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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

PAPER 69-10

SIMPSON LAKE MAP-AREA, DISTRICT OF MACKENZIE (97 B)

(Report, 3 figures and P.S. Map 16-1969)

H. R. Balkwill and C. J. Yorath

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ABSTRACT

Rocks exposed in the Simpson Lake map-area belong to the Cambrian, Ordovician, Devonian, and Cretaceous Systems. About 2,000 feet of Paleozoic rocks, chiefly carbonates with subordinate shales, are mapped from oldest to youngest as: "Ronning Group", and Bear Rock, Hume, and Hare Indian Formations. Paleozoic strata are regionally overlapped by widespread, but poorly exposed, Cretaceous clastic rocks. Informal Cretaceous units, which have an estimated total thickness of about 1,500 feet, are the "Silty", "Bentonitic", and "Bituminous zones" (from oldest to youngest).

Rocks in the map-area dip regionally westward to northwestward at small angles. There appear to be few structural complications, although small structures may be concealed by Pleistocene drift.

SIMPSON LAKE MAP-AREA, DISTRICT OF MACKENZIE (97B)

INTRODUCTION

Geological field studies of Simpson Lake map-area were made in 1968 as part of Operation Norman (Aitken, et al., 1969). H.R. Balkwill mapped the Paleozoic rocks; C.J. Yorath studied the lithostratigraphy and distribution of Cretaceous strata; T.P. Chamney investigated the biostratigraphy of Cretaceous rocks along parts of the Horton River; and W.S. MacKenzie measured sections of Paleozoic rocks along Anderson River. L.A. Love and A.J.M. Elliot were able and resourceful field assistants and T. Samuel was a superb cook.

The eastern third of the map-area is part of Horton Plateau, which is a barren upland where Paleozoic rocks are widely exposed; the remainder lies within the Anderson Plain, a region of hummocky terrain and water-filled depressions, underlain by relatively thick and widespread drift with a topographically prominent moraine (Qm) in the north (see Klassen in Yorath et al., 1969). Bedrock is well exposed along Anderson and Horton Rivers and over much of Horton Plateau; elsewhere there are few outcrops.

STRATIGRAPHY

The rocks exposed in the map-area belong to the Cambrian, Ordovician, Devonian, and Cretaceous Systems. Informal nomenclature and age designations of Cambrian and Ordovician strata are based on personal communications with B.S. Norford and R.W. Macqueen (see also Macqueen, in press). Stratigraphic nomenclature and age assignments of Devonian strata are based on designations southwest of the map-area (Bassett, 1961) and personal communications with A.E.H. Pedder and W.S. MacKenzie. Informal Cretaceous units were named by J.C. Sproule and Associates, Limited, in 1960 field studies.[1]

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[1] Geological reconnaissance report, P. & N.G. Permit No. 3031, Wood Bay area, Northwest Territories, 1960, Prepared for Siebens Leaseholds Limited by J.C. Sproule and Associates, Limited, Calgary, Alberta; on file with Department of Indian Affairs and Northern Development, Calgary, Alberta (Released 1963).

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Table of map-units

ERA	System or Series	Map-unit and estimated thickness (feet)	Lithology
CENOZOIC	Quaternary	Alluvium (Qal) ?	Unconsolidated gravel, sand, silt, clay; mapped only where deposits are thick and widespread
		Unconformity	
		Moraine (Qm) 200	Unconsolidated gravel, sand, silty, clay; thick deposits forming prominent topography
Unconformity			
MESOZOIC	Upper Cretaceous	"Bituminous zone" (Kbt) 200	Black, bituminous shale; bedded jarosite; local earthy hematite; pale grey clay; local basal ironstone-pebble and shale chip conglomerate
	Unconformity		
	Lower Cretaceous	"Bentonitic zone" (Kb) 300-500	Black, soft, plastic shale; fossiliferous, orange, concretionary ironstone beds
		"Silty zone" (Ks) 800-1,000	Upper division: argillaceous siltstone and mudstone; Lower division: light grey, friable sandstone and coal
Unconformity			
PALEOZOIC	Middle Devonian	Hare Indian Formation (Dhi) 300	Black, fissile shale at base; green-grey shale in upper part
		Hume Formation (Dh) 150	Thin-bedded, rubbly, fossiliferous limestone; minor dark grey shale
	Lower (?) and Middle Devonian	Bear Rock Formation (Dbr) 700	Bedded limestone in upper part; dolomite and limestone solution breccia with minor gypsum in lower part
	Unconformity		
	Upper Cambrian (?) and Lower Ordovician	Unit 2b (COr2b) 500-700	Grey and buff, thick-bedded, fine- to coarse-crystalline dolomite; drusy quartz; stromatolitic and oolitic chert
	Upper Cambrian and (?) Lower Ordovician	Unit 2a (COr2a) 400	Pale grey, fine- to coarse-crystalline dolomite; interbedded with greyish-orange, laminated dolomite

