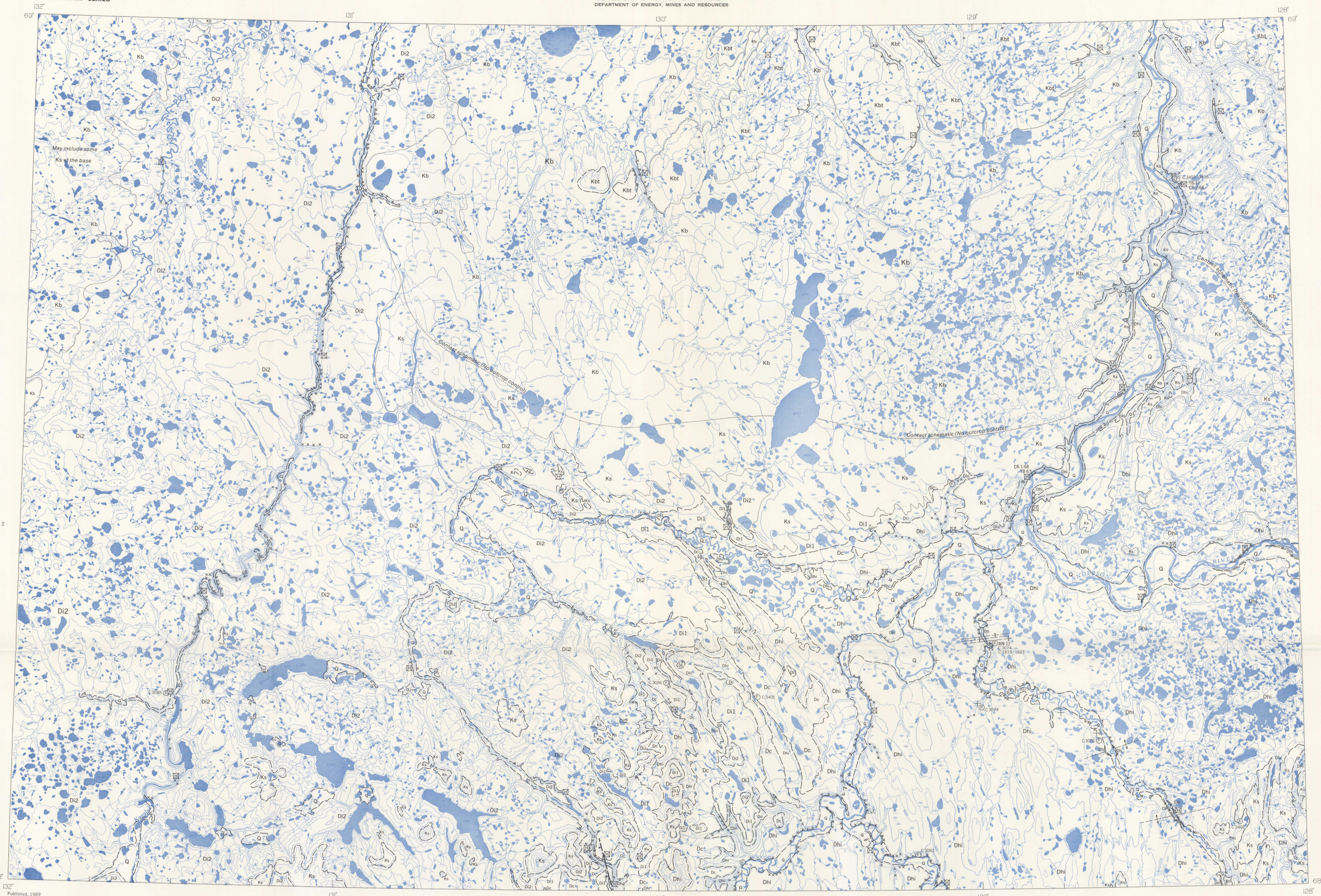
PRELIMINARY SERIES

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES



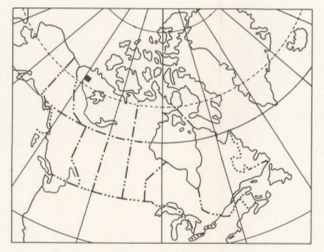
Published, 1969
Copies of this map may be obtained from the Geological Survey of Canada, Ottawa

