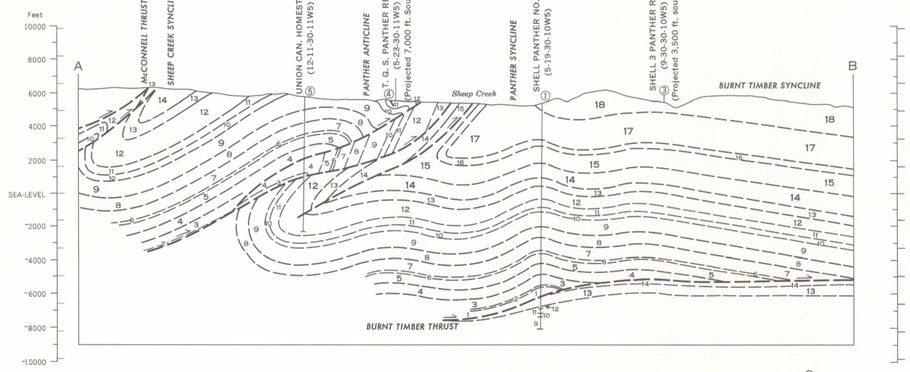
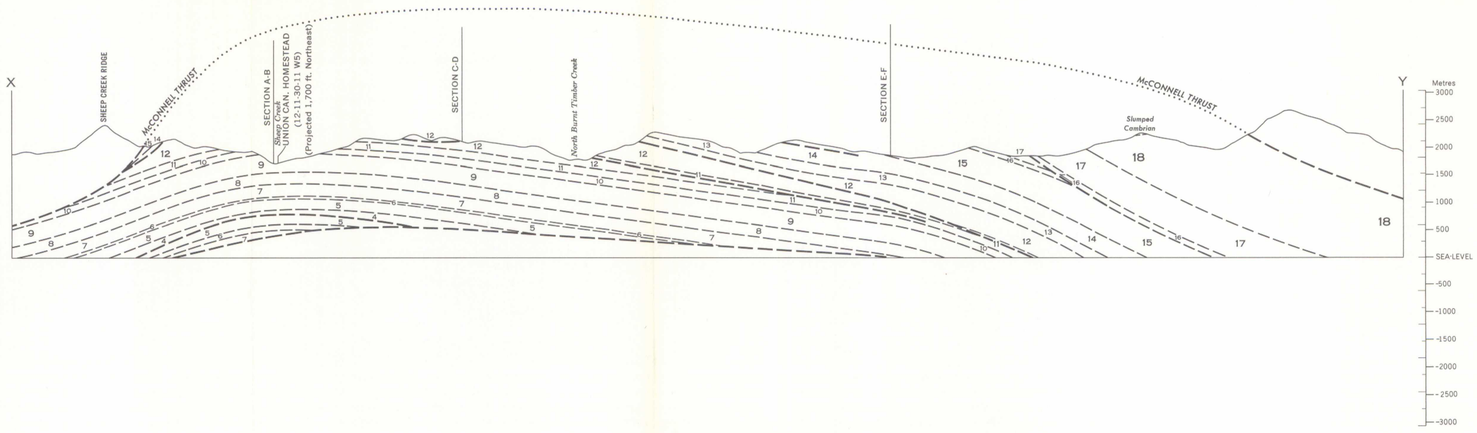
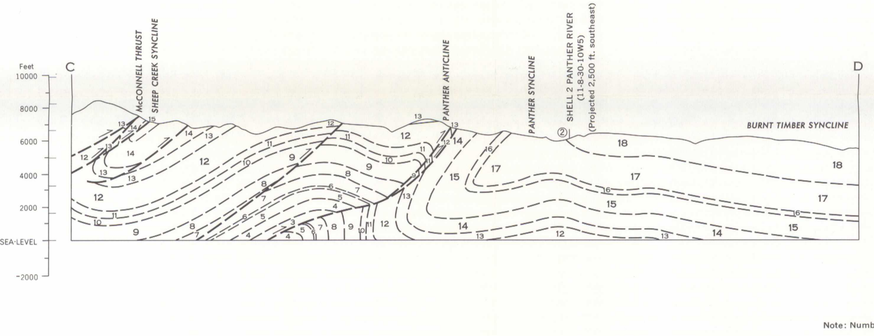
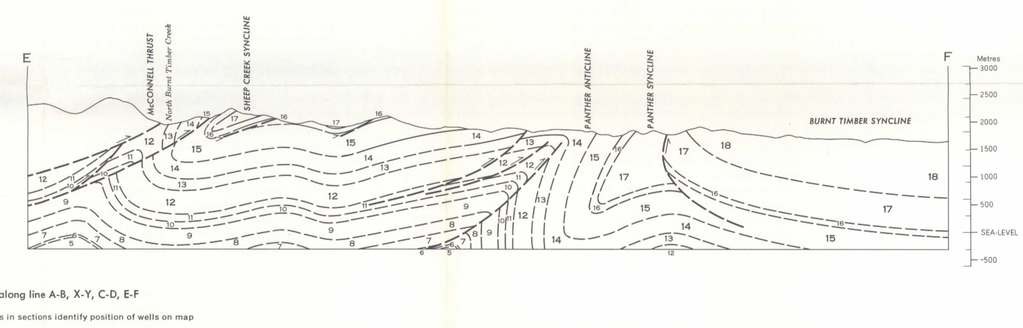
GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES









