



GEOLOGICAL SURVEY OF CANADA  
DEPARTMENT OF ENERGY, MINES AND RESOURCES

LEGEND

- TERTIARY**
- OLIGOCENE**
- 12 CYPRESS HILLS FORMATION: conglomerate (non-marine)
- PALEOCENE**
- 11 RAVENSCRAIG FORMATION: soft, grey- and buff-weathering, grey and light brown, fine-grained sandstone; soft, grey- and buff-weathering, argillaceous sandstone and siltstone; soft, grey- and buff-weathering, brownish grey clays and shales; lignitic coal seams; bentonite layers; ironstone (non-marine)
- CRETACEOUS**
- UPPER CRETACEOUS**
- 10 FRENCHMAN FORMATION: massive, fine- to coarse-grained crossbedded, buff- to reddish-brown-weathering, grey and light brown sandstone; green and grey shale, silty shale and siltstone (non-marine)
- 9 WHITEMUD AND BATTLE FORMATIONS: white-weathering, green and grey, argillaceous sandstone; green and grey clay and silty clay (Whitemud Formation); overlain by mauve-weathering, dark grey to purplish grey, bentonitic, rubby shale; light-grey weathering tuff (Battle Formation) (non-marine)
- 8 EASTEND FORMATION: grey- to buff-weathering, grey and pale brown, fine- to medium-grained, clayey, in part cross-bedded, sandstone; green, grey and dark grey shale; grey silty shale and siltstone; black, carbonaceous shale; coal seams (marine and non-marine)
- 7 BEARPAW FORMATION: dark grey and brownish grey, rubby and faky shale; silty shale; light buff-weathering, grey, argillaceous sandstone; ironstone concretionary bands; bentonite layers (marine)
- 6 OLDMAN FORMATION: massive, crossbedded, medium- to coarse-grained, light-grey weathering sandstone; grey, clayey siltstone; grey and light grey weathering, green and grey shale; dark grey and brown, carbonaceous shale; ironstone concretionary beds (non-marine)
- 5 FOREMOST FORMATION: green and grey shale; dark carbonaceous shale; grey and green siltstone; grey and pale brown sandstone; ironstone; coal seams (non-marine)
- 4 PAKOWKI FORMATION: dark grey shale and sandy shale; grey sandstone; thin chert pebble conglomerate at base; chert pebble bed at base (marine)
- 3 MILK RIVER FORMATION (Upper Member): soft, grey-weathering, grey, argillaceous sandstone; lenses of massive, light-buff weathering, grey sandstone; soft, grey shale and silty shale; dark grey, carbonaceous shale; ironstone (non-marine)
- 2 MILK RIVER FORMATION (Lower Member): massive, light-grey to white-weathering, grey, soft and hard, sandstone; ironstone concretions; grey and light grey shale and sandy shale (marine)
- 1 ALBERTA GROUP: dark grey, friable and fissile shale and sandy shale; brown-weathering, grey sandstone (marine)

- Geological boundary (approximate) .....  
 Rock outcrop .....  
 Oil and gas fields .....  
 Thrust fault (position approximate) .....

