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THE DEVONIAN-JURASSIC CONTACT  
AND THE SUBDIVISION OF THE FERNIE GROUP  
IN THE BANFF AREA, ALBERTA

(Report, figure, 7 plate)

Hans Frebald



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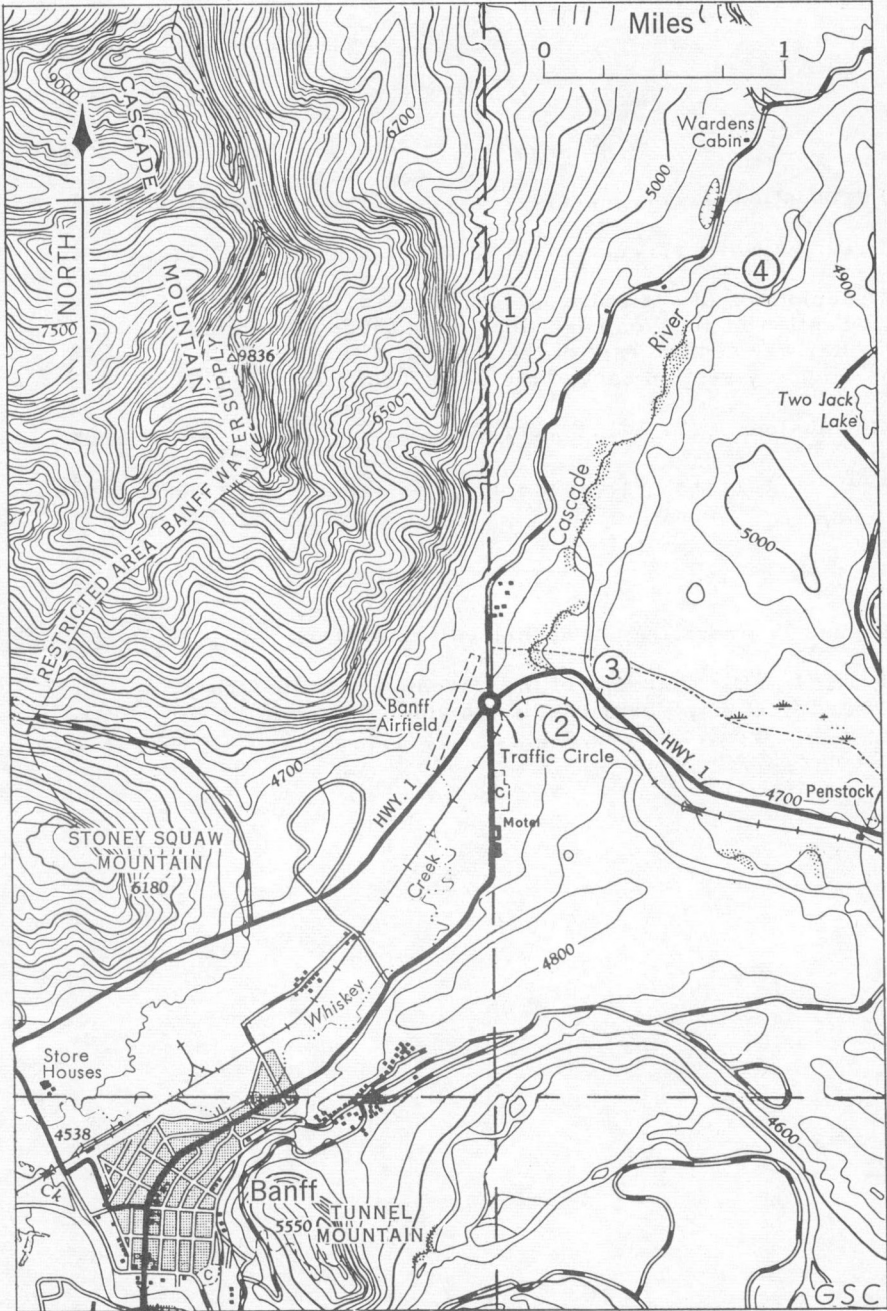
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THE DEVONIAN-JURASSIC CONTACT AND THE  
SUBDIVISION OF THE FERNIE GROUP  
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INTRODUCTION

