in the rock which, in turn, is related to the bulk density. Higher densities are reflected by a log reading to the right. Coal, consisting mainly of carbon and hydrogen with low atomic numbers, gives a low bulk-density reading showing up as a sharp kick to the left on the density log.

STRATIGRAPHIC VARIATIONS

GOODRICH

The Goodrich Formation becomes increasingly important as a prominent ridge-capping formation to the northeast. Regionally, the formation shales out to both the south and east (Stott, 1982). South of the Murray River (93I/15), the Goodrich consists of only of a few thin sands. Mapping in 93P/5 indicates the fine-grained Goodrich sandstones and interbedded shales increase to over 150 metres in thickness (Figure 5-7-4) and they are best developed on the western limb of a broad syncline west of Gwillim Lake. Subsurface geophysical logs show three distinct coarsening-upward cycles which can be correlated laterally to the eastern edge of 1990 mapping.

BOULDER CREEK

The Boulder Creek Formation is a prominent ridge-forming unit of conglomerates, sandstones and carbonaceous sediments. It is easily recognized in the subsurface by the presence of the two thick conglomerates that generally define the upper and lower boundaries of the formation. These units are known as the Paddy and Cadotte formations in the subsurface (Figure 5-7-4). Most coal in the Boulder Creek Formation is found between the upper and lower conglomerates as shown in the figure close to Borehole F. North of the Sukunka River, however, carbonaceous sediments and coal seams up to 1.5 metres thick have been deposited above the upper conglomerates, and this package has been named the Walton member. Coal seams from both stratigraphic intervals were sampled.

GATES

The most dramatic stratigraphic variation is the loss of thick, laterally extensive coal seams in the Gates Formation. Mapping this season identified only a few thin coals seams (<1 metre thick) at the southern edge of the map area. Northward from that point, the Gates Formation is composed dominantly of more marine-influenced shelf-facies sediments (Stott, 1982). The geophysical log comparison shows only a few thin carbonaceous horizons in Well B, compared to the thick coal seams of Well I in the Kinuseo Creek area.

GETHING

The major target for coal exploration in the Burnt River area is the Gething Formation. As with the Gates Formation, the southern limit of the map area also marks a major change in deposition for the Gething. Previous work in the southern area has divided it into three distinct units. The upper and lower Gething are mainly coal-bearing non-marine sediments which are separated by the coarsening-upward middle Gething marine package (Figure 5-7-4). Gas-well logs clearly show the pinching out of the upper coal measures and thickening of the middle Gething in the Gwillim Lake region (Legun, 1985).

The lower Gething coals have been extensively explored for in the Burnt River map area. The thickest seams (>5 metres) are found in the Burnt River deposit just north of the Sukunka River. This prospect has been closely drilled and sampled as a high-rank thermal coal deposit.

CADOMIN

The Cadomin Formation within the 1990 map area is in a transitional location as far as stratigraphic nomenclature is concerned. While the authors have kept the formation definitions used previously (Kilby *et al.*) and as set out by Stott (1982) it became apparent that the Cadomin becomes a less distinct marker horizon north of the Sukunka River. The conglomerates are not as thick or as laterally continuous and may be absent in some areas. Mapping farther to the north may have to use the stratigraphic divisions set up by Hughes (1964) which redefine the lower Bullhead Group and subdivide the Minnes Group into three separate formations.

Figure 5-7-4 shows the typical log signature of a thick Cadomin conglomerate from the southern region at Well G. Well E, however, has only two thinner conglomerates defining the top and bottom of the formation, with sands and siltstones in between. This well was previously interpreted as a thrust-faulted Cadomin section, however, log signatures for the formation do not indicate any repetition of units.

STRUCTURE

The map area covers the complete range of structures in the inner and outer Rocky Mountain Foothills. Structural traces of faults and fold axes generally follow the northwesterly regional trends (Figures 5-7-5 and 6).

In the Gwillim Lake area the Upper Cretaceous Smoky Group is exposed by the broad gentle folds of the outer foothills. Westward, folding of the Dunvegan Formation and Fort St. John Group becomes increasingly narrow and more complex. The Boulder Creek, Hulcross and Gates formations, being relatively competent units, are exposed as tight chevron folds that are clearly visible on air photographs. Farther west is a broad area of the more subdued topography underlain by the Gething Formation. The lack of outcrop and traceable resistant horizons in the Gething make determination of structure extremely difficult. Folding is believed to be fairly complex and is complicated by more faulting than is seen farther east. Structural interpretations of the Gething Formation are based mainly upon drilling results, especially for the Burnt River deposit north of the Sukunka River.