Sections along line A-B, X-Y, C-D, E-F

Note: Numbers on wells in sections identify position of wells on map

PRELIMINARY SERIES

LEGEND

CRETACEOUS

UPPER CRETACEOUS

18 — BRAZEAU FORMATION: massive, greenish grey and grey, brown-weathering sandstone; greenish grey and grey siltstone; rubbly (locally shaly) green and grey mudstone; local conglomerate; minor coal and bentonite (non-marine)

ALBERTA GROUP

17 — WAPIABI FORMATION: silty, dark grey shale and mudstone, typically platy, locally calcareous; grey to dark grey siltstones and argillaceous siltstone; common concretionary shale and mudstone; minor sandstone; minor pebble layers and bentonite seams (marine)

16 — CARDIUM FORMATION: very fine- to fine-grained, grey sandstone; grey to dark grey, argillaceous siltstone and silty shale (locally concretionary); minor pebbly layers and conglomerate lenses (marine)

15 — BLACKSTONE FORMATION: dark grey shale, including silty shale, rubbly shale, calcareous shale and minor concretionary shale; grey to dark grey siltstone; minor sandstone, bentonite seams and pebble layers (marine)

LOWER CRETACEOUS

BLAIRMORE GROUP

14 — BEAVER MINES FORMATION: massive, coarse-grained, greenish grey sandstone, siltstone and rubbly mudstone; minor grey and black shale; minor reddish grey mudstone; minor conglomerate and pebbly sandstone (non-marine)

13 — LOWER BLAIRMORE: grey siltstone and sandstone, commonly calcareous; grey and black, locally carbonaceous shale; limestone; minor coal seams. Includes light yellowish grey sandstone, minor pebbly sandstone and conglomerate of the Cadomin Formation at the base (non-marine)

LOWER CRETACEOUS AND JURASSIC

12 — KOOTENAY FORMATION: grey and black, commonly carbonaceous and limonitic sandstone; grey and black siltstone; black, carbonaceous shale; minor coal (non-marine)

JURASSIC

FERNIE GROUP

11 — Dark grey to black shale; dark grey siltstone and sandstone; local concretions; dark grey, platy, silty, argillaceous limestone at the base (Nordegg Member) (marine)

TRIASSIC

SPRAY RIVER GROUP

10 — Platy, grey and brownish grey, dolomitic siltstone; hard, grey siltstone and very fine-grained sandstone at the top (marine)

MESOZOIC

MISSISSIPPIAN

RUNDLE GROUP

9 — Fine-grained to dense, yellowish brown and grey dolomite; cherty dolomite; light grey, coarse-grained crinoidal limestone, locally dolomitic; minor calcarenite, oolite, chert and collapse breccia (marine)

PALEOZOIC

SUB-SURFACE ONLY

MISSISSIPPIAN

8 — BANFF FORMATION: platy and banded, calcareous siltstone and silty, argillaceous limestone; minor black chert layers; crinoidal, silty and argillaceous limestones, dolomite, dolomitic limestone; minor shale and chert occur at the top. Includes minor black shales of the Exshaw Formation at the base (marine)