Paleozoic

The oldest rocks in the Simpson Lake map-area are assigned to Macqueen's (in press) "rhythmic unit" (COr2a). This is one of four informal lithostratigraphic units recognized by Macqueen in rocks in the plains east of the lower Mackenzie River and mapped as the "Ronning Group" by participants in Operation Norman. From oldest to youngest, these are the "cyclic", "rhythmic", and "cherty" units, as well as the Mount Kindle Formation ("Ronning Group" - see Hume, 1954 - is used by Macqueen in a reconnaissance sense, pending forthcoming revision of the nomenclature of Lower Paleozoic strata). The "cyclic unit" is beneath the lowermost strata exposed in the map-area, and the Mount Kindle Formation is absent because of pre-Devonian erosion.

Unit COr2a consists of beds of very fine-crystalline, greyish orange and brownish grey dolomite that alternate with beds of pale grey, fine- to coarse-crystalline dolomite. The alternation of colours provides a distinctive banding to the sequence in some outcrops. About 150 feet of the "rhythmic unit" are exposed in the eastern part of the map-area; the base of the unit is not exposed. Cook and Aitken (in press) estimate that the unit is about 400 feet thick in adjoining Erly Lake Map-area (97A). B.S. Norford dated taxa from the lower part of unit COr2a as Late Cambrian (possibly Franconian); it is uncertain whether the Cambrian-Ordovician boundary is near the top of this unit or in overlying strata assigned to unit COr2b.

Unit COr2a is conformably overlain by 500 to 700 feet of light to medium grey, and buff, thick-bedded, fine- to predominantly medium- and coarse-crystalline dolomite that is assigned to Macqueen's "cherty unit" (COr2b). These rocks are distinguished by abundant drusy quartz that lines vugs and by beds of light grey and white chert. Chert beds commonly have stromatolitic and oolitic textures. Rocks composing unit COr2b have poor to fair vuggy and intercrystalline porosity. Silicified gastropods collected by Macqueen in 1968 from this unit are thought by B.S. Norford of the Geological Survey of Canada to be Early Ordovician; lowermost beds of the unit may be Upper Cambrian.

The Lower (?) and Middle Devonian Bear Rock Formation (Dbr) disconformably overlies the "Ronning Group"; the contact is well exposed along Horton River where local relief on the disconformity is as great as 50 feet. The lower part of the Bear Rock Formation consists mainly of calcareous and gypsiferous, buff and grey dolomite with excellent intercrystalline and local cavernous porosity. Most beds in this succession are extensively brecciated; unsorted, angular blocks and fragments of fine-crystalline dolomite are randomly distributed in a calcareous, gypsiferous, coarse-crystalline dolomite matrix. Evidence that some of the brecciation is geologically recent is furnished by large, sub-cylindrical sink-holes that truncate rocks throughout the Bear Rock succession. These karst features are particularly well expressed along Anderson and Horton Rivers. Locally, however, minor thin beds of unbrecciated, fine-crystalline dolomite are interlayered with beds of breccia which are unrelated to sink-holes, suggesting a much earlier phase of brecciation. The upper part of the formation consists of slightly to moderately dolomitic, medium brown-grey limestones that are distinguished by abundant calcarenite beds with fine-grained, well-rounded clasts. These rocks are generally thick bedded and resistant, and are well exposed along Anderson and Horton Rivers where they locally constrict streams to narrow canyons (Fig. 1). Thin- to very thin-

Figure 1.

Limestone beds in the upper part of the Bear Rock Formation (Dbr), Anderson River at 68°30'N, 126°05'W. Folds, which have amplitudes of a few tens of feet, are apparently random in orientation; many similar structures in the map-area are probably concealed by the extensive cover of Pleistocene drift.
G.S.C. photo 148292.