The Devonian-Mesozoic contact in the Banff area is exposed in a number of sections that are easily accessible and have been seen by hundreds of geologists. Two of these sections are a few hundred yards east of the so-called 'Banff Traffic Circle' where the Calgary-Banff Highway and the road from Banff to Lake Minnewanka join; others are on the east side of Cascade Mountain. Some description of these sections is appropriate as the contact has frequently been misinterpreted and some of the Mesozoic rocks have been given incorrect stratigraphic designations, both in the literature and on field trips.

PREVIOUS WORK

Dowling (1907)<sup>1</sup> expressed the opinion, that on Cascade Mountain, rocks of Palaeozoic age had been thrust over his "upper ribboned sandstone", a rock sequence assigned in his Cascade Mountain map-sheet to the "Dakota", i. e. the Cretaceous. According to Dowling (1957) his "Dakota" is underlain by the coal-bearing rocks of the Kootenay Formation.

More recently, the Palaeozoic rocks at the Mesozoic contact on Cascade Mountain were shown as Devonian and assigned to the Fairholme Group (see Field Trip Guide Book, 1950—map by Layer, Harding and Clark, and cross-sections by Clark). The Mesozoic rocks at the contact were, however, still considered to belong to the Kootenay Formation. Also, Gussow (1957, p. 18), when describing the section east of the Banff Traffic Circle, assigned the Palaeozoic rocks above the "Rundle-Cascade-Three Sisters thrust fault" to the Devonian Fairholme Group, but considered the underlying Mesozoic to belong to the Kootenay Formation. He stated (1957) that at this locality "we have now entered the Cascade coal basin, and for the next half mile an almost continuous section of Kootenay strata is exposed in the rock cuts on the left", i. e. on the highway, immediately east of the bridge across the Cascade River channel.

Recent field studies by the writer<sup>2</sup> have shown this interpretation to be incorrect. The Mesozoic rocks at the Devonian contact belong to the Fernie Group, of which most units are represented in their typical lithology and with their characteristic marine faunas. The Kootenay Formation follows farther to the east.

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<sup>1</sup>Dates or names and dates in parentheses refer to publications listed in the References.

<sup>2</sup>Acknowledgment is made to Stanley A. Hashimoto for able assistance in the field.

## DESCRIPTION OF SECTIONS

### 1. Section in gully on east side of Cascade Mountain

This section (see Plate II, Figure 1) is situated on the east slope of Cascade Mountain above part of the former townsite of Bankhead. The gully joins the Banff-Lake Minnewanka Highway a few hundred yards south of the Bankhead war memorial.

The lower part of the gully is covered with large boulders. At about 5,250 feet altitude the Kootenay Formation is exposed. Brown shale, coal, and sandstone bands are present up to an altitude of about 5,300 feet, where a coal seam is overlain by massive, greyish, brown-weathering sandstone that, at about 5,360 feet altitude, is overlain in turn by some shale with sandstone bands. Exposed above these beds is more or less massive sandstone topped by shale and sandstone bands.

All these beds belong to the Kootenay Formation; they are overlain by a sandstone, 20 feet thick, which did not yield fossils but probably belongs to the middle Bajocian Rock Creek Member of the Fernie Group. The contact with the Kootenay Formation is probably a fault, as younger beds of the Jurassic Fernie Group, i. e. the Callovian Grey beds, and the equivalents of the Oxfordian-Kimmeridgian Passage beds are missing. This sandstone is overlain by indurated dark shale, in part rusty-weathering, about 75 to 100 feet thick. Some poorly preserved ammonites and belemnites were found. This shale is considered to belong either to the middle Bajocian Rock Creek Member or to the Toarcian Paper Shale.

Above this indurated shale follows a massive sandstone, about 30 feet thick, with pebbles and belemnites. Lithologically, this sandstone is similar to sandstones that locally occur in the middle Bajocian Rock Creek Member.

