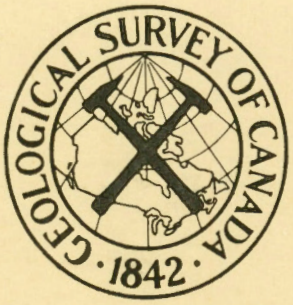

GEOLOGICAL
SURVEY
OF
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DEPARTMENT OF ENERGY
MINES AND RESOURCES

PAPER 73-39

THE EPWORTH GROUP ROCKNEST LAKE AREA, DISTRICT OF MACKENZIE

J. A. Fraser

CANADA

GEOLOGICAL SURVEY

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86 G/NE; H/NW; I/SW; J/SE

J. A. Fraser

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ILLUSTRATIONS

Map 1384A ..... in pocket

ABSTRACT

The Epworth Group outcrops in the southern half of the Epworth basin, an area of about 3,500 square miles and comprises mainly unmetamorphosed sediments and minor interlayered volcanic rocks which have been subdivided into five conformable formations. In order of decreasing age these are: the Odjick Formation, from 2,100 to 7,500 feet thick, composed of argillite and quartzite with minor conglomerate, carbonate, and andesite or metabasalt; the Rocknest Formation, from 2,300 to about 5,500 feet thick, consisting chiefly of stromatolitic dolomite with some interlayered argillite and minor limestone and chert; the Recluse Formation, from 2,000 to more than 6,500 feet thick, composed principally of argillite, greywacke, siltstone, and subordinate limestone; the Cowles Lake Formation, about 2,600 feet thick, a succession of interlaminated and interlayered limestone and argillite with minor greywacke; and the Takiyuak Formation, 1,200 feet thick, comprising reddish lithic and feldspathic arenite. The total thickness of the Epworth Group increases from about 10,000 feet near the eastern margin of the Epworth basin to about 20,000 feet in the central part of the basin. Derivation of clastics of the Odjick and Rocknest formations from the east, and clastics of the younger formations from the west, is consistent with their deposition in the evolving Coronation Geosyncline.

The lowermost Epworth sediments lie with pronounced angular unconformity on Archean basement rocks. Along the western margin of the basin where Epworth strata have been intruded and migmatized by late Aphebian granite, metamorphism has reached upper amphibolite facies grade under intermediate to low pressure conditions. In general metamorphism and intensity of deformation increase progressively westward. Folding around northerly trending axes of shallow plunge and displacement along north-trending dip-slip, possibly thrust, faults, is associated with granite emplacement. Numerous northeasterly trending, dextral, predominantly strike-slip faults, and sparse, northwesterly trending, sinistral, strike-slip faults post-date the granite, folds and dip-slip faults. The Epworth Group has been intruded by diabase dykes and sills of Helikian and probably Hadrynian age. Dykes of the Mackenzie swarm post-date the strike-slip faults.

RÉSUMÉ

Le groupe d'Epworth affleure dans la moitié sud du bassin Epworth, région d'environ 3,500 milles carrés et comprenant surtout des sédiments n'ayant pas subi de métamorphisme et quelques roches volcaniques interlitées, qui ont été subdivisés en cinq formations concordantes. Par ordre d'âge décroissant, nous avons la formation d'Odjick, épaisse de 2,100 à 7,500 pieds, composée d'argilite et de quartzite, d'un peu de conglomérat, de roches carbonatées, d'andésite ou de métabasalte; la formation de Rocknest, épaisse de 2,300 à environ 5,500 pieds, constituée surtout de dolomie stromatolitique avec de l'argilite interlitée et un peu de calcaire et de chert; la formation de Recluse, épaisse de 2,000 à plus de 6,500 pieds, principalement composée d'argilite, de grauwacke, de siltstone et de calcaire secondaire; la formation de Cowles Lake, épaisse d'environ 2,600 pieds, une succession de calcaire et d'argilite interlités accompagnés d'un peu de grauwacke; et la formation de Takiyuak, épaisse de 1,200 pieds, comprenant de

l'arénite rougeâtre feldspathique d'agglomérat. L'épaisseur totale du groupe d'Epworth va en augmentant et est d'environ 10,000 pieds près de la bordure orientale du bassin Epworth et passe à environ 20,000 pieds dans la partie centrale du bassin. Les roches clastiques des formation d'Okjick et de Rocknest proviennent de l'est et les roches clastiques des formations plus jeunes proviennent de l'ouest, ce qui est compatible avec leur déposition dans le géosynclinal Coronation qui se développait.