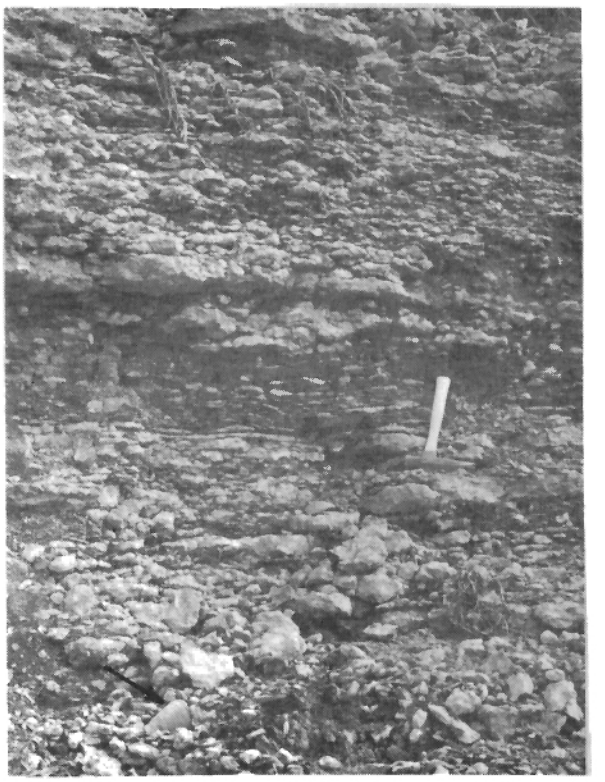

Figure 2.

Nodular beds of limestone in the Hume Formation (Dh), Anderson River, at 68°25'N, 127°30'W. Note large tetracoral in rubble at lower left (indicated by arrow).
G.S.C. photo 148248.

bedded, medium grey-brown limestone, composed of microcrystalline calcite with a few bioclasts (broken and unidentifiable), occur within the calcarenite strata. The upper part of the Bear Rock Formation has only local, poor intergranular porosity. The formation is estimated to be about 700 feet thick in the Simpson Lake Map-area.

The Bear Rock Formation is conformably overlain by the Middle Devonian Hume Formation (Dh), which consists of medium grey-brown, argillaceous limestone with calcarenitic and biosparitic textures. The beds are distinctively thin and nodular (Fig. 2). Laminations and thin beds of dark grey, calcareous shale are interlayered with limestone and compose about one-third of the sequence. Well preserved fossils (chiefly brachiopods, but also gastropods, crinoids, bryozoans, corals, and trilobites) are abundant. The Hume Formation is about 150 feet thick in good exposures along Anderson River.

Dark grey, bituminous shale of the Middle Devonian Hare Indian Formation (Dhi) conformably overlies the Hume Formation. Tentaculites sp. and inarticulate brachiopods are abundant in the lower beds of the formation. The upper part is predominantly medium green-grey, soft, fissile shale. The formation is about 300 feet thick in the map-area; this thickness represents incomplete development of the unit beneath a regional unconformity overlain by Cretaceous strata. In adjoining Crossley Lakes map-area (107A), where the formation is about 600 feet thick (Yorath and Balkwill, in press), it is overlain by the Upper Devonian Canol Formation.

Cretaceous

Paleozoic rocks are unconformably overlain by widespread, but poorly exposed, poorly to moderately well indurated Lower Cretaceous clastic rocks which are assigned to the "Silty zone" (Ks) (Yorath et al., 1969). In the eastern part of the area, about four miles south of Horton River, the lowest strata of the "Silty zone" overlie the "Ronning Group" on an erosional surface with abrupt local relief in the order of a few tens of feet. These basal deposits are fine- to very coarse-grained, friable quartz sandstones with conglomerate lenses. Pebbles and cobbles in the conglomerates consist of light grey and white chert, and were apparently derived from the underlying "Ronning" sequence (COr2b). Extensive crossbedding and channelling within the deposits, local distribution of conglomerate lenses, and the channelled disconformity with underlying Ordovician strata, suggest that these coarse-grained rocks are of fluvial origin. Furthermore, the general decrease in clast size toward the northwest, and the westerly azimuths of cross-stratification indicate that the streams may have drained highlands in the region of the Coppermine Arch to the east of the map-area (Douglas et al., 1963; Yorath et al., 1969).