DEVONIAN

7 — PALLISER FORMATION: grey-brown dolomite; mottled dolomitic limestone; grey limestone (marine)

6 — "ALEXO FORMATION": recessive, brownish grey, bedded dolomite; sandstone; intraformational conglomerate and breccia (marine)

5 — SOUTHESK FORMATION: massive to thick-bedded, light to medium grey, fine to coarsely crystalline dolomite; local medium to dark brownish grey dolomite (marine)

4 — CAIRN FORMATION: massive, dark brownish grey and dark grey, medium crystalline dolomite with Amphipora and stromatoporoid beds; minor chert. Includes thin-bedded dolomite and conglomerate of the Yahatinda Formation at the base (marine)

CAMBRIAN

UPPER CAMBRIAN

3 — LYNX FORMATION: dolomite, silty dolomite and dolomitic siltstone; minor shale, calcarenite, oolite and chert (marine)

MIDDLE CAMBRIAN

2 — ARCTOMYS FORMATION: recessive, platy, dolomitic siltstone and shale; shallow-water and desiccation structures; minor evaporitic breccia (marine)

1 — PIKA FORMATION: thin-bedded, commonly banded, brown and grey dolomitic siltstone and limestone; silty dolomite; flat-pebble conglomerate; calcarenite and oolite (marine)

PALEOZOIC

Geological boundary (defined, approximate, assumed)
Limit of geological mapping
Bedding, tops known (horizontal, inclined, vertical, overturned)
Bedding, tops unknown
Fault (approximate)
Thrust fault (teeth in direction of dip; defined, approximate, assumed)
Anticline (defined, approximate)
Syncline (defined, approximate)
Anticline overturned (defined, approximate)
Syncline overturned (defined, approximate)
Coal seam
Gas producer
Show of gas
Abandoned well
Line of section C — D

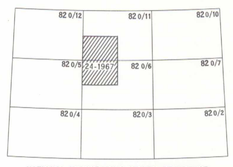
Note: wells on sections and map identified by numbers.

Geology by N.C. Ollerenshaw, 1963, 1966.

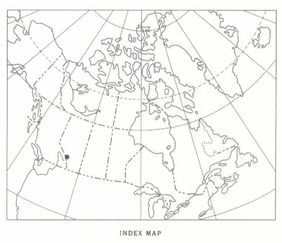
Geological cartography by the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, 1968

Road, all weather
Other roads
Bulldozed track or seismic line
Cut line or trail
Intermittent stream
Marsh
Contours (interval 100 feet)
Horizontal control point

Base-map Lake Minnewanka west half, Burnt Timber Creek west half, compiled and drawn by the Surveys and Mapping Branch, 1958, 1963 (with minor modifications by N.C. Ollerenshaw, 1967)



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE



INDEX MAP

Published, 1968
Copies of this map may be obtained from the Director, Geological Survey of Canada, Ottawa

Printed by the Surveys and Mapping Branch

MAP 24-1967

GEOLOGY

PANTHER CULMINATION

WEST OF FIFTH MERIDIAN

ALBERTA

Scale 1:63,360
1 inch to 1 mile

Miles 1 0 1 2 3 Miles

Kilometres 1 0 1 2 3 4 5 Kilometres

Approximate magnetic declination 22° 22' East, decreasing 3.5' annually

DESCRIPTIVE NOTES

The Panther River culmination is located in the southern foothills of Alberta at the mountain front, a few miles south of Red Deer River. The mountains-foothills boundary is defined at the surface trace of the McConnell thrust fault, which superimposes resistant Paleozoic strata over recessive Mesozoic rocks to form a pronounced escarpment. The McConnell fault, together with overlying and underlying strata are involved in the culmination, although the hanging-wall portion has been eroded in the apex region (the area mapped). As a result, the mountain front deflects sharply westward to form an embayment around the Panther River culmination.

The Panther River culmination is a structural high, modifying the northwest-southeast regional axes of folding. Folds on the regional trend plunge sharply northwest and southeast over the culmination. Its structural relief is estimated to be 15,000 feet, but decreases to zero 7 miles to the northwest and 15 miles southeast from its apex. The culmination is therefore asymmetrical to the northwest with its steepest gradient in that direction (Section X - Y).