Les sédiments Epworth les plus bas reposent en discordance angulaire prononcée sur les roches de base de l'Archéen. Le long de la bordure occidentale du bassin où les strates Epworth ont été pénétrées et migmatisées par du granite de l'Aphébien supérieur, le métamorphisme a atteint le degré supérieur de faciès à amphibolite dans des conditions de pression moyenne à basse. En général, le métamorphisme et l'intensité de la déformation s'accroît progressivement vers l'ouest.

Le plissement autour des axes à direction nord, au faible plongement, et le rejet le long des failles normales, possiblement des chevauchements, sont associés à la mise en place du granite. De nombreuses failles à direction nord-est situées à droite, surtout des failles à rejet horizontal, et de rares failles à rejet horizontal, à direction nord-ouest, situées à gauche, sont postérieures au granite, aux plis et aux failles normales. Des dykes de diabase et des filons-couches de l'Hélikien et probablement de l'Hadrynien ont pénétré dans le groupe d'Epworth. Les dykes de l'essaim du Mackenzie sont postérieurs aux failles à rejet horizontal.

THE EPWORTH GROUP, ROCKNEST LAKE AREA, DISTRICT OF MACKENZIE

INTRODUCTION

This report and the accompanying map summarize the results of a field study made in the summers of 1964, 1965, and 1966, on the Epworth Group, the thick Aphebian succession of predominantly sedimentary strata exposed between Redrock Lake on the Coppermine River system and Coronation Gulf on the Arctic coast. The area underlain by these rocks, known as the Epworth basin, is about 150 miles long, 50 miles wide, and covers approximately 7,000 square miles. The map-area, extending from 65° 30'N to 66° 30'N and from 113° 00'W to 115° 00'W, contains only the southern half of the Epworth basin. Part of a much larger region mapped on a reconnaissance scale by Fraser et al. (1960), it includes territory previously examined by Stockwell (1933) as well as the southernmost part of the Muskox Intrusion, described in detail by Smith (1962).

The basin topography is characterized by northerly trending outcrop ridges and escarpments separated by narrow, drift-filled, valleys. It is drained mainly by Coppermine River which flows northward through Redrock and Rocknest lakes, occupying a broad valley with a floor 800 feet or so below the surrounding terrain. Rocky hills capped by diabase sills in some places rise several hundred feet above adjacent lakes and valleys but over much of the area relief is less than 300 feet.

The area west of Redrock and Rocknest lakes, that south and east of Odjick Lake, and parts of the region immediately west of Takiyuak Lake are extensively drift-covered. Elsewhere bedrock is generally well exposed. Glacial features, including drumlinoid ridges, boulder trains, crescentic fractures, striated bedrock surfaces and roches moutonnées attest a westward movement of ice. Northerly to northeasterly movement is recorded near Takiyuak Lake. At Morel Lake, striae representing both northerly and westerly directions of movement are preserved.

The western and central parts of the map-area support a sparse growth of spruce with some birch and tamarack; the eastern part is barren.

The writer was assisted in 1964 by R. J. Mongeau, W. A. Gibbins, K. E. Denike, G. Nakahara, W. F. Tuer, and B. E. Timbres (cook); in 1965 by P. J. Street, U. H. Kretschmar, B. P. Kaus, and D. L. Austen (cook); and in 1966 by M. W. Sargent.

GENERAL GEOLOGY

The map-area straddles the boundary between the Bear and Slave (structural) provinces of the Canadian Shield which, in this region, has been drawn along the eastern margin of the Epworth basin following the unconformity at the base of the Aphebian sediments (Stockwell, 1961, p. 110). The oldest rocks are Archean granites, migmatite, and related metasediments and

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metavolcanics (units 1, 2). They are unconformably overlain by a westward thickening succession of Aphebian (Epworth Group) clastics and carbonates (units 3-7). Minor intermediate to basic volcanic flows are interlayered with the lowermost sediments in the central and western parts of the Epworth basin.

