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STRATIGRAPHY & STRUCTURE IN MOUNT  
HULCROSS-COMMOTION CREEK MAP-AREA,  
BRITISH COLUMBIA  
(REPORT AND MAP)

By

R. T. D. Wickenden and G. Shaw



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Paper 43-13

STRATIGRAPHY AND STRUCTURE IN MOUNT HULCROSS-COMMOTION CREEK  
MAP-AREA, BRITISH COLUMBIA  
(Summary Account)

By

R. T. D. Wickenden and G. Shaw

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O T T A W A, 1943

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### Illustration

Preliminary map-----~~at~~ Hulcross-Commotion Creek,  
British Columbia.

STRATIGRAPHY AND STRUCTURE IN MOUNT HULCROSS-COMMOTION CREEK MAP-AREA,  
BRITISH COLUMBIA

INTRODUCTION

Mount Hulcross-Commotion Creek map-area lies in the Peace River district of northeastern British Columbia between latitudes 55° 30' and 55° 45' and longitudes 121° 45' and 122° 15'. Field work in 1942 was confined to parts of the map-area, and to small adjacent areas to the west and north, where the stratigraphy and structure of the exposed formations could be studied best. The geological mapping of the area as a whole is, therefore, quite incomplete, and the present report is merely a preliminary account of some of the more salient features.

The writers were assisted in the field by H. K. Riedford and I. D. Crawford. J. S. Stewart of the Geological Survey completed some detailed mapping on the Commotion Creek structure and co-ordinated this work with that being done along Peace River to the north. Thanks are due to Dr. T. B. Williams and Mr. C. R. Stelck, of the British Columbia Department of Mines, for drill logs and other information pertaining to Pine River No. 1 well. Mr. Stelck was also helpful in pointing out localities where sections could be measured and fossils collected. F. H. McLearn of the Geological Survey determined all fossils collected during the course of the field work and gave helpful advice on the correlation of the formations of the map-area with those of outside areas.

STRATIGRAPHY

Formations exposed in the map-area range from the upper part of the Bullhead group, of Lower Cretaceous age, to the Dunvegan formation of Upper Cretaceous age. They appear to be somewhat thicker and somewhat different in lithology from those on Peace River and in the Plains, and for these reasons local names have been given in preference to using others for which correlations are none too certain.

The following table gives the sequence and approximate thicknesses of the formations in the map-area:

Age		Formation	Description	Thickness Feet
Upper Cretaceous		Dunvegan	Nonmarine, mainly cross-bedded sandstone and conglomerate.	800-1,200 +
Lower Cretaceous	Fort St. John group	Cruiser	Marine shale, with minor sandstone bands	800-900
		Goodrich	Sandstone with some dark grey shale; mostly marine	550-600
		Hasler	Mostly dark grey marine shale with some thin sandstone beds	1,100-1,200
		Commotion	Conglomerate near top with a little sandstone and shale above, several sandstone and shale members below; marine and nonmarine. Lower part may include part of Moosebar	1,300-1,500
		Moosebar	Dark grey, calcareous marine shale; some sandstone near top	800 +
	Bullhead group		Sandstone, shale conglomerate and coal. Largely nonmarine	? Probably over 4,000

#### Bullhead Group

The term "Bullhead group" is here used to designate beds that are probably correlative with the Bull Head Mountain formation of the Peace River section (McLearn, 1917)<sup>1</sup>. There the formation is divided into a lower conglomeratic member and an upper coal-bearing member named the "Gething". The contact between the lower and Gething members is not sharply defined, and the section has not been studied in sufficient detail to preclude the possibility of its subsequent division into smaller map-units. It seems advisable, therefore, that a group name be given these beds.

<sup>1</sup>For list of references See last page of this report.