In that part of the culmination below the McConnell thrust fault, three main folds occur along the regional trend. They comprise the Panther anticline in the centre, flanked on the east by the Panther syncline and on the west by the Sheep Creek syncline. All three structures are overturned toward the northeast.

Numerous thrust faults repeat, or locally thin the succession. The Panther anticline overrides the Panther syncline along the largest of these faults.

Several subsidiary folds locally deform the limbs of the major folds. Syncline and anticline pairs occur at three localities. One pair modifies the crestal region of the Panther anticline in the vicinity of Sheep Creek, and a second pair modifies its western limb in the southwest corner of the culmination. A third pair occurs on the east limb of the Panther syncline between North Burnt Timber Creek and Panther River.

To the west of the Panther River culmination, successive thrust sheets repeat the Paleozoic-Mesozoic succession. To the east, the culmination is bounded by the broad, shallow Burnt Timber syncline.

A major fault, the Burnt Timber thrust (Section A - B), occurs about 13,000 feet below the surface in the area of the culmination. It is not certain whether this thrust is folded with the culmination, or forms a lower boundary along which the culmination has been displaced.

Evidence reveals that the Panther River culmination is structurally related to typical foothills deformation, involving sheet overthrusting and associated folding of Paleozoic and Mesozoic strata. There is no apparent evidence to support Hunt's (1956 and 1959) hypothesis of basement involvement and, in fact, the seismic analysis and data supplied by Bally et al. (1966) preclude this.

The Panther River culmination is interpreted to be the result of the development of a shoulder or step on the McConnell thrust where the fault surface abruptly cuts up through the section southwest of the present site of the culmination. Similar developments were illustrated by Douglas (1950). West of this shoulder, compression would be accommodated by the northeastward translation of the hanging-wall above a decollement surface. At the shoulder, considerable force would be transferred to strata in the foot-wall to produce folding, overturning, and arching in the foot-wall. Such arching would inevitably involve the overlying McConnell thrust and strata above the thrust. Once the transferred stress had built up to some critical level, fracture could be expected at depth in the foot-wall, with transfer of motion and crustal shortening to this fracture (i.e. the Burnt Timber thrust). A possible step development in the Burnt Timber thrust beneath the culmination may have contributed to the development of the culmination, or its modification. Southwest (down-dip) to northeast (up-dip) variations in the position of the shoulder could explain the location and magnitude of the structural highs and lows along the McConnell thrust, as the greatest frictional drag and resultant arching would be developed at the shoulders farthest to the southwest.

Stratigraphic information on the sub-surface (see Legend) Cambrian to Mississippian strata is derived from well data and data from sections above the McConnell thrust. All thicknesses in this interval are approximate.

The Pika Formation (1) is 200-300 feet thick and is overlain conformably by the Arctomys Formation (2). The latter comprises 70 feet of shallow-water, evaporitic strata. The Lynx Formation (3) is 500-600 feet thick. Its basal contact is gradational and its upper contact is a disconformity with a gentle relief, typically ranging from a few inches to a few feet, but locally with channels up to 50 feet deep. Relict weathering suggests some sub-aerial erosion. The basal Devonian Yahatinda Formation (4, in part), overlies this disconformity. The Yahatinda is 0-20 feet thick, increasing locally to 60-70 feet at the conglomerate-filled channels.

The Upper Devonian Fairholme Group is represented by 1,100 to 1,200 feet of carbonate rocks belonging to the Cairn (4) and Southesk (5) Formations. 135 feet of recessive-weathering, bedded dolomite, sandstone, breccia and conglomerate above the Southesk have been assigned to the "Alexo Formation" (6). The overlying Palliser Formation (7) is about 700 feet thick, with a gradational basal contact.

The Mississippian section begins with a few feet of black shale, the Exshaw Formation, conformable with, but lying on the slightly undulating upper surface of the Palliser Formation. The Exshaw is overlain conformably by the Banff Formation (8) which is 600-700 feet thick. The Rundle Group (9) is gradational from the Banff Formation and includes the Pekisko, Shunda, Turner Valley and Mount Head Formations. The Mount Head Formation outcrops on Sheep Creek and the yellow-brown dolomites and collapse breccias comprising the uppermost 100 feet may belong to the Etherington Formation. A few small, scattered outcrops of sandstone on tributaries of Sheep Creek may indicate the presence of 10 - 30 feet of the Rocky Mountain Group. The Rundle Group thins gradually from west to east and averages 900 feet thick in the map-area.