Printed by the Surveys and Mapping Branch

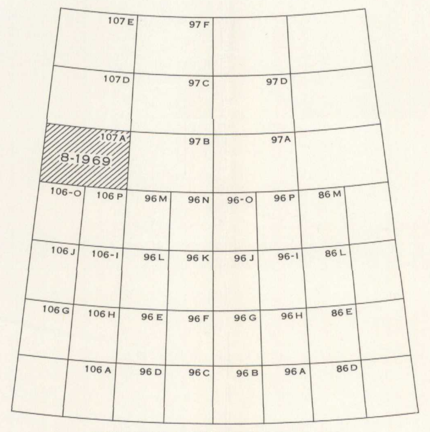
MAP 8-1969
GEOLOGY
CROSSLEY LAKES
DISTRICT OF MACKENZIE

Scale 1:250,000

Miles 4 0 4 8 12 Miles
Kilometres 6 0 6 12 18 Kilometres



INDEX MAP



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

National Topographical System designations indicate other quadrangles mapped geologically during Operation Norman

LEGEND

Note: Weighted legend blocks indicate map-units that appear on this map

CENOZOIC

QUATERNARY

- **Q** Glacial till, outwash, alluvium, etc.; mapped only where deposits are thick and continuous
- **Qm** Thick morainal deposits forming prominent topography (Amundsen and Great Bear lobe moraines)

TERTIARY and/or QUATERNARY

- **Tb** BEAUFORT FORMATION (?): unconsolidated gravel and sand; quartzite, dolomite and black chert pebbles; wood fragments

MESOZOIC

CRETACEOUS

UPPER CRETACEOUS

- **Kps** "Pale shale zone": pale grey shale and mudstone; grey brown ferruginous shale; minor ironstone concretionary beds
- **Kbt** "Bituminous zone": black bituminous shale; yellow jarosite; local earthy hematite; pale grey clay; local basal ironstone-pebble and shale-chip conglomerate

LOWER CRETACEOUS

- **Kb** "Bentonitic zone": black, soft, plastic shale; fossiliferous orange ironstone concretionary beds
- **Ks** "Silty zone": upper division - argillaceous siltstone and mudstone; lower division - light grey friable sandstone and coal
- **Ksh** Undifferentiated shales, equivalent to the "Silty", "Bentonitic", and "Bituminous" zones
- **Kss** Basal sandstone, white, very fine to coarse-grained, crossbedded, partly calcareous, commonly porous, locally oil-stained; equivalent to lower division of "Silty zone"
- **K** Cretaceous deposits (Undivided)

PALEOZOIC

DEVONIAN

UPPER DEVONIAN

- **Di2** IMPERIAL FORMATION: shale, brown, greenish grey, generally fissile; subordinate sandstone, brown, impure, very fine grained; minor siltstone
- **Di1** Basal unit: shale, brown, fissile, with siltstone laminae and clay ironstone concretions
- **Di** IMPERIAL FORMATION (Undivided)
- **Dc** CANOL FORMATION: shale, dark brown to black, mostly bituminous, partly fissile, partly siliceous and blocky

MIDDLE AND (?) UPPER DEVONIAN

- **Drk** RAMPARTS AND KEE SCARP FORMATIONS (Undivided): limestone, generally well bedded and partly argillaceous below, massive above; commonly fossiliferous

MIDDLE DEVONIAN

- **Dhi** HARE INDIAN FORMATION: shale, black and highly fissile at base, green above; beds of siltstone and fossiliferous limestone locally developed
- **Dh** HUME FORMATION: limestone, well bedded and rubbly, highly fossiliferous; shales in middle and lower parts