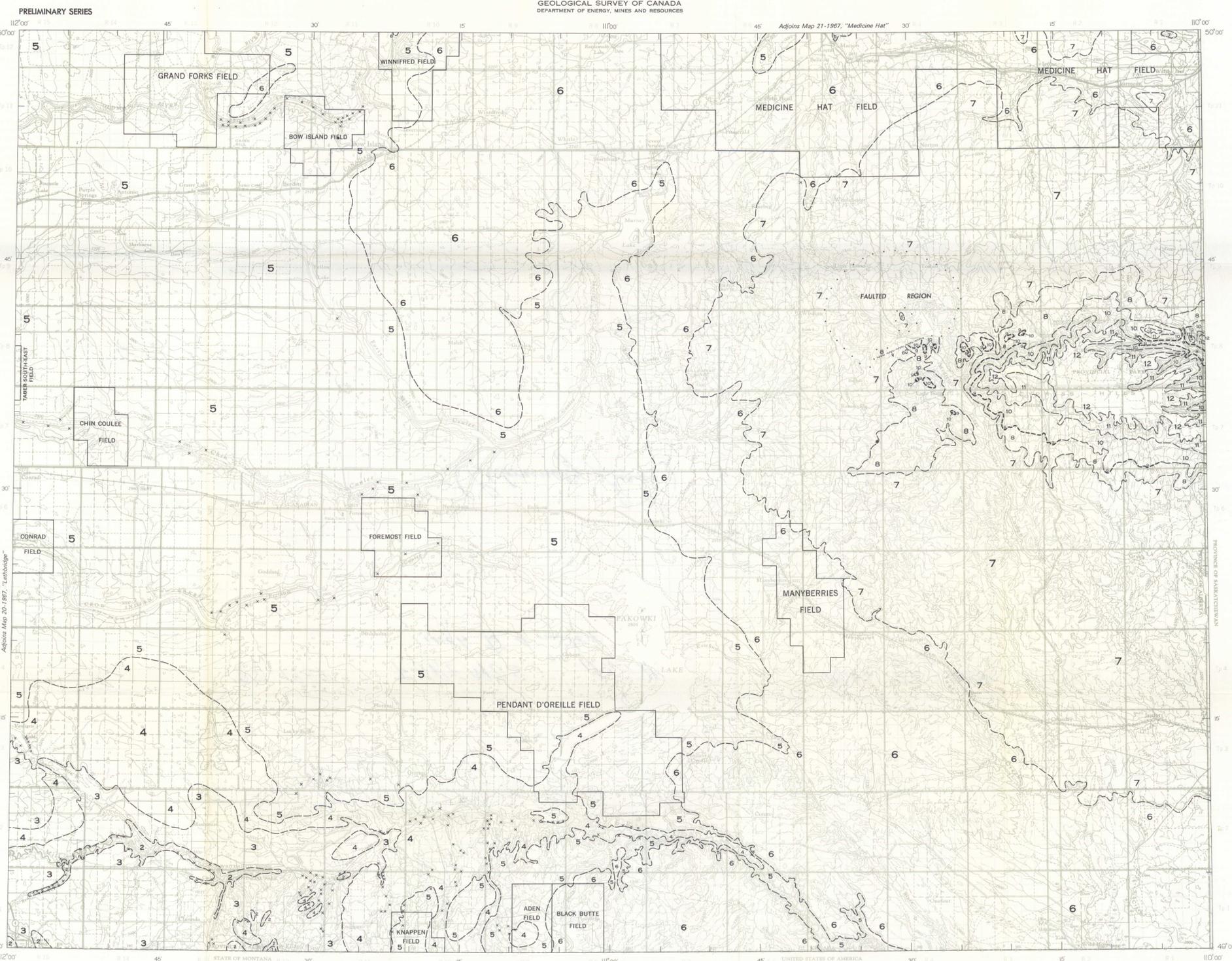
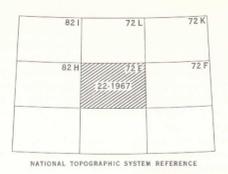
Geology by E. J. W. Irish, 1964, 1965, 1966, 1967

Geological cartography by the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, 1967

Base-map compiled and drawn by the Surveys and Mapping Branch, 1958

Magnetic declination 1965 varies from 19° 09' easterly at the centre of the east edge to 19° 16' easterly at the centre of the west edge. Mean annual change decreasing 3.1'

All elevations in feet above mean sea-level



DESCRIPTIVE NOTES

Glacial and fluvio-glacial deposits of clay, silt, sand, gravel and till cover most of the map-area so that bedrock exposures are rare except in the deeply eroded parts of stream valleys, along the northern slopes of the Cypress Hills and in the "badland" regions east and southeast of the village of Manyberries.

The northern part of the map-area is drained by tributaries of South Saskatchewan River which cuts across the northwest corner. The southern part of the map-area is drained by Milk River, a tributary of the Missouri River. The region between is relatively flat but contains the remains of several large Pleistocene stream valleys now known as Etzikom, Chin, and Seven Persons Coulees. The centre of the eastern part of the map-area is occupied by the western end of the Cypress Hills, an erosional remnant having a maximum altitude of 4,400 feet and an approximate height above the general prairie level of 2,400 feet.

The geological formations that occur at the surface or immediately below the unconsolidated deposits are of late Upper Cretaceous and Tertiary ages. The outcrop symbols shown on the map indicate the relative amount of rock exposure rather than specific outcrops.

The oldest strata are those of the Alberta Group (1) but they are exposed only at one locality within the map-area. Beds in the upper part of this group, though not the upper contact, are exposed in the valley of Deer Creek in Sec. 5, Twp. 1, Rge. 12W4, along the south boundary of the map-area.

The lower member of the Milk River Formation (Virgelle member) (2) is almost continuously exposed along Milk River between Sec. 2, Twp. 2, Rge. 15W4, to Sec. 33, Twp. 1, Rge. 11W4, in Secs. 4, 5, and 17, Twp. 1, Rge. 12W4, and in Sec. 4, Twp. 1, Rge. 15W4. The most striking outcrop of this massive sandstone unit occur in Milk River valley in Sec. 35, Twp. 1, Rge. 13W4, which is the location of Writing-on-Stone Provincial Park. The member consists of a transition zone about 15 feet thick at the base overlain by approximately 100 feet of massive, cliff-forming sandstone.