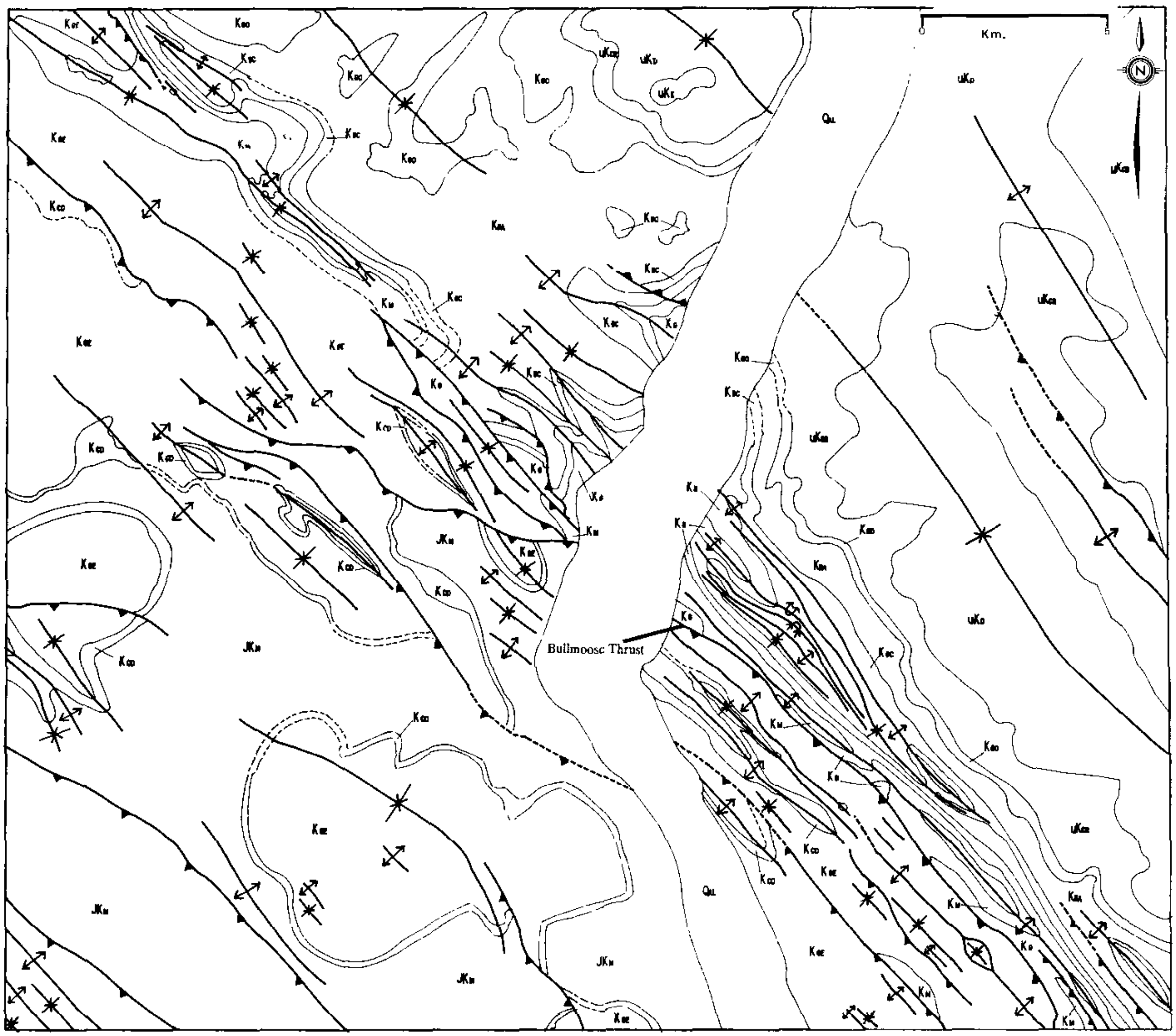


Figure 5-7-5. Geologic map – Burnt River map sheet (93P/5). Adjoins Figure 5-7-6. For legend *see* Figure 5-7-3.

The southwest corner of the map shows Bullhead and Minnes group strata deformed into a broad syncline outlined by the Cadomin Formation. Exposures of Minnes Group rocks generally exhibit extremely complex, short wavelength folds that extend for only short distances. Figure 5-7-7 shows a plot of poles to bedding for all outcrops in the study area. Eigen-vector analysis shows the regional fold axis has a trend of 314° and plunges at 1.4° and indicates that bedding has been cylindrically folded.