Bullhead strata are exposed in the central part of an anticline that trends northwestward across the southwest corner of the map-area. On Hasler Creek, 7 miles south of Pine River, the exposed beds contain several coal seams and are considered to be about the equivalent of the Gething member of the Peace River section. Here the beds are contorted and somewhat faulted, and the actual sequence was not determined. In Pine River valley west of Crassier Creek, the main anticlinal structure is also complicated by many minor folds and probably by faults. The presence of a thick conglomerate suggests that beds equivalent, in part at least, to the lower Bull Head Mountain of the Peace River section are here present.

The well drilled near the mouth of Commotion Creek (See map) passed through a vertical thickness of over 4,000 feet of beds, thought to belong to the Bullhead group, without reaching the base. The attitude of the beds, as shown by drill cores, indicates a wide variety of dips, ranging from a few degrees to nearly vertical. This suggests that the structure of the Bullhead is here very similar to that shown on the Pine River anticline west of Crassier Creek. No satisfactory estimate of the true thickness of the group as drilled could be made, but it is probable that it is not less than that of the corresponding section on Peace River, namely 4,000 feet.

#### Fort St. John Group

The term "Fort St. John" was first used by McConnell in 1893 in referring to shales outcropping along Peace and Pine Rivers. Later, McLearn (1917) defined the St. John formation as constituting "all the strata lying between the Bull Head Mountain below and Dunvegan sandstones above". He subdivided it into a lower shale, 800 feet thick, a middle sandstone member, called the "Gates sandstone", 50 to 80 feet thick and an upper shale zone, 1,300 feet thick. Still later (1922) McLearn restricted the St. John formation to the shales lying between the Gates sandstone and the Dunvegan.

The present work indicates that, in this area at least, there are five distinct formations, chiefly of marine origin, between the Bullhead and Dunvegan. Rather than attempt to correlate any or all of these with the St. John formation as previously defined, it seems advisable to redefine the term as a group name to include all these predominantly marine strata. Such a usage would equate the group with the St. John formation as defined in 1917.

#### Moosebar Formation

The Moosebar formation was named by McLearn (1922, page 5B) and corresponds to his original lower St. John shale. In the map-area dark grey calcareous shales of the Moosebar overlie the Bullhead group. The contact with the Bullhead can be seen on Hasler Creek, but the section showing most of the formation is exposed on Crassier Creek about 3 miles north of Pine River. Here the beds dip from 15 to 45 degrees northeast and the slope of the exposure is about 40 degrees southwest.

The lowest member exposed in this section is probably not more than 50 feet stratigraphically above the Bullhead, and the true thickness of the exposed beds is calculated to be about 540 feet, as shown in the following section:

Lithology	Thickness Feet
Shale, dark grey, somewhat calcareous, with some brown weathering concretions .....	200
Sandstone, grey weathering, yellowish brown .....	20
Shale, dark grey, somewhat calcareous, with a few concretions as above; a little glauconite at base .....	35
Sandstone, grey, weathering yellow; very tough .....	10
Shale and sandstone in alternate layers; same lithology as above .....	7
Shale, dark grey with brown weathering concretions, calcareous .....	175
Bentonite parting .....	0.1
Shale, dark grey, rather conchoidal fracture, calcareous, with numerous brown weathering concretions .....	95

It is difficult to estimate the total thickness of Moosebar at this locality. Above the exposed section is a long, sloping terrace with no outcrops for several hundred feet. From this terrace the hill rises more steeply until at an elevation of 700 feet above the section the Commotion formation is exposed. It seems probable, therefore, that if the dip remains constant, there is several hundred feet more shale in the formation between the top of the exposed section and the base of the Commotion. The beds described above are apparently those referred to by Spieker (1920) as "Pine River Shales" older than the Bullhead and probably of Jurassic age. Their position in the sequence of formations both here and on Hasler Creek makes it obvious now that they are part of the Moosebar formation and that they are younger than the Bullhead group.

In the Pine River No. 1 well dark grey shaly beds lithologically similar to Moosebar shales exposed elsewhere in the area were drilled between depths of 1,080 and 2,410 feet. The difference of 1,230 feet cannot, however, be regarded as a true estimate of the thickness of the formation. It is possible that either the structure here actually has increased the thickness of the formation by folding or faulting, or that the well was drilled down the dip. No cores were taken from this part of the well, so that the attitude of the beds is not known.