This sandstone is overlain again by dark indurated shale, in part concealed, which in turn is topped by the Devonian; 20 feet below the contact some poorly preserved Dactyloceratids occur. They determine the age of the shale as Toarcian. The Devonian-Toarcian contact (see Plate I, Figure 1) is at an altitude of 5,660 feet. The Devonian rock at the contact is a limestone band about 1 1/2 feet thick. Above follow the same slightly calcareous light grey siltstones that in turn are overlain by bluish grey limestones.

Comments. The shale with sandstone bands that underlie the lower sandstone, here assigned to the Fernie Group, are probably the rocks that were mapped by Dowling (1907, map of Cascade Coal Basin) as "Upper Ribboned Sandstone (Dakota)". In this unit he may also have included the shales that now have been shown to belong to the Toarcian.

The Devonian rocks immediately on top of the Toarcian belong to the Fairholme Group.

## 2. Railway Section east of the Banff Traffic Circle

The section is situated just south of the highway-bridge crossing Cascade River. The rocks exposed are inverted and lie on strike with those described in the Cascade Mountain section. Section 2 is immediately south of section 3 on the highway; it includes older Jurassic and Devonian rocks that are not exposed in the highway section.

From west to east the following Devonian rocks are exposed: bluish grey limestones, slightly calcareous light grey siltstones (about 40 feet exposed) (see Plate III, Figure 1) and, at the contact with the Jurassic, a 1 1/2-foot-thick limestone band. These Devonian rocks are the same as in the Cascade Mountain section and are accordingly assigned to the Fairholme Group.

The contact of the basal Devonian limestone band with the Toarcian Paper Shale of the Fernie Group was made visible by digging (see Plate II, Figure 2). The total thickness of the Toarcian Paper Shale in this section could not be measured because most of it is concealed. Also concealed in this section are the immediately younger rocks of the Fernie—the Rock Creek Member. Parts of still younger Fernie units are exposed in this section but are more clearly visible in the highway section.

Comments. The succession of the Jurassic and Devonian rocks at their contact is the same as in the Cascade Mountain section. The Devonian is thrust over Toarcian Paper Shale of the Fernie and not over Kootenay Formation as had been suggested by other geologists.

## 3. Highway section east of the Banff Traffic Circle

The section (see Plate III, Figure 2, and Plate IV, Figure 1) is situated just north of the railway section described above, immediately east of the highway-bridge crossing Cascade River, and about 550 yards east of the traffic circle.

The section is inverted, considerably disturbed by folds and faults, and accurate measurements cannot be made. It is obvious that only parts of the various Fernie units are present.

The lowermost Jurassic beds in this section are the Grey beds (see Plate IV, Figure 2) that are exposed for 260 feet along the highway. They are badly distorted by folds and faults. Fossils found in this unit are: Warrenoceras sp., Kepplerites sp., belemnites and pelecypod fragments. The age of these beds is early Callovian.

The next younger unit (see Plate V, Figure 1) comprises dark shales with big concretions which are exposed for about 52 feet along the highway. The contact with the Grey beds and the next unit to the east is faulted. Fossils found in this unit are "Turbo" ferniensis Frebold, which is a guide-fossil for this part of the Fernie Group and for the Green beds that are equivalent in age, i.e. Oxfordian. These

RIBBON CREEK MBR



shales with big concretions are much better exposed in the Cascade River section below Bankhead<sup>1</sup>, where they have yielded many specimens of "Turbo" ferniensis in recent years.

Towards the east this unit is in faulted contact with more dark shales with concretions (exposed for 36 feet along the highway). Some Grey beds are faulted in this part of the section. This unit is in contact with similar dark shales with big concretions and siltstone bands (exposed for 30 feet along the highway). The latter unit is strongly folded and faulted (see Plate V, Figure 2). No fossils were found, but it is obvious that the shales with large concretions are the same as the above-described beds with "Turbo" ferniensis and that the shales with siltstone bands correlate with similar rocks in the Cascade River section (see Plate VII, Figure 1) below Bankhead, which in recent years have yielded Buchia concentrica (Sowerby). These beds are equivalent in age (late Oxfordian or early Kimmeridgian) to the lower part of the Passage beds in southern Alberta and southern parts of eastern British Columbia, which have a similar lithology.