MIDDLE AND (?) LOWER DEVONIAN

- **Db** BEAR ROCK FORMATION: dolomite and limestone solution-breccia; bedded brown bituminous dolomite and dense limestone: gypsum

ORDOVICIAN AND SILURIAN

UPPER ORDOVICIAN AND LOWER SILURIAN

RONNING GROUP

- **OSk** MOUNT KINDLE FORMATION: dolomite, brownish grey to medium grey, fine crystalline; locally colour mottled; silicified fauna common

LOWER AND (?) MIDDLE ORDOVICIAN

RONNING GROUP

- **Or2b** Unit 2b: dolomite, pale yellow-brown to pale grey; mainly medium crystalline, abundant white and yellowish grey stromatolitic and locally oolitic chert, abundant drusy quartz
- **Or2a** Unit 2a: dolomite, pale brownish grey, fine to coarse crystalline; interbedded with dolomite, greyish orange, very fine crystalline, partly laminated
- **Or2** Unit 2 (Undivided)
- **Or1** Unit 1: dolomite and rare limestone; cyclic repetitions of dense, laminated beds, oolite beds, conglomerate beds, stromatolitic beds and thin dolomitic shale beds
- **OSr** MOUNT KINDLE FORMATION and Unit 2 (Undivided)

CAMBRIAN

- **Єs** SALINE RIVER FORMATION: red and green shales, gypsum, halite, siltstone; dense flaggy dolomite with salt-crystal casts
- **Єcp** MOUNT CAP FORMATION: green, grey, and minor red shales, glauconitic sandstone and siltstone; subordinate orange-weathering dolomite in some areas
- **Єck** MOUNT CLARK FORMATION: sandstone, white, grey, locally red, quartzose, fine to very coarse-grained and conglomeratic, crossbedded, partly friable

PROTEROZOIC

NEOHELIKIAN OR HADRYNIAN

SHALER GROUP

- **P6** Diabase and gabbro dykes and sills
- **P5** Dolomite, mainly yellow-weathering; gypsum, varicoloured shales: minor limestone, chert; non-resistant
- **P4** Dolomite, mainly massive, resistant, weathering mainly deep brownish-orange; minor limestone; stromatolites large and abundant
- **P3** Quartzite, mainly grey, fine and medium-grained
- **P2** Dolomite, grey, locally pink, mainly yellow-weathering, flaggy, siliceous
- **P1** Shale, green, locally red

COPPERMINE RIVER SERIES

- **Pcb** Basaltic flows

HORNBY BAY GROUP

- **Phd** Dolomite, partly silicified; many stromatolitic beds
- **Phq** Quartzite, white, pink, purple-mottled

Rock outcrop .... ×
Rock outcrop visited by helicopter .... Ⓗ
Fossil locality (GSC catalogue number where collection taken) .... Ⓕ C 3086
Geological boundary (defined, approximate, assumed; includes contacts extended by air photo interpretation) ....
Bedding, tops known (horizontal, inclined) 10
Fault (defined, inferred; solid circle indicates downthrown side) ....
Anticline (defined, approximate) ....
Syncline (defined, approximate) ....
Stratigraphic section studied ....

Stratigraphic Section References

C.J. Yorath YB-11
W.S. MacKenzie MN-12
T.P. Chamney CR-1-68

Geology by C.J. Yorath, H.R. Balkwill, W.S. MacKenzie, T.P. Chamney, 1968

Compiled by C.J. Yorath, H.R. Balkwill, 1968

Geological cartography by the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, 1969

Topographic base-map at the same scale published by the Army Survey Establishment R.C.E., 1961

Magnetic declination 1969 varies from 39° 50' easterly at centre of west edge to 41° 11' easterly at centre of east edge. Mean annual change -6.8'

DESCRIPTIVE NOTES

Geological field studies of Crossley Lakes map-area, a part of the Anderson Plain (see Klassen in Yorath et al., 1969), were carried out in 1968 as part of Operation Norman (Aitken et al., 1969).