Field mapping has shown only two major faults in the area. Preliminary evidence indicates that the Gwillim Lake fault may terminate northwards within the map area. This fault has previously been traced southeast to 93I/15 (Kilby and Johnston, 1988a, b, c). Mapping has also extended the Bullmoose thrust fault northwards to the Sukunka River where it may be represented by a number of splay faults west of the Burnt River deposit (Figure 5-7-5). The Bullmoose thrust displaces lower Gething strata against the Gates and Moosebar formations.

Significant evidence for east-dipping underthrust faulting usually associated with triangle-zone geometries (McMechan, 1985) has also been noted. East-dipping thrust faults have been seen in outcrops ranging from the Kaskapau Formation to the Minnes Group, including the east limb of an anticline of Boulder Creek Formation just north of the Sukunka River (Figure 5-7-5). A number of folds with east-dipping axial planes have also been mapped, giving a further indication of the prevalence of these faults in the region.

COAL OCCURRENCES

Coal samples were taken from coal seams in the Boulder Creek and lower Gething formations and the upper Minnes Group. Mean random vitrinite reflectance values (Rm) have

Figure 5-7-6. Geologic map – Gwillim Lake map sheet (93P/6). For legend *see* Figure 5-7-3.

been recieved for all samples. Rm Readings range from 1.03 to 1.76, placing all samples in the high to low-volatile bituminous rank using the ASTM (American Standard Testing Methods) classification scheme (Stach, 1982).

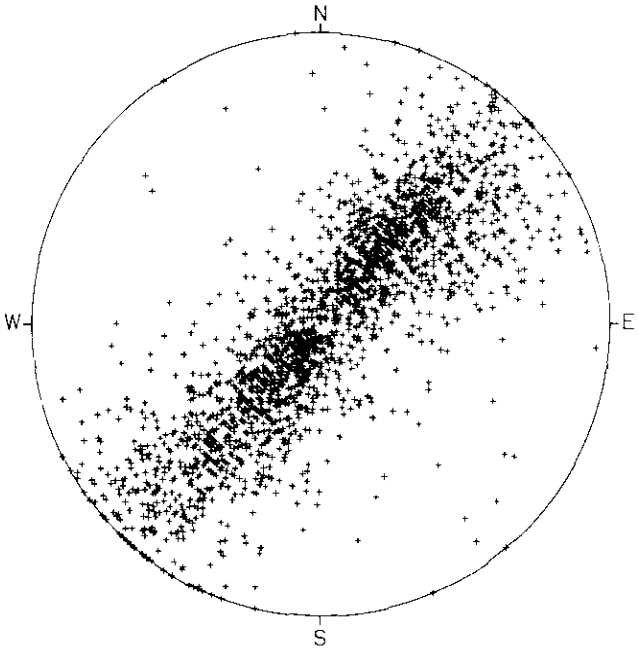
Reflectance values for samples from the Boulder Creek Formation ranged from 1.06 Rm for Walton member coal, to 1.19 for thin seams in the lower stratigraphic horizons. This places the coal at or near the high-medium volatile boundary.

Most lower Gething Formation coals ranged from 1.38 to 1.76 Rm, placing them in the low-volatile or upper-medium volatile bituminous categories. The one sample falling outside this range has an Rm value of 1.03 with over 80 per cent of the macerals being thought to be coarse micrinite. Samples with similiar characterisitics have previously been associated with devolatization of the coal macerals, transforming the vitrinite into the anisitropic mosaic of micrinite particles (Kilby, 1989).

Samples taken from the Minnes coal measures have Rm values ranging from 1.10 to 1.69. The low-rank samples were taken from the most western coal outcrops in the southwest corner of 93P/5 on Mount Jilg. This decrease in rank is attributed to thrust faulting early in the coalification process as has been noted previously for Gething coals in the subsurface (Karst and White. 1980).

ECONOMIC GEOLOGY

Exploration in the region has mainly been limited to conventional structural gas-traps and surficial coal prospecting in the lower Gething Formation. Vitrinite reflectance values (all in the bituminous range), and the number of coal-bearing formations, also make the area of potential interest



EIGENVALUE/N	TREND	PLUNGE
.603265	50.7	79.6
.359942	222.3	10.2
.003679	312.6	1.4

Figure 5-7-7. Pi diagram of poles to bedding for all outcrops in Burnt River Project database.

for the development of coalbed methane production. The most obvious targets would be the thicker seams of the lower Gething and the thinner but more numerous seams of the Minnes Group. The Burnt River thermal coal deposit is apparently not economically viable at this time, but future development of the Sukunka deposit just south of 93P/5 may improve that situation.

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