The next unit towards the east is exposed for 36 feet along the highway. It has a thickness of 30 feet, but some beds may be repeated. It consists of dark shales and sandstone bands (see Plate VI, Figure 1). Some poorly preserved Cardioceratids (Amoeboceras sensu lato) were found which are indicative of late Oxfordian or early Kimmeridgian.

Towards the east these beds with Amoeboceras are followed by dark shales with a few sandstone bands which have not yielded determinable fossils but which in the writer's opinion are transitional beds from the Fernie to the Kootenay. They in turn are followed by shales with an increasing number of sandstone bands and plant fragments (see Plate VI, Figure 2) and eventually by Kootenay sandstones (see Plate VII, Figure 2).

#### CONCLUSIONS

It has been shown that in the sections on Cascade Mountain and in the railway-cut near the Banff Traffic Circle, Devonian rocks are thrust over the Toarcian Paper Shale of the Fernie Group and not over the Kootenay Formation or "Dakota" as had been previously supposed. The Devonian rocks at the contact with the Fernie are, in ascending order: a limestone band (1 1/2 feet thick), slightly calcareous grey siltstones (more than 40 feet thick), and greyish blue limestones. These rocks that are overlain by the Palliser Formation belong to the Fairholme Group.

In all three sections, rocks of the Fernie Group are inverted, the stratigraphically lower units being on top of younger ones.

Rocks of the lower Fernie, i. e. the Toarcian Paper Shale, are exposed below the Devonian in the Cascade Mountain and

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<sup>1</sup>Description of this section is given in Memoir 287 (Frebald, 1957).

railway sections. In the Cascade Mountain section some rocks probably equivalent to the middle Bajocian Rock Creek Member are present. They are concealed in the railway section. Due to erosion, both the Toarcian Paper Shale and the Rock Creek Member are concealed in the highway section.

The various units of the upper Fernie are best exposed in the highway section near the Banff Traffic Circle; the Grey beds with Warrenoceras and Kepplerites (lower Callovian), the dark shales with large concretions and "Turbo" ferniensis (Oxfordian), the dark shales with siltstone bands (upper Oxfordian or lower Kimmeridgian) and about 30 feet of dark shales and sandstone bands with Amoeboceras sensu lato (upper Oxfordian or lower Kimmeridgian) are present, though, due to folding and faulting, are not represented by their true thicknesses. The next younger rocks are shales with a few sandstone bands which are transitional to the Kootenay Formation. Stratigraphically higher, more and more sandstone bands appear, grading eventually into a black massive Kootenay sandstone.

Part of the upper Fernie is also exposed in the railway section but these beds were not seen in the Cascade Mountain section. Here, some older Fernie rocks, probably the middle Bajocian Rock Creek Member, are in faulted contact with the "ribboned" shales (the "Dakota" of Dowling, 1907) that are transitional from the Fernie to the Kootenay.

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PLATE I

Figure 1. Toarcian Paper Shale with Dactylioceratids (A) overlain by Devonian (B) on east side of Cascade Mountain.

Figure 2. Fernie shale (A) and sandstone (A1) overlain by Devonian (B) on east side of Cascade Mountain. Same section as Figure 1.



PLATE II

Figure 1. Section on east side of Cascade Mountain. K - Kootenay Formation, A - Fernie Group, B - Devonian.

Figure 2. Toarcian Paper Shale (A) overlain by Devonian limestone band (B) in railway section east of Banff Traffic Circle.



PLATE III

Figure 1. Devonian calcareous siltstones (foreground) and limestones (about at the second telegraph pole in the background) in railway section east of Banff Traffic Circle. The siltstones overlie the basal Devonian limestone band that is on top of the Toarcian Paper Shale (see Plate II, Figure 2).

Figure 2. Highway section east of Banff Traffic Circle, western part. (See continuation on Plate IV, Figure 1.) A - Grey beds (lower Callovian); B - Black shales with "Turbo" ferniensis (Oxfordian); C - Shales and sandstones with Amoeboceras (upper Oxfordian - lower Kimmeridgian). East side of Cascade Mountain is in the background.