The regional topographic slope is northwestward and prominent mesas, formed by basal Cretaceous rocks along the southern border, are the highest parts of the area. Deeply incised valleys provide abrupt topographic relief in the generally subdued landscape so that rocks are fairly well exposed in cutbanks of major rivers and tributaries, although there is much slumping of poorly indurated Cretaceous strata. Interstream areas, particularly north of Wolverine River, are generally covered by drift, poorly drained, and devoid of outcrop.

Exposed strata belong to the Devonian and Cretaceous Systems. Stratigraphic nomenclature of the Devonian is that of Bassett (1961). The oldest exposed strata are nodular, thin-bedded, abundantly fossiliferous limestones exposed on the crests of low-amplitude anticlines along Andrew River; these rocks are assigned to the Middle Devonian Hume Formation (Dh). The base of the Hume Formation is not exposed in Crossley Lakes map-area but, along Anderson River about a mile upstream from the eastern boundary, the unit is in abrupt, conformable contact with underlying, thick-bedded, pelletal limestones assigned to the Bear Rock Formation. The Hume Formation is about 150 feet thick in Simpson Lake map-area (97B).

The Middle Devonian Hare Indian Formation (Dhi), which is well exposed along Carnwath River, is predominantly medium green-grey, soft, fissile shale although there are laminae and thin beds of siltstone near the top of the sequence. Micritic limestone, bituminous shale, and green-grey shale occur in four thick cycles in the basal 100± feet of the unit. *Tentaculites* sp. are abundant in the basal strata, inarticulate brachiopods occur throughout the formation, and there are some well-preserved, articulate brachiopods near the top. Hare Indian Formation conformably overlies the Hume Formation and the contact is well exposed at several places along Andrew River. The unit is estimated to be about 600 feet thick.

Most of the Upper Devonian Canol Formation (Dc), which is about 125 feet thick, is black siliceous shale characterized by a distinctively blocky type of fracture. The unit is locally distinguished by bright yellow, orange and red secondary minerals on weathered surfaces. The Canol Formation disconformably overlies the Hare Indian Formation; about 25 feet of thin-bedded, medium brown, very fine-grained sandstone overlies the disconformity and forms a thin, distinct ledge in the hills west of Carnwath River. North of Wolverine River the basal Canol strata are black, siliceous shale with a few thin siltstone beds.

The basal 150± feet of the Upper Devonian Imperial Formation (Di_1) consists of dark brown, fissile, slightly silty shale with a few thin concretionary beds of tan-weathering siltstone. These rocks are conformable with underlying Canol strata, from which they are demarcated by the following characteristics: they are fissile, only slightly siliceous, include recognizable siltstone intercalations, and tend to form recessive slopes; the contact is usually sharply expressed in topography, particularly in fresh exposures. The upper part of the Imperial Formation (Di_2) consists of micaceous, medium green-grey and brown-grey siltstone and very fine-grained sandstone with thin argillaceous beds and laminations. These strata are best exposed along Kugaluk River. Siltstones and sandstones are mostly thin- to medium-bedded and cross-laminated; ripple marks and flute casts are abundant. These strata are well indurated when contrasted with the lower beds of the Cretaceous 'Silty zone'. The Imperial Formation (including the basal dark shales) is estimated to be about 800 feet thick.

Cretaceous strata underlie much of Anderson Plain and are exposed principally in broad river valleys. Pending establishment of formal nomenclature it was found useful to employ the unpublished informal nomenclature used by J.C. Sproule and Associates Ltd. in their reports based on 1959 field studies.