The non-marine, upper member of the Milk River Formation (3) underlies large areas both north and south of Milk River and extends from the west border of the map-area as far as Sec. 13, Twp. 2, Rge. 11W4. This part of the Milk River Formation is softer than the lower member and consists of grey-, dark grey-, and brown-weathering, argillaceous sandstones and sandy shales; lenticular beds of fine-grained, massive, light buff colored sandstone; reddish brown ironstone bands; and small amounts of carbonaceous shale. The character of the beds changes laterally so that no two sections are similar. The thickness of this member is estimated to be about 120 feet in Twp. 1, Rge. 11W4.

Milk River strata are overlain by the marine, Pakowki Formation (4) consisting of dark grey shale and sandy shale with some interbedded, thin, grey sandstone strata. The base of the formation is marked at many places by a thin, chert-pebble conglomerate or by a layer of small chert pebbles within the shale. The presence of the pebble bed at the base of the Pakowki may indicate that the Milk River - Pakowki contact is a disconformity.

Pakowki shales underlie an area north of Milk River from the west border of the area to the east boundary of Rge. 11W4, from Rge. 11W4, to the east boundary of Rge. 9W4, the Pakowki Formation occurs in the valley of Milk River and underlies extensive regions on either side of the valley; and from Rge. 9W4, to Sec. 4, Twp. 2, Rge. 9W4, the shales are confined to the valley of Milk River.

The marine Pakowki shales are gradational upward into the Foremost Formation (5). Foremost strata underlie most of the western one-half of the map-area north of Milk River. Good exposures of these strata occur in Milk River canyon east of Rge. 8W4, and in the valley of South Saskatchewan River in the northwest corner of the area. Scattered outcrops occur in Seven Persons Coulee, Chin Coulee, and Etzikom Coulee. The formation comprises a succession of interbedded green and grey shales; dark grey carbonaceous shales; grey siltstones and grey to pale brown sandstones. Ironstone beds are common. The carbonaceous shales grade, in some places, into coal seams. The sandstones are mainly soft and argillaceous though thin, hard layers and concretionary masses of calcareous, buff-weathering sandstone occur throughout. Individual units are thin lenses and do not extend far in any direction. Shell beds containing *Ostrea* and *Corbula* are common in the middle part of the formation. The formation becomes thinner both to the north and east so that its thickness differs from place to place. In Twp. 2, Rge. 7 and 8W4, the approximate thickness of the formation is 260 feet. The upper beds are transitional into the overlying Oldman Formation and the contact is usually placed arbitrarily.

The Oldman Formation (6) underlies, mainly, a semi-circular area north, west and south of the Cypress Hills and, also, the region south of Medicine Hat between Fortmanie and Etzikom Coulees. Good exposures occur in Milk River valley, in an area of "badland" topography southeast of the village of Manyberries, and on the south side of the Trans-Canada highway near the town of Irvine. Scattered outcrops are present at many places on the east side of the Cypress Hills. Oldman strata comprise green, grey and light grey shales and silty shales interbedded and interlensed with grey and light grey sandstones. Hard, calcareous sandstone beds, as well as thin ironstone bands occur throughout the succession. Thick, crossbedded, light-grey weathering, lenticular sandstone units are typical of the upper part of the formation. The strata are not very carbonaceous except for the Lethbridge coal member at the top. This carbonaceous zone marks the approximate top of the Oldman Formation throughout southern Alberta and contains mineable coal seams at several localities. Fragments of vertebrate remains are common and shells, principally *Ostrea*, occur at several horizons. The estimated thickness of the formation in Twp. 2, Rge. 8W4, is about 600 feet, and in the published log of the Eagle Butte No. 2 well to the north in Sec. 30, Twp. 7, Rge. 3W4, 480 feet of beds are assigned to the Oldman Formation.

The marine Bearpaw Formation (7) rests conformably and relatively abruptly upon the Oldman beds. It underlies an extensive region in the eastern part of the map-area flanking the Cypress Hills. The best outcrop occur on Ross Creek, Bullhead Creek, Bullhead Butte, Medicine Lodge Coulee, and in several coulees south of Cypress Hills. The formation consists of grey-weathering, dark grey or brownish grey shale and silty shale; spheroidal ironstone concretions; fine-grained, clayey sandstone; and bentonite beds. Thick sandstone units, that occur in the upper part of the formation, are poorly exposed along the sides of Medicine Lodge Coulee. The Bearpaw Formation is about 550 feet thick in this map-area.