Most of the Epworth Group deposits are unmetamorphosed. Formations near the western margin of the basin, however, were metamorphosed and intruded by late Aphebian granite (unit 8a) and at about the same time, Epworth strata were folded around north-trending axes and displaced along related north-trending dip-slip faults. Fold axes, faults, and granite-sediment contacts were later displaced along northerly and northwesterly trending strike-slip faults. Both metamorphism and deformation show a marked increase in intensity westward.

The Epworth Group is intruded by dykes and sills of diabase and gabbro (unit 9) of Helikian to Hadrynian age and by the Muskox Intrusion (unit 9a) (Smith, 1962), a basic and ultrabasic body of Helikian age.

ARCHEAN ROCKS

The Archean basement (units 1, 2) consists principally of massive to gneissic granite and hornblende granodiorite, belts and remnants of metasediments and metavolcanic rocks of the Yellowknife Group, and associated migmatite. The metasediments are chiefly biotite-quartz schist and gneiss; the metavolcanics are mainly amphibolite.

Prominently exposed, sheared, dark green, pillowed and fragmental, fine-grained amphibolite or 'greenstone' (unit 1) considered to have been derived from Archean basalt, follows the boundary between the Slave and Bear provinces south of Redrock Lake. Granitic rocks to the east of this volcanic belt yield typical Archean ages and to the west, Aphebian ages. Granitic rocks in the basement inlier east of Rocknest Lake, although of Archean type, have given an Aphebian (K-Ar) age of 1770 m.y. (GSC 64-61). Sediments adjacent to the inlier, unlike those bordering Aphebian granite elsewhere in the map-area however, are not metamorphosed. The updating of the rocks of the inlier may therefore be associated with uplift. A well-documented example of uplifted Archean basement at the northern margin of the Epworth basin has been described by Hoffman et al. (1971).

EPWORTH GROUP

The term 'Epworth formation' was employed first by O'Neill (1924) as a formation name for the dolomite exposed near Port Epworth (now abandoned) at the mouth of Tree River on Coronation Gulf. Later its meaning was extended to include the Aphebian strata that lie conformably above and below the dolomite (Fraser et al., 1960). This succession was subsequently referred to as the Epworth Group (Douglas and MacLean, 1963).

The Epworth Group comprises five conformable formations. In ascending order they are: Odjick Formation, consisting principally of quartzite and argillite; Rocknest Formation, composed mainly of stromatolitic dolomite with subordinate interbedded argillite; Recluse Formation, comprising argillite, shale, greywacke, and siltstone; Cowles Lake Formation, a

Table 1

Formations, Rocknest Lake Area

EON	ERA	GROUP	FORMATION OR MAP-UNIT (thickness in feet)	LITHOLOGY
	CENOZOIC			Clay, sand, gravel, till
Unconformity				
PROTEROZOIC	HELIKIAN-HADRYNIAN		Map-unit 9	Diabase dykes and sills; Muskox Intrusion: picrite, bronzite, gabbro, norite
	Intrusive Contact			
	APHEBIAN		Map-unit 8	Granite and allied rocks; migmatite, schist and gneiss; minor amphibolite
		Intrusive Contact		
		EPWORTH GROUP	Takiyuak Formation (1,200 +)	Sandstone, siltstone
			Cowles Lake Formation (2,670)	Limestone, argillite; minor greywacke
			Recluse Formation (2,000 – 6,500 +)	Argillite, siltstone, quartzite, greywacke; minor carbonate and andesite
			Rocknest Formation (2,300 – 5,500)	Dolomite; minor argillite, chert, limestone, and andesite
			Odjick Formation (2,100 – 7,500)	Argillite, quartzite; minor conglomerate, carbonate, and andesite
Unconformity				
ARCHEAN			Map-unit 2	Granite and allied rocks; granite-gneiss, migmatite; includes undifferentiated biotite-quartz schist and amphibolite of Yellowknife Group
		Intrusive Contact		
		YELLOW-KNIFE GROUP		Metabasalt, amphibolite, chlorite schist

succession of interlaminated and interbedded limestone and argillite and Takiyuak Formation, a monotonous sequence of red lithic and feldspathic arenites. In the Takiyuak Lake region, near the eastern margin of the Epworth basin, the only region where all the formations are preserved, their aggregate thickness is about 10,000 feet. In the central regions of the basin, as for example, in the vicinity of Rocknest, Recluse, and Carousel lakes, where only the three lowermost formations are found, the combined thickness may be as much as 20,000 feet.