The "Silty zone" (Ks) of the Cretaceous succession is divisible into two units; a lower sandstone and coal division and an upper siltstone and mudstone division. The lower division, nowhere exposed in the map-area, but occurring to the east in the Hornaday, Horton and Brock River valleys and in the Smoking Hills, is composed of white, light grey and buff, friable, medium- to locally coarse-grained, crossbedded sandstones, and minor amounts of sandy mudstones. Near the base, lignite and argillaceous sandstone are rhythmically interbedded. Locally, the sandstone is calcareous and contains marcasite. The unit grades into the upper division, composed of argillaceous sandstones, siltstones and interbedded mudstones which contain concretionary limestones bearing pelecypod shells, coquina beds and well-preserved tree trunks. In the Crossley Lakes map-area only the upper division is present and, near the junction of Anderson and Carnwath Rivers, it rests with angular unconformity on the Hare Indian Formation (YB-6; CR-1-68). At this locality the unit is much less arenaceous than its equivalent on Horton River. Immediately above the unconformity is a 0.8-foot thickness of interbedded, calcareous and ferruginous, banded, grey- and brown-weathering shale with thin laminae of marl near the base. The remaining 80 feet of the exposure consists of medium to dark grey and grey-brown blocky shales, locally banded with thin, pale yellow, bentonitic laminae and thin, argillaceous, siltstone laminae. Thirty-six miles downstream from the junction of Anderson and Carnwath Rivers (YB-11; CR-2-68) the uppermost 40 feet of this division is exposed in conformable contact with the overlying "Bentonitic zone" (Kb). The upper beds are more arenaceous and contain thin bentonite laminae and some limestone concretions bearing pelecypods. Calculations, based on mapped contact elevations and the regional dip, indicate that the "Silty zone" thickens from about 200 feet at the intersection of latitude 68° 35' N. and Anderson River to about 500 feet near the downstream exposure edge of the Hare Indian Formation.

Exposures of the "Silty zone" south and east of Hyndman Lake consist of poorly exposed concretionary mudstones occurring as relatively resistant ledges capping recessive siltstones and mudstones of the Imperial Formation.

The "Bentonitic zone" (Kb) is composed of a uniform succession of dark, plastic, soft shales with rusty-brown and orange-weathering ironstone concretionary intervals. Many of these concretions are several feet in diameter; some contain ammonite fragments. The iron content of the shales is variable and, locally, sections exhibit a banded appearance caused by dark grey to black beds alternating with rusty brown intervals a few inches thick. The silt content is small and mainly concentrated near the upper and lower contacts. At section YB-11, CR-2-68, 230 feet are exposed in sharp but conformable contact with the "Silty zone". The contact is marked by a sharp break in slope indicating a change in lithology to the less arenaceous "Bentonitic zone" and by a pale yellow-weathering concretionary band. Elsewhere, along Horton, Hornaday and Brock Rivers, and in the Smoking Hills to the east, a laterally persistent and well developed cone-in-cone concretionary bed marks the base of the "Bentonitic zone".

The upper beds of the "Bentonitic zone" are exposed at a number of localities in the uplands west of Anderson River. Here they are in disconformable contact with the overlying "Bituminous zone" (Kbt). In surface exposures the "Bituminous zone" is composed of a variable sequence of black, bituminous shale; bedded yellow jarosite; and, locally, dark maroon beds of earthy hematite. At a number of localities within the Horton River system, in the Smoking Hills and in the uplands west of Anderson River the base of the unit is marked by an ironstone-pebble and shale-chip conglomerate of variable thickness that locally overlies an irregular erosion surface. The yellow jarosite beds are interbedded with black shale; three intervals containing such beds were observed in sections along Anderson River north of the map-area and along Horton River to the northeast. The dark maroon, earthy hematite occurs where the unit is actively burning or where it has undergone oxidation. At a number of localities the black shales exhibit a dark scoriaceous appearance and large selenite cyrstals are scattered about the surface of the exposures. No "burnt" outcrops were observed in the map-area.