Results as a whole seem to indicate that the Moosebar in the vicinity of Pine River is at least as thick as, and possibly thicker than, on Peace River, where it is about 800 feet thick.

#### Commotion Formation

"Commotion formation" is the name proposed for beds that overlie the Moosebar formation and underlie the Hasler. As already mentioned, there is a considerable gap between the upper exposures of Moosebar on Crassier Creek and outcrops of Commotion formation above. On Hasler Creek a similar gap was observed, but the beds exposed there are a little lower in the Commotion formation than those that were seen on Crassier Creek.

The lowest beds observed on Hasler Creek are part of a sandstone member 500 to 600 feet thick. Overlying it is about 250 feet of dark grey shale, which is in turn overlain by a second sandstone about 200 feet thick. Above this bed of sandstone is a bed of chert-pebble conglomerate, usually not over 100 feet thick. The thickness of the conglomerate varies from place to place even within short distances, and on the south side of the Pine, near Goodrich Creek, two bands of conglomerate were observed. On Commotion Creek about 180 feet of sandstone, shale, and coal overlies the conglomerate.

Information at hand indicates that there is at least 1,300 to 1,500 feet of beds in this formation. Its actual thickness depends on where the contact with the Moosebar is placed.

Earlier workers had considered the conglomerate outcropping at the mouth of Commotion Creek as part of the "Bull Head Mountain formation". This error arose from the lithological similarity of the conglomerates of the two formations. However, the stratigraphic position of the Commotion formation with respect to the Bullhead makes such a correlation impossible. Inoceramus cadottensis occurs in the Commotion formation in sandstone beds just below the conglomerate. This fossil indicates a correlation with a zone outcropping on Peace River at the mouth of Deep Creek and 500 to 600 feet stratigraphically above the Gates sandstone (McLearn, 1931). This zone is within the Hasler formation on Peace River, and it appears that the Commotion formation is the equivalent of the Gates plus several hundred feet of Hasler, or conversely that the Hasler has a greater vertical range in the Peace River section than it has along the Pine. Some fossil plant fragments found in beds above the Commotion conglomerate on Commotion Creek are of Albian (upper Lower Cretaceous) age, probably the equivalent of the upper part of the Blairmore in Alberta.



### Hasler Formation

The shale beds overlying the Commotion formation have been called the "Fort St. John formation" (Spieker, 1920), but in view of the lack of definite correlations with the type section and the fact that some of the beds normally included in the Fort St. John formation may be included in other formations in this area, the name "Hasler formation" is suggested for this shale.

The formation consists mostly of dark grey to black shale with many thin beds of fine-grained sandstone and siltstone in parts of the formation. In one exposure a band of conglomeratic sandstone was observed. The thickness of the formation is probably between 1,100 and 1,200 feet.

Only one locality was observed where the contact with the underlying Commotion formation is exposed. This outcrop is about three-quarters mile above the falls on the east side of Commotion Creek. There the rocks show a transition from light and medium grey sandstone upward to dark grey, non-calcareous shale. In the lower part of the shale there is a bed about 6 inches thick of chert-pebble conglomerate. A short distance downstream from this exposure there is a heavy band of hard, dense sandstone, regarded as the top of the Commotion formation.

There are numerous exposures of the Hasler in the map-area. Above the falls on the first tributary of Commotion Creek entering from the east are several exposures showing much of the lower part of the formation. Some beds fairly well down in the formation can be seen in a gully on the north side of Pine River valley about  $1\frac{1}{2}$  miles west of Commotion Creek.

Beds near the top of the Hasler formation can be seen on the east bank of Hasler Creek 3 miles south of Pine River. This section, measured from the top down, shows 370 feet of beds, as follows:

Lithology	Thickness Feet
Shale, dark grey with numerous thin bands of fine-grained sandstone or siltstone .....	112
Sandstone, conglomeratic .....	3
Shale, dark grey, with thin beds of fine-grained sandstone, becoming more numerous near the top ..	255

The top of this exposure is about 100 feet below the contact with the overlying Goodrich formation.