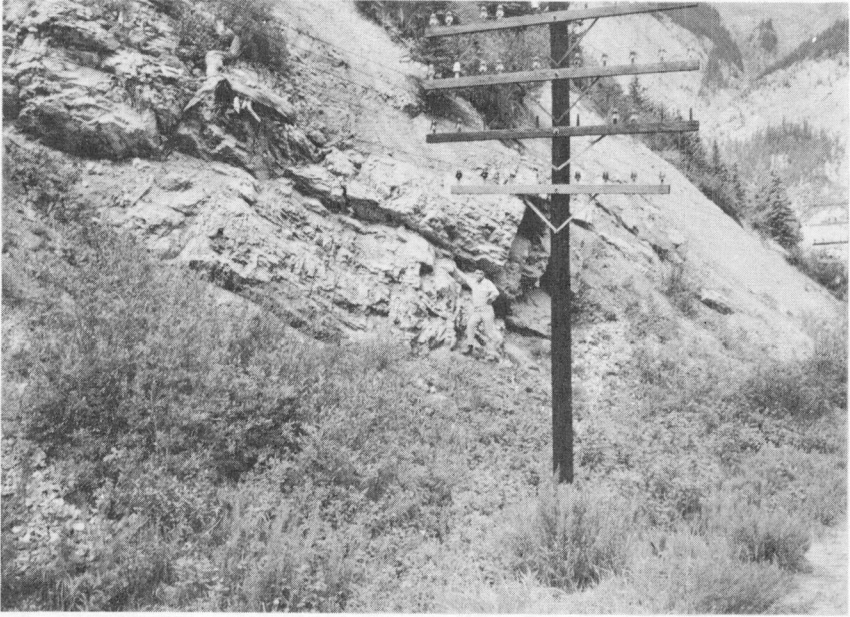




PLATE IV

Figure 1. Highway section east of Banff Traffic Circle, eastern part (for western part see Plate III, Figure 2). C — Shales and sandstones with Amoeboceras (upper Oxfordian-lower Kimmeridgian), R — ribboned shales and sandstones.

Figure 2. Disturbed Grey beds with Warrenoceras and Keplerites (lower Callovian), highway section east of Banff Traffic Circle.

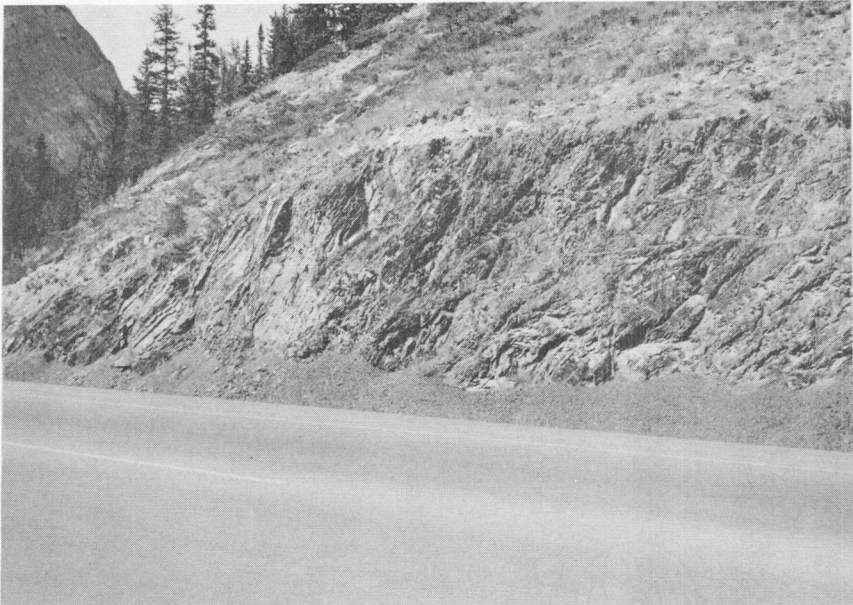


PLATE V

Figure 1. Dark shales with big concretions and "Turbo" ferniensis Frebold (Oxfordian). To the left are Grey beds. T - "Turbo" bed. Highway section east of Banff Traffic Circle.