Sandstone strata of the Eastend Formation (8) conformably overlie the Bearpaw shale. Eastend strata are confined to the Cypress Hills area and occupy a belt at the foot of the main escarpment. The best sections outcrop near the west end of the hills on Thelma Creek, and in Medicine Lodge Coulee. The formation consists of grey- to buff-weathering, grey and pale brown, fine- to medium-grained, clayey sandstone; green, grey and dark grey shale; grey, silty shale and siltstone; black, carbonaceous shale; coal seams. The thickness of the formation in Medicine Lodge Coulee is approximately 330 feet. Marine fossils occur in some of the lower beds though the upper part of the formation is of non-marine origin. In the vicinity of Elkwater Lake, a mineable coal seam occurs about 70 feet below the top of the formation. Eastend strata grade upward into the overlying Whitemud Formation.

The relatively thin Whitemud and Battle formations have been combined and mapped as a single unit (9) on the map. Outcrops of these formations are confined to the lower slopes of the Cypress Hills.

The Whitemud Formation outcrops at several places both on the north and south slopes of the Cypress Hills but, because of its softness, good exposures are rare. The formation is of non-marine origin and consists of white-weathering, fine- to medium-grained, feldspathic, crossbedded, argillaceous sandstone; white- to cream-weathering, grey, white and pale green clay and silty clay. Generally, a three-fold division can be recognized: a lower unit composed mainly of argillaceous sandstone; a middle thin unit composed of buff-colored clay and siltstone with interbedded brown and black carbonaceous clay; and an upper unit composed mainly of white- to cream-weathering, clay and silty clay. There is considerable lateral variation of each of the three subdivisions and, also, of lithologic units within each subdivision. The total thickness of the formation in southeastern Alberta is about 25 feet.

The Whitemud Formation is overlain conformably and, in most places abruptly, by the dark clays and shales of the Battle Formation. A complete exposure of these beds, showing both the upper and lower contacts, occurs on the north face of Eagle Butte in a quarry of the Medicine Hat Brick and Tile Company. The formation is very uniform, consisting of mauve-weathering, dark brown to purplish black, bentonitic shales, all of which contain some fine silt. A grey-weathering, grey-brown, siliceous tuff bed, about 8 inches thick occurs within the upper part of the shale. The upper contact of the Battle is an erosion surface so that thicknesses are different at different localities. The maximum thickness of the formation is about 30 feet.

The Battle shale is overlain unconformably by the Frenchman Formation (10). These beds, also, are confined to the slopes of the Cypress Hills and consist, mainly, of massive, medium-grained, crossbedded, buff- to reddish brown-weathering grey and light brown sandstone intercalated with beds of green and grey siltstone, silty shale and shale. The maximum thickness of the non-marine, Frenchman Formation in southeastern Alberta is estimated to be 200 feet.

The upper contact of the Frenchman Formation is transitional into the overlying non-marine Ravenscrag Formation (11). Ravenscrag strata are confined to a narrow rim around the higher parts of the Cypress Hills. The beds consist of soft, grey- and buff-weathering, grey and light brown, fine-grained sandstone; soft, grey- and buff-weathering, brownish grey clays; lignitic coal seams; bentonite layers; and thin beds of ironstone. Because of the similarity of the upper Frenchman and lower Ravenscrag beds, the contact is usually placed at the base of the lowest coal seams.

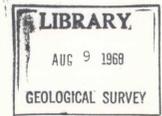
The youngest beds within the map-area comprise the Cypress Hills Formation (12). This formation caps the Cypress Hills and consists, mainly, of a hard, well-cemented, pebble and cobble conglomerate with some intercalated grey, coarse, sandstone lenses. Most of the pebbles and cobbles of the conglomerate are composed of grey, brown and purplish chert and grey quartzite and the matrix is composed of medium-grained, calcareous sandstone.

All formations lie on the east flank of the Sweetgrass Arch and the strata dip at very small angles to the east and southeast. Several small thrust faults are known to exist near and just north of Eagle Butte but slumping in this region combined with the thick cover of glacial materials prohibits the determination of their lateral extent by surface mapping.

At Elkwater and vicinity coal was mined for several years from the main seam in the Eastend Formation. These workings are now abandoned. The Medicine Hat Brick and Tile Company quarries clay on Eagle Butte and from a hill just east of Elkwater Lake. Although the Whitemud Formation is the main source, some clay is obtained from both the Eastend and Ravenscrag formations.

Natural gas and some oil are recovered from the area and the established fields are shown on the map.

Alberta, Foremost  
 1 inch to 4 miles  
 Map 22-1967 (Preliminary Series)



MAP 22-1967  
 GEOLOGY  
**FOREMOST**  
 WEST OF FOURTH MERIDIAN  
 ALBERTA

Scale 1:253,440  
 1 inch to 4 miles

Miles 0 4 8 12  
 Kilometres 0 6 12 18

MAP 22-1967  
 FOREMOST  
 ALBERTA  
 72E