The contact of the Hasler and Goodrich formations can be seen in several places in the map-area; on Hulcross Creek; on Walton Creek about 3 miles above the forks; in a gully on the north side of Pine River valley about  $1\frac{1}{2}$  miles west of Boulder Creek; and high up on the east side of Boulder Creek valley. At the first two localities the contact is fairly sharp and represents a change from dark grey shale below

to hard, massive sandstone above; at the remaining localities the contact is transitional through several beds of alternating sandstone and shale. This difference in the type of contact is not an indication of an unconformity, but illustrates the variability in composition of the formations in different parts of the area.

No diagnostic fossils were found in the Hasler formation. A few worm burrows and fish scales were observed at several localities, and some pelecypods were found in the transitional beds near the contact with the Goodrich formation.

### Goodrich Formation

This name is suggested for beds lying between the Hasler shales below and the Cruiser shales above. Difficulty was experienced in measuring the true thickness of the formation because the contact with the overlying Cruiser is covered in most places. At only one locality, on Boulder Creek 700 feet below the forks, was the contact seen. The estimated thickness of 550 to 600 feet is calculated from differences in elevation between this contact and the contact with the Hasler, taking into account the dip of the beds. The only section measured was that exposed on the first eastern tributary of Boulder Creek. It comprises only 273 feet of beds above the contact with Hasler shales, and in detail is as follows:

Lithology	Thickness Feet
Sandstone, light grey, fairly thin-bedded, little crossbedding .....	33
Grey sandstone, thin-bedded, becoming shaly at base ....	24
Shaly sandstone, medium to dark grey .....	29
Sandstone, greenish grey, medium-grained, rather massive	10
Sandstone, grey, rubbly, fine-grained .....	3
Covered, may be more shaly .....	20 <u>±</u>
Sandstone, grey, thin-bedded .....	9
Sandstone, grey, massive .....	26
Sandstone, grey, somewhat rubbly, fine-grained .....	8
Covered, probably mostly sandstone as above .....	11
Sandstone, grey, fairly massive .....	37
Shaly sandstone, medium grey .....	0.8 - 1
Shale, medium to dark grey .....	16
Sandstone, grey .....	16
Shaly sandstone and sandy shale, medium grey .....	19
Hasler, dark grey shale .....	12

Although this section indicates that the Goodrich consists chiefly of sandstone, exposures elsewhere in the area point to the presence of several fairly thick shale bands. In general these shales are covered by surface deposits or talus, but at three localities - on Hulcross Creek, 2 and 4 miles above the forks of Alvin Creek, and on Walton Creek, 4 miles above the forks - exposures of these shales can be seen. On Walton Creek they are about 60 feet thick and occupy a position approximately 300 feet above the base of the formation.

In contrast with most of the formations in the map-area, fossils are fairly common in the Goodrich formation. One of the most common is a species of Oxytoma. Although this genus has a long range and species are difficult to identify, it serves as a very good means of identifying the Goodrich beds, as these fossils were not found in any of the other formations in the map-area. Other kinds of fossils, chiefly pelecypods, occur at several horizons. Among these is Inoceramus ? (or Posidonomya ?) nahwisi var. goodrichensis. I. ? (or P. ?) nahwisi is found in the Neogastrolites zone below Cache Creek on Peace River (McLearn, 1931). Because of this the Goodrich fauna is tentatively placed in the late Lower Cretaceous, close in age to the Neogastrolites fauna. It is realized, however, that too much reliance cannot be placed on a single fossil, and so the correlation is given a tentative status. A few specimens of ammonites were found, but these were too poorly preserved to be identified. Previous workers have called this formation in part, or entirely, Dunvegan. It is now recognized as a distinct formation separated from the Dunvegan by the Cruiser shale.