Figure 2. Folded dark shales with thin sandstone bands (equivalents of lower Passage beds, upper Oxfordian-lower Kimmeridgian) stratigraphically above beds with "Turbo" ferniensis. Highway section east of Banff Traffic Circle.

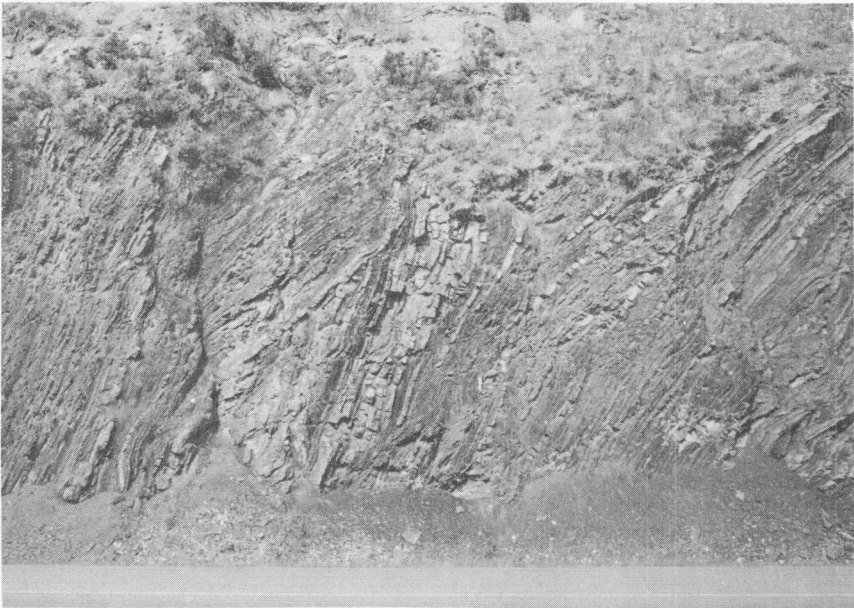
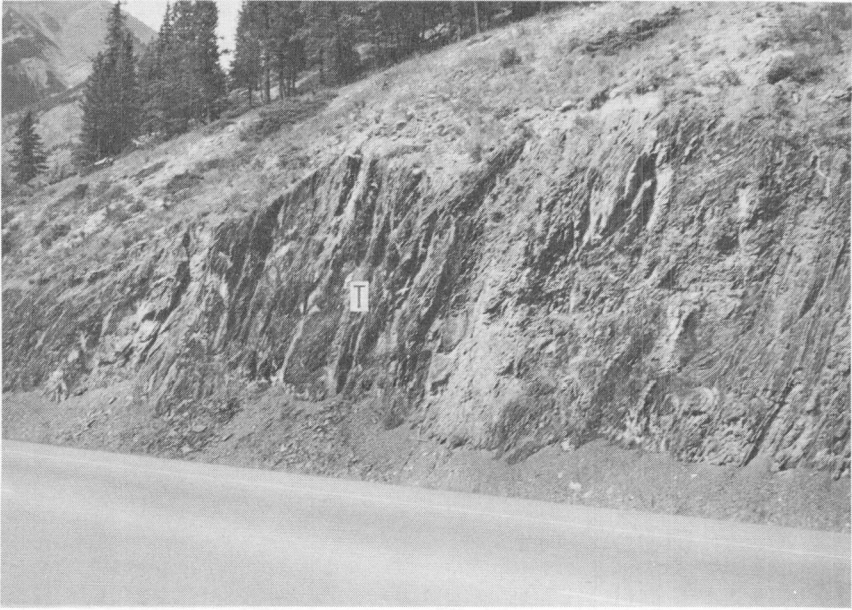


PLATE VI

Figure 1. Dark shales with sandstone bands containing *Amoeboceras sensu lato* (upper Oxfordian-lower Kimmeridgian). Stratigraphically below are the equivalents of the lower Passage beds. Highway section east of Banff Traffic Circle.