Age assignments of the Cretaceous units are based on micropaleontological studies by T.P. Chamney, and by comparison with formations of similar lithology on Banks Island. The lower sandstone and coal division of the "Silty zone" appears to be the lithologic equivalent of the Isachsen Formation as described by Thorsteinsson and Tozer (1962) and is probably pre-Albian in age. The upper siltstone and mudstone division is similarly correlative with the lower member of the Christopher Formation which has yielded diagnostic Early to Middle Albian faunas. The upper member of the Christopher Formation has been dated as Middle to late Middle Albian in age (ibid.) and is lithologically correlative with the "Bentonitic zone". Chamney (personal communication) has identified Middle Albian glomospirellid foraminifers from the upper beds of the "Bentonitic zone".

A late Cretaceous age (Late Coniacian to Early Santonian) has been assigned to the lower beds of the "Bituminous zone" by Chamney (1969) on the basis of the occurrence of *Hedbergella* cf. *H. delrioensis* (Carsey). The uppermost beds contain vertebrate remains including *Hesperornis regalis* Marsh which indicate an Early Campanian age for these beds (Russell, 1967). Chamney (personal communication) believes that deposition of the "Bituminous zone" ranges from Late Coniacian to Early Campanian.

The "Bituminous zone" is gradationally overlain by the "Pale shale zone" (Kps) which is composed of pale grey- and rusty-brown weathering shales of noticeably light weight. This unit does not occur within the map-area but is found in adjacent regions to the north and northeast (107D and 97C).

The map-area is part of the Anderson structural province (Douglas et al., 1963). The strata dip at low angles and there are few faults, folds or other structural complications. Regional epeirogenic events are marked by a widespread disconformity at the base of the Upper Devonian (Canol) strata; by a regional angular unconformity at the base of the Cretaceous sequence; and by a regional disconformity between the Lower and Upper Cretaceous successions.

Paleozoic strata dip regionally westward at a few feet to a few tens of feet per mile. This homocline is locally interrupted by isolated folds that cross Andrew River, and by a subtle monocline (northwest side down) that strikes northeasterly through the central part of the region. The vaguely defined axis of the monocline approximates the trend of exposed Canol strata near three lakes with noted elevations of 465±, 397±, and 795±. This structure does not appear to be expressed in Cretaceous rocks although local control on the Paleozoic-Cretaceous contact is poor.

The contact between Devonian and Cretaceous rocks suggests the presence of a northerly trending arch, the axis of which is approximately coincident with Kugaluk River, in the western part of Anderson Plain. A pre-Cretaceous age for the arch is suggested by the following:

1. Near the mouth of Kugaluk River, 8 miles north of the north boundary of the map-area, the "Silty zone" is missing and 88 feet of "Bentonitic zone" beds rest unconformably on the Imperial Formation. These in turn are disconformably overlain by the "Bituminous zone".

2. West of the map-area, at Sitidgi Lake, rocks assigned to the "Silty zone" and "Bentonitic zone" are present (B. Plauchut, Elf Oil Exploration and Production Ltd., - personal communication, 1968).

It appears, therefore, that the "Silty zone" thins toward the paleotopographically high "Kugaluk Arch" and is overstepped by the "Bentonitic zone". Again, Cretaceous outcrop control in this region is poor; the "Silty zone" - "Bentonitic zone" contact is shown schematically. However, westward thinning of the "Silty zone" from Horton River to Anderson River, the absence of the lower sandstone and coal division at Anderson River, and the absence of the entire unit at the mouth of Kugaluk River, all lend support to the existence of the arch.

East of Anderson River (Lat. 68° 53' N.; Long. 128° 13' W.) an inlier of "Silty zone" rocks occurs beneath and surrounded by "Bentonitic zone" beds. This structure is minor and insufficient data are available for the delineation of the axis of uplift.

Small, tight, randomly oriented folds are locally impressed upon rocks assigned to the "Bituminous zone" and "Pale shale zone" within the uplands west of Anderson River immediately north of the map-area, and in the region between Anderson and Horton Rivers to the east of the map-area. These structures are probably non-tectonic and are disharmonic above extremely ductile "Bentonitic zone" shales.

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MAP 8-1969
CROSSLEY LAKES
DISTRICT OF MACKENZIE