#### Cruiser Formation

Overlying the Goodrich is a formation consisting of dark grey shale and sandstone beds. The name "Cruiser" is suggested for this formation, which is well exposed on Cruiser Mountain.

The lower 60 to 70 feet of the Cruiser and the contact with the Goodrich can be seen on Boulder Creek between 400 and 700 feet below the forks. The contact shows a change from heavy massive sandstone in the Goodrich to dark grey shale and sandy shale of the Cruiser through several alternating beds of sandstone and shale.

In the valley of a small tributary on the south side of Pine River, about  $\frac{3}{4}$  to 1 mile east of Young Creek, more than 700 feet of the top part of the Cruiser was observed. The section, starting at the contact with the overlying sandstone of the Dunvegan, is as follows:

Lithology	Thickness Feet
Shale and sandstone, dark and medium grey .....	30
Shale, dark grey to black; few sandstone bands .....	154
Shale, dark grey, with many thin sandstone bands .....	257
Shale, dark grey to black, with few thin sandstone bands .....	188
Shale, dark grey, with many thin sandstone bands .....	84

Below this section the valley is filled with drift, and no attempt was made to estimate the thickness of beds occurring between the section and the top of the Goodrich formation.

On the north side of Pine River valley, along the valley of Stone Creek, the top 370+ feet of the Cruiser formation is exposed.

On a hill forming the east side of the valley of the east branch of Boulder Creek, near the head of the valley, the top of the Cruiser was observed, and the following section was measured downwards and includes beds that may be part of the overlying formation:

Lithology	Thickness Feet
Sandstone, grey with shale parting .....	22.3
Shale, dark grey, blocky, with thin sandstone beds ...	33.0
Conglomeratic sandstone, grey, pebbles $\frac{1}{4}$ inch to $\frac{1}{2}$ inch; few small ironstone concretions .....	3.7
Shale, dark grey, with many beds of sandstone; con- tains many fragments of fossil plants .....	10.2
Sandstone, coarse-grained, conglomeratic; pebbles $\frac{1}{8}$ to $\frac{1}{4}$ inch .....	1.0
Shale, dark grey, with many thin sandstone beds .....	<u>5.0</u>
Total .....	<u>75.2</u>

The total thickness of the Cruiser was estimated by measuring the difference in elevation between the base of the Dunvegan and the top of the Goodrich on the north side of Pine River valley about 3 miles west of Commotion Creek, where the beds are almost flat-lying. The thickness determined was 800 feet.

No diagnostic fossils were found in the Cruiser. However, it has been the custom to place the contact between the Lower and Upper Cretaceous at the top of the "St. John" and hence

at the base of the Dunvegan (McLearn, 1931). Because the Cruiser is of marine origin, as are the older formations of the Fort St. John group, and because no fossils have been found to indicate that it belongs in the Upper Cretaceous, it is included in the Fort St. John group of Lower Cretaceous age.

### Dunvegan Formation

The Dunvegan formation is a thick series of sandstones overlying the Cruiser shales. Unfortunately, some earlier workers included the Goodrich and Cruiser formations west of Commotion Creek in the Dunvegan, but excluded them from the Dunvegan in areas east of the creek. This led to considerable difficulty in interpreting the structure. However, diagnostic fossils, in particular Unio dowlingi, were found near the base of the Dunvegan in several localities both east and west of Commotion Creek, leaving no doubt in the minds of the writers as to the lower limit of the formation. The total thickness of the Dunvegan is uncertain, as it is the youngest formation in the area and the top has been eroded. On the north side of Pine Valley, between Stone and Bissett Creeks, there is a difference in elevation of 1,200 feet between the base of the Dunvegan in the valley and the beds exposed on the hill to the north. As the beds are almost flat-lying, this may indicate that the formation is at least 1,200 feet thick. On Cruiser Mountain 800 feet of Dunvegan was measured.