Figure 2. Ribboned sandstones and shales transitional from Fernie Group to Kootenay Formation. Highway section east of Banff Traffic Circle.

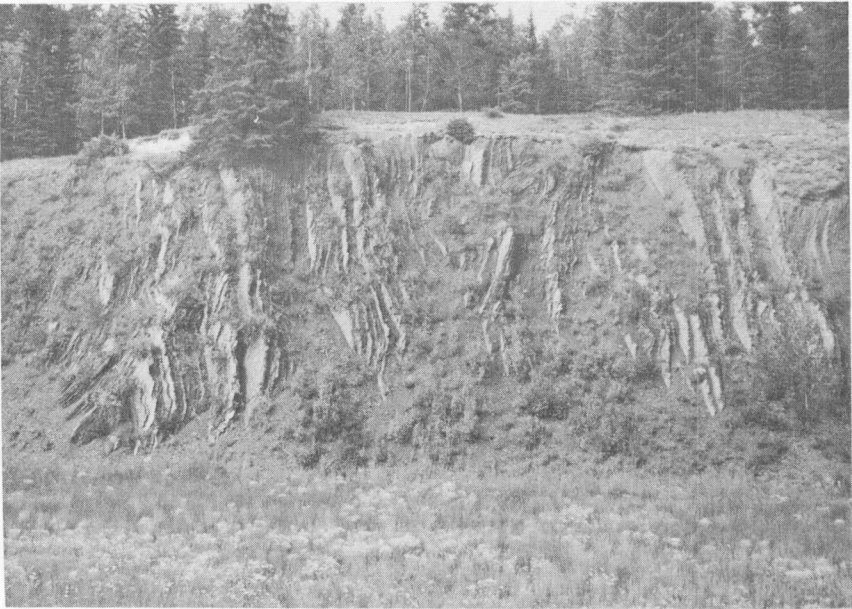
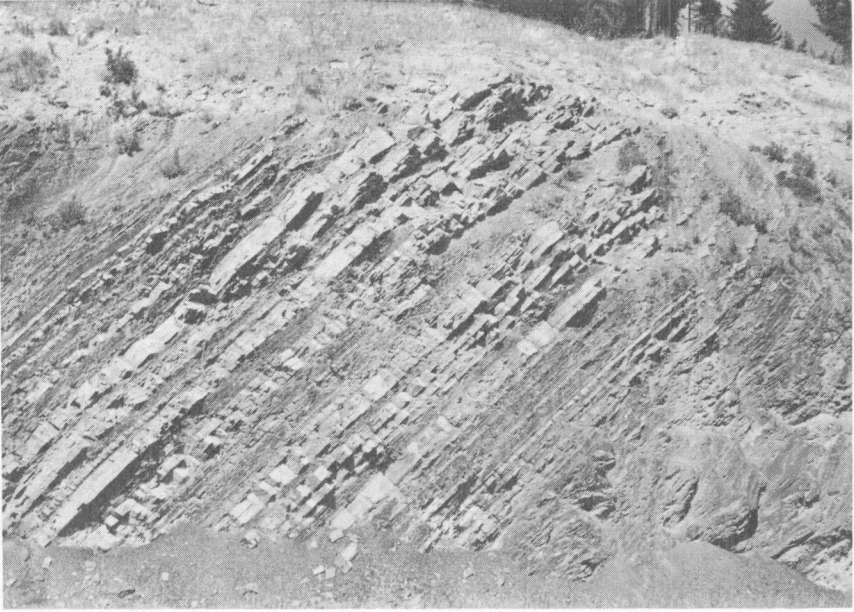


PLATE VII

Figure 1. Equivalents of Passage beds with Amoeboceras sandstone (C) — Cascade River section. At (A) is Buchia concentrica (Sowerby) (upper Oxfordian-lower Kimmeridgian). In background (B), is the described section on east side of Cascade Mountain.

Figure 2. Kootenay sandstone, highway section east of Banff Traffic Circle. In background is east side of Cascade Mountain.