Elsewhere in the eastern part of the region, basal strata of the "Silty zone" are principally light grey to light buff, fine- to medium-grained, friable, clean quartz sandstone with minor interbedded mudstone and lignite. At Horton River (Section CR-8A; YB-50) a 220-foot-thick section of the "Silty zone" contains large angular blocks of the underlying Bear Rock Formation in its basal beds (Fig. 3). These basal sandstones, mudstones and coals of the "Silty zone" are informally called the lower sandstone and coal division (Yorath et al., 1969).

In the central and western parts of the Simpson Lake map-area, the "Silty zone" is represented by dark grey, soft, argillaceous siltstone and silty mudstone, collectively called the informal upper siltstone and mudstone division. Widespread minor concretionary limestone beds, with pelecypod coquinas, occur at several intervals. There are no complete sections of the "Silty zone" exposed in the map-area. The unit is estimated to have a maximum thickness of about 1,200 feet throughout the region (Yorath et al., 1969); in Simpson Lake map-area it is probably thinner based on the elevations and positions of extrapolated contacts, and the regional dip.

To the west, in the Crossley Lakes area (107A), and to the north, in the Franklin Bay area (97C), the "Silty zone" was observed in conformable contact with overlying dark grey, plastic, concretionary shales of the "Bentonitic zone" (Kb). No exposures of the latter unit were observed in the map-area owing to extensive cover by glacial drift, but the contact has been extrapolated from the adjoining map-areas (107A and 97C).

Near Anderson River (map-area 107A) the "Bentonitic zone" is about 600 feet thick; it appears to be thinner than this in the Simpson Lake area, probably in part owing to erosion and truncation beneath the sub-Upper Cretaceous unconformity.

"Bentonitic zone" strata are disconformably overlain by rocks assigned to the "Bituminous zone" (Kbt). The latter is composed of black, bituminous shale, very thin beds of yellow jarosite, and locally, dark maroon beds of earthy hematite. It is believed that the hematite is the oxidation product of jarosite (a hydrous iron and potassium sulphate) and occurs only in surface exposures. In the Franklin Bay area (97C), the unit is burning at several localities; the Smoking Hills derive their name from columns of smoke that rise from outcrops along the cliffs. At many localities in adjoining map-areas, an ironstone-pebble and shale-chip conglomerate occurs at the base of the "Bituminous zone" and the contact with the underlying "Bentonitic zone" is an irregular erosion surface.

No exposures of the "Bituminous zone" were observed in Simpson Lake map-area, but immediately north of its northern boundary numerous exposures of the lower beds were observed in contact with the underlying "Bentonitic zone". In the Franklin Bay area the unit has a variable thickness of 100 to 328 feet, and is conformably overlain by strata of the "Pale Shale zone".

Age assignments of Cretaceous strata are based on micropaleontological studies by T.P. Chamney; the units are tentatively correlated with formations of similar lithology on Banks Island (Yorath et al., 1969). The lower sandstone and coal division of the "Silty zone" appears to be the lithologic equivalent of the Isachsen Formation (pre-Albian), as described by Thorsteinsson and Tozer, (1962). The upper siltstone and mudstone division is similarily 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 (Thorsteinsson and Tozer, ibid.) and is lithologically similar to the "Bentonitic zone". Chamney (personal communication) has identified Middle Albian glomospirellid foraminifers from the upper beds of the "Bentonitic zone". A few immature and fragmental ammonites were collected from the "Bentonitic zone" on

Horton River, north of the map-area. Jeletzky (GSC Paleontology Report No. Km-3-1969) tentatively suggested that they represented the late Lower or early Middle Albian Arcthoplites or Beudanticeras affine zone, but was unable to provide positive identifications due to the paucity, immaturity, and fragmental nature of the specimens collected.

A Late Cretaceous age (Late Coniacian to Early Santonian) has been assigned to the lower beds of the "Bituminous zone" by Chamney (in Oilweek, 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" took place during Late Coniacian to Early Campanian.

Quaternary

Thick, topographically prominent moraines (Qm) in the northeastern sector of the map-area are part of the Melville Hills Morainic Belt (Klassen in Yorath et al., 1969). The deposits are mostly coarse- to very coarse-grained and are poorly stratified in some places. Thickness of the moraines is quite variable but the maximum is estimated to be about 200 feet. Mackay (1958 included these deposits with constructional features associated with the Great Bear Lake ice lobe.