Odjick Formation

The lowermost unit of the Epworth Group, the Odjick Formation (3), takes its name from Odjick Lake where strata of this formation were first described (Stockwell, 1933). The base of the formation is defined by the pronounced angular unconformity that separates Odjick strata from the underlying crystalline basement rocks. The top of the formation, the contact with the overlying Rocknest Formation, is marked by a relatively sharp transition from a succession dominated by argillite and quartzite to one composed mainly of carbonate.

The best exposures of Odjick Formation occur in the heavily drift-covered region along the eastern margin of the Epworth basin north and south of Takiyuak Lake, and on the east limb of the anticlinal structure that follows the basement inlier east of Rocknest Lake. At Impostor Lake, on the eastern margin of the basin, the formation is about 2,100 feet thick and at Carousel Lake in the central part of the basin, about 7,500 feet thick.

Odjick strata have not been recognized in the western third of the map-area. Their occurrence farther north (Hoffman et al., 1971) however suggests the possibility that some of the rocks in the map-area mapped as Recluse Formation (5) may actually belong to the Odjick Formation (3).

The Odjick Formation is made up of roughly equal amounts of quartzite and argillite, but quartzite appears to predominate in the middle and upper parts. Beds of dolomite and limestone, and locally argillite containing carbonate concretions, occur near the base of the formation and beds of dolomite near the top. Most sections contain a few beds of quartz-pebble conglomerate. Andesitic flows are found in the area between Redrock and Carousel lakes at or near the base of the formation.

The quartzites are predominantly pale green, buff, white, and pink to reddish or mauve quartz arenites composed of angular to rounded grains of quartz and chert with minor feldspar, carbonate, chlorite, muscovite, and opaque minerals. The content of quartz and chert ranges from 40 to 100 per cent and in most of the quartzites is more than 90 per cent. Grains range from 0.05 mm to 1 mm or more in diameter, and sorting is generally moderate to good. Some of the quartzites, however, exhibit a bimodal size-distribution in which both the smaller and larger grains are rounded and well sorted, the smaller, ranging from 0.15 mm to 0.20 mm in diameter and the larger, from 0.5 mm to 2.0 mm. These sizes are comparable to those observed by Folk (1968) in bimodally distributed dune sands of the desert from which wind action had removed the intermediate sized grains. In general the larger grains in either the unimodal or bimodal quartzites are better rounded and more spherical. Silica overgrowths are apparent in many of the quartzites, particularly in those in which quartz constitutes more than 95 per cent.

Suturing and mortar structure observed in the uppermost and lowermost quartzites from the region northwest of Carousel Lake, appear to be related to local dislocation.

Carbonate, muscovite, and chlorite each average less than 5 per cent of the quartzite but locally each may constitute as much as 20 per cent. Pale grey, grey-weathering quartzite commonly contains carbonate as detrital grains or interstitial material which weathers brownish and imparts a speckled appearance to the rock. Muscovite, most abundant in rocks where quartz grains are of silt size, defines a bedding foliation. Chlorite is abundant only in quartzite overlying volcanic flows. Magnetite, normally present in trace amounts, constitutes more than 5 per cent of some of the quartzite beds exposed near Rocknest Lake.

The white, pink, and greenish quartzites commonly contain rounded pebbles of quartz and jasper up to 5 cm in diameter and, less commonly, angular to rounded clasts of carbonate and argillite up to 3 cm in diameter. In relatively few beds however are pebbles or clasts so numerous that their volume exceeds that of the matrix.

The quartzite forms thick, almost massive, successions in which adjacent beds are distinguished by small colour and textural differences and also successions in which arenites and siltstones are intercalated with argillite. The quartzite beds are from 15 to 75 cm thick, the argillite beds 10 to 15 cm, and in some cases, up to 60 cm thick.