Sandstones and some conglomerate make up most of the formation, and no distinctive horizons were noted. The beds near the base are usually fine-grained sandstone and at many localities conglomerate or conglomeratic sandstone occur about 100 feet above the base. Crossbedding is prevalent throughout most of the formation. In places some of the cross-bedded sandstone appears to have been folded or distorted before consolidation. Such horizons can easily be mistaken for closely folded zones.

Correlation of this formation with the Dunvegan of the type locality is based on the occurrence of Unio dowlingi and other freshwater fossils about 50 feet above the base of the formation. Some fossil plant fragments found on Cruiser Mountain indicate a Cenomanian (early Upper Cretaceous) age for these beds, a fact that may also be evidence of correlation with the Dunvegan.

### STRUCTURE

The structure of the region is characterized by gentle folds over most areas and by a few comparatively narrow belts of closely folded and faulted rocks. The main structural trend varies from northwest to north. The area surveyed in 1942 contains two closely folded belts: the Pine River anticline in the southwest, and the Commotion Creek-Hulcross structure in the north-central part. A broad structural basin separates

these two structures, and a similar gently folded syncline occurs east of the Commotion Creek-Hulcross structure. Other minor parallel and cross folds occur within these structures, but no attempt was made to map them.

#### Pine River Anticline

This structure was named by Spieker (1920) who saw it on Pine River near Crassier Creek. It was studied during the 1942 season chiefly to get stratigraphic information, but the survey indicated a somewhat different structure from that described by Spieker.

The anticline trends southeast across the southwest corner of the area, and judging from observations made on a high hill west of Hasler Creek, appears to extend in both directions well beyond the limits of the map-area. Sections across the fold were studied on Hasler Creek 7 miles south of Pine River and on Pine River in the vicinity of Crassier Creek.

The stratigraphic section exposed in the fold ranges from the Bullhead to the Goodrich, but exposures are by no means continuous and hence the complete section cannot be studied. Beds younger than the Bullhead have been eroded from the crest of the fold in the vicinity of Hasler Creek and Pine River, but the Commotion formation seems to form a complete arch on the sides and top of a mountain a few miles southeast of the map-area. The southwest flank of the structure dips gently, but the northeast flank shows dips as high as 50 degrees.

Beds of the Bullhead group are crumpled and somewhat faulted in the two sections examined--a feature not noted in the younger formations in the same fold. This may be due to the greater competence of the younger strata or to a greater intensity of folding at depth.

Work on the Pine River anticline, in 1943, by J. Spivak of the Geological Survey, indicates a southeast plunge to the fold. The contacts of formations older than Commotion have been plotted on the accompanying map by Spivak.

#### Commotion Creek-Hulcross Structural Zone

The above name is applied to a series of discontinuous folds and faults that extend across the area from Goodrich Creek along Commotion Creek valley and across Hulcross Creek to the Moberly. Within this structural zone are at least three folds:

- (a) Commotion Creek anticline
- (b) Hulcross anticline
- (c) Moberly anticline



Commotion Creek Anticline. This fold trends slightly west of north and extends along Goodrich and Commotion Creeks. The southern limit of the fold is not known, but to the north it terminates 6 miles north of Pine River. Sections across the fold can be studied on both sides of Pine Valley at the mouths of Commotion and Goodrich Creeks. In these sections beds ranging in age from Commotion to Dunvegan are exposed, the younger sandstones being confined to the area east of the two creeks.

The crest of the fold on the conglomerate of Commotion formation lies about  $\frac{1}{4}$  mile west of the crest on the top of the Goodrich formation, indicating a dip of the axial plane of the fold about 45 degrees westward. This is shown on the map by the curvature of the surface trace of the axial plane convex to the west.

The contact between Hasler shale and Goodrich sandstone has a calculated elevation on the crest of the fold, on the north side of Pine Valley, of 3,600 feet. Four miles north this contact was determined barometrically to have an elevation, at the crest of the fold, of 3,464 feet, giving a northerly plunge of 35 feet a mile to this part of the fold.