Recent alluvium (Qal) mantles the narrow floodplains of parts of Horton and Anderson Rivers.

STRUCTURAL GEOLOGY

Structural provinces, which include Anderson and Horton Plains (Douglas et al., 1963), largely coincide with physiographic divisions (Anderson Plain and Horton Plateau). The vague boundary is marked by a gentle monocline (west side relatively down) that trends northwesterly from the southeastern part of the map-area (where it is locally anticlinal) to Gilmore Lake; this fold appears to be a regional feature which may extend through the western part of Franklin Bay.

Rocks in the map-area dip regionally westward to northwestward at low angles and there are few faults, well-delineated folds, or other structural complications (although many small structures may be concealed by the extensive cover of Pleistocene drift) (Fig. 1). Small folds in basal strata of the Bear Rock Formation are partly caused by depositional draping on erosional irregularities in underlying "Ronning" strata. Local, small folds in the "Ronning Group" appear to have tectonic origins. The Bear Rock Formation is exposed in the core of a narrow, northwesterly trending, doubly plunging anticline in the western part of the area; closure on this fold is about 200 feet. This structure is aligned with, and may be genetically related to anticlines near Colville Lake (Aitken, et al., 1969). Systematic joints are well developed in the relatively brittle rocks in the area ("Ronning Group", Bear Rock and Hume Formations), and are largely responsible for the abruptly rectangular courses of Anderson and Horton Rivers.

ECONOMIC GEOLOGY

The economic potential of the area depends mainly on the possibilities of hydrocarbon accumulation. Porous clastic strata of the "Silty zone" crop out over much of the area and are unlikely reservoirs in the restricted sectors where they occur in the subsurface. The Bear Rock Formation is commonly petroliferous and has good intercrystalline and local cavernous porosity; supratenuous folds which are developed in this unit over erosional knobs of "Ronning" strata may provide potential traps. "Ronning Group" rocks locally display fair to good intercrystalline and vuggy porosity.

Metallic minerals were not observed, other than very minor concentrations of iron sulphides.

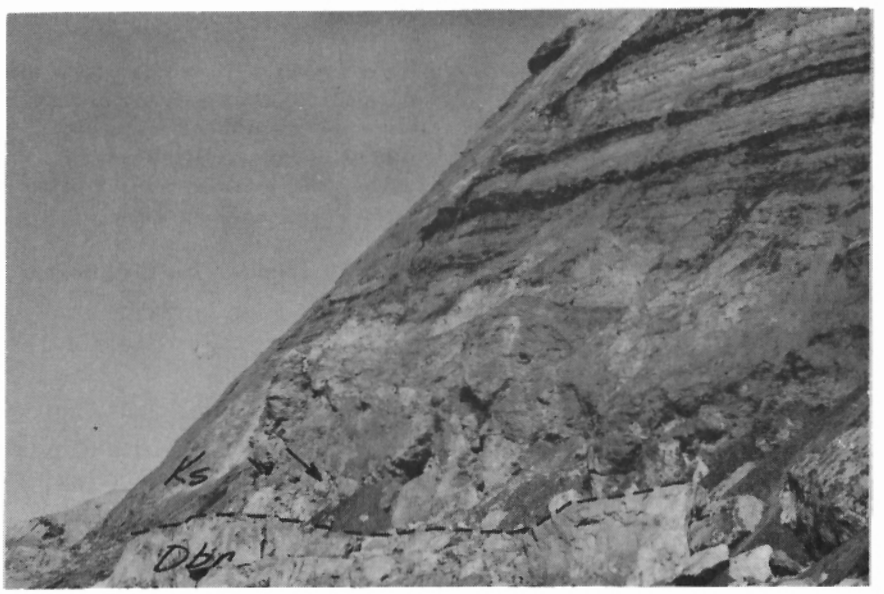

Figure 3. Poorly indurated sandy mudstone and sandstone of the Cretaceous "Silty zone" (Ks) disconformably overlying limestone beds of the Bear Rock Formation (Dbr), Horton River at 68°51'N, 125°24'W. Note large limestone blocks (indicated by arrow) in basal Cretaceous beds. G.S.C. photo 201410.

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