The Spray River Group (10) also thins progressively eastwards and has an estimated thickness of 400 feet in the map-area. Both the Sulphur Mountain and Whitehorse Formations outcrop on Sheep Creek.

The Fernie Group (11) is fairly well exposed on Sheep Creek, where a composite section is 500 feet thick. The section includes Nordegg Member, Toarcian Shales, Rock Creek Member, probable Green Beds, and Passage Beds in ascending order. The middle part of the Nordegg Member contains a Pliensbachian fauna. The gradational Fernie-Kootenay contact is placed at the base of a prominent and persistent ridge-forming sandstone unit 50-60 feet thick.

The Kootenay Formation (12) is commonly folded and faulted, and exposures are scattered and incomplete. Graphic estimates give a thickness of 1,500 feet, but the formation becomes rapidly thinner eastward in the sub-surface. A small number of coal seams occur, ranging from a few inches to 4 feet thick.

The Cadomin Formation (13, in part), of the Blairmore Group, overlies the Kootenay Formation on an erosional surface. The Cadomin Formation is a sandstone unit in this area, with only local, minor amounts of pebbly sandstone or conglomerate lenses. The sandstone varies from 15 to 40 feet thick.

The Lower Blairmore division (13) overlies the Cadomin conformably. It consists of 410 feet of thin-bedded, calcareous, grey sandstone and siltstone; grey to black shales; grey, argillaceous, platy limestones and shelly limestones, and a few thin coal seams. Slump structures occur locally in the shale.

The Beaver Mines Formation (14) averages 900 feet thick. Its basal contact is a conformable erosion surface. The greenish-grey colour and massive nature of the Beaver Mines sandstone and rubbly mudstone units are in marked contrast to the Lower Blairmore. A unit of conglomerate, in a series of lenses up to 50 feet thick, occurs in the lower part of the Beaver Mines Formation. Phenoclasts include chert, quartzite, different types of igneous rock and quartz. The Beaver Mines Formation is tectonically thinned on the east limb of the Panther anticline and thickened on the west limb.

The marine Blackstone Formation (15) overlies the non-marine Beaver Mines Formation along a sharp, conformable, flat to slightly uneven contact. The basal beds of the Blackstone typically consist of dark grey shale, although 5-10 feet of sandstone occur at the base of the formation in the south. Scattered chert and quartz pebbles, or thin conglomerate lenses, occur locally in both shale and sandstone near the basal contact. The Blackstone Formation is 1,400 feet thick, but commonly thickened or thinned tectonically. Its contact with the overlying Cardium Formation (16) is transitional (interbedded shale and sandstone). The Cardium Formation is about 300 feet thick and comprises two, and locally three, clean, resistant sandstone units separated by recessive-weathering shales, argillaceous siltstones and sandstones. Local lenses of conglomerate occur. The Cardium Formation forms conspicuous, sharp ridges.

The Wapiabi Formation (17) overlies the Cardium conformably on a sharp but slightly undulating surface. It is 1,900 feet thick. Concretions are abundant and conspicuous. In the southern part of the culmination, a sandstone unit, 60 feet thick, occurs about 100 feet below the top of the formation, in the Chungo Member. This sandstone strongly resembles the clean Cardium sandstone units.

The non-marine Brazeau Formation (18) overlies the marine Wapiabi conformably but with local minor channelling at the contact. Only the lowermost 2,000-3,000 feet of the formation are exposed. Sandstone units are lenticular and pass laterally into rubbly mudstones and siltstones. Pebbly sandstones and lenticular beds of conglomerate occur locally in the lower 1,000 feet.

Five wells have been drilled to date in the north and northeastern part of the structure. Four of the wells have been capped and three are potential gas producers. The reservoir rocks are of Mississippian and Devonian age. Some of the gas has a remarkable 86 per cent content of hydrogen sulphide, constituting an important potential source of sulphur.

The best remaining localities for gas exploration appear to be the small Cardium anticline in the southwest and structures to the west, beneath the McConnell thrust.

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MAP 24-1967
PANTHER CULMINATION
ALBERTA