The beds on the west limb of the fold rise at angles of about 5 degrees. On the east limb, however, the beds dip at low angles eastward for about  $\frac{3}{4}$  mile east of the crest, but from that point the dip increases rapidly to 50 or 60 degrees, and on Young Creek, about  $1\frac{1}{4}$  miles east of the crest, the beds are vertical and in places are faulted. A corresponding section of steep beds on the north side of the Pine east of Commotion Creek is covered, but lies between Submarine and Cruiser Mountains. This zone of steep beds is thought to dip westward roughly parallel to the axial plane of the fold. Steep dips, as shown in cores from a depth of 4,600 feet in the Pine River No. 1 well, may represent a downward extension of this zone.

The high dips referred to above indicate a rupture plane on the east flank of the Commotion Creek fold dipping westward under the fold, but it is not apparent from the displacement of the beds on either side that the fault represents a thrust from the west. In fact, horizons east of this fault, on South Cruiser Mountain, are at higher elevations than corresponding beds west of the fault on Submarine Mountain. This would suggest that the ruptured beds occur along a narrow compressed syncline that trends between the two mountains parallel to the anticline, although there is no supporting outcrop evidence. A thrust displacement of 200 feet was, however, observed in beds of the Cruiser and Dunvegan formations in the first coulée east of Young Creek. The dip of this fault is such that it may be a continuation or at least a branch of a fault plane passing through Young Creek.

The zone of high dips continues northward along the east side of Commotion Creek for a distance of 3 miles above the forks. Here the fold appears to terminate by passing into a northeasterly dipping monocline. The assumed syncline east of the Commotion Creek fold here appears to be only a minor flexure.

In the area between the headwaters of Commotion Creek and the tributaries of the Hulcross, outcrops appear to be scarce.

Recent forest fires have left much fallen timber and in many places the area is impassible. Because of these conditions no attempt was made to locate all outcrops. The hills bordering this area to the north and east are capped by the Dunvegan formation, which dips northeast to north. The rocks are the northward continuation of beds previously mentioned as occurring on South Cruiser Mountain east of the Commotion Creek structure. The strike of these beds indicates a westward swing in the structural trend towards Hulcross Valley.

Hulcross Anticline. Hulcross Creek flows across an anticline that may be a continuation of the Commotion Creek fold, but some structural features between the headwaters of Commotion and Hulcross Creeks do not support this view. On the Hulcross, 2 miles above the mouth of Alvin Creek, the contact between Hasler and Goodrich formations is from 700 to 1,000 feet lower than it is at the head of Commotion Creek, and the fold is some distance south of the projected strike of the Commotion Creek fold. This suggests that the anticline is not a continuation of the Commotion Creek structure, but is a fold en échelon to that along Commotion Creek.

The fold plunges to the southeast towards the Commotion Creek fold, as indicated by the fact that to the west, in the valley of Alvin Creek, Commotion beds are exposed in this structure at a higher elevation than the Hasler beds on Hulcross Creek.

Along the north side of the anticline, in Alvin Creek valley, the beds of Hasler and Goodrich formations dip 75 to 80 degrees north. A short distance north beds of the Cruiser formation dip 15 degrees southeast. Also, exposures on the east side of Hulcross Creek indicate that in the same fold beds of the Hasler appear to be thrust over the Goodrich. These facts suggest a pronounced rupture along the northern flank of the anticline, as in the case of the Commotion Creek fold.

Moberly Anticline. North of the fault on Alvin Creek the Goodrich and Cruiser formations are exposed in another easterly plunging anticline. The beds lie at about the same elevation as those of the Commotion formation in the folds to the south of the creek, and thus give further evidence of a fault along Alvin Creek and imply that the intervening syncline between the two anticlines has been faulted out.

The northern, or Moberly, anticline trends about north 60 degrees west, and its northeastern limb is exposed on the large hill occupying the area west of Hulcross Creek and just south of the Moberly. The beds exposed on the south side of this mountain range from Goodrich at the base to Dunvegan at the top. They appear to be continuous with the Dunvegan formation as traced northward from east of Young and Commotion Creeks.

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