Argillite in the Odjick Formation is mainly greenish grey and mauve, and rarely, variegated. Commonly it is interlayered or interlaminated with siltstone. Fissile argillite is not abundant. The thickest argillite sections observed are several tens of feet thick but much thicker sequences are probably concealed under many of the drift-covered intervals.

Andesitic flows (3b) that occur near the base of the Odjick Formation in the Rocknest Lake - Carousel Lake region include massive, porphyritic, amygdaloidal, and pillowed varieties. Much of the andesite is green and fine grained, with an ophitic or, less commonly, trachytic, texture. It is composed of 50 to 60 per cent andesine or, in some cases, albite, and 40 to 50 per cent combined chlorite, carbonate, epidote, muscovite, and opaque minerals including traces of pyrite. Subhedral crystals of plagioclase 1 cm in length constitute about 20 per cent of the porphyritic lavas. In the amygdaloidal flows amygdules are filled with calcite and clear, unstrained, quartz. In view of the high content of secondary minerals, some of which have evidently been derived from calcic plagioclase, it is probable that the flows were originally basaltic. Potassium-argon ages of 1740 m.y. (GSC 64-47) and 1600 m.y. (GSC 65-67) obtained from the volcanics are anomalously low considering that older ages have been determined from Aphebian granite that clearly postdates the Epworth Group. The ages may therefore reflect a period of uplift following extrusion.

Primary structures such as erosion channels, scour-and-fill structures, graded beds, mudcracks, and stromatolites suggest a fluvial to shallow marine origin for the Odjick Formation. Northeast-trending ripple-marks and westerly to northwesterly inclined crossbeds indicate transport of sediment from a source lying east and southeast of the Epworth basin.

Table 2

Odjick Formation. Composite section measured in region south of Takiyuak Lake

Lithology	Per cent interval exposed	Interval thickness (feet)
_____ Conformable contact (not exposed) ___		
Thinly to thickly bedded grey and green shale, slate, and siltstone; thick-bedded red, pink, light green quartzite	15	490
Clean, white, crossbedded quartzite containing rare carbonate interbeds; pink to grey pebbled quartzite	25	110
Thinly bedded to thickly bedded pink to red quartzite, pebbled in part, intercalated with grey, green, and red argillite	40	420
Coarse-grained, red, arkosic quartzite, white quartzite with minor carbonate lenses and layers, and grey, quartz-pebble conglomerate	10	400
Pale grey, carbonate-speckled quartzite; thick-bedded to massive, white and pink quartzite	10	460
Mainly red, thin-bedded and laminated quartzite, siltstone, argillite, and slate	65	120
Mainly massive, fine-grained, pale grey to greenish, carbonate-speckled quartzite	30	100
Thin-bedded to thick-bedded maroon argillite and siltstone; red and green banded slate containing carbonate concretions and thin, graded beds of sandstone	70	200
_____ Unconformable contact (not exposed) ___		
Total		2,300

Table 3

Odjick Formation. Composite section measured in region north of Takiyuak Lake

Lithology	Per cent interval exposed	Interval thickness (feet)
Conformable contact (not exposed)		
Thinly bedded, pink to grey siltstone, argillite, and dolomite	5	90
Thickly bedded, fine-grained, green quartzite with minor interlaminated argillite, grading upward to thickly bedded, coarse-grained, mauve quartzite intercalated with thick-bedded limy argillite	50	50
Grey, green, and mauve quartzite containing thin limy beds; minor maroon dolomite with interlaminated argillite	5	265
Thickly bedded mauve, pale grey, and white quartzite, in part carbonate-speckled, and thick-bedded carbonate	75	35
Fissile, green and grey argillite, and thinly bedded, cross-bedded siltstone	40	220
Thinly to thickly bedded, fine-grained, white, greenish, and mauve, graded quartzite; red, locally variegated fissile, and thin-bedded to thick-bedded argillite	100	20
Thick-bedded, fine-grained, pink, pale grey, and greenish grey quartzite, carbonate-speckled in part; rare beds of quartz-pebble conglomerate; minor thick-bedded, micaceous, mauve argillite	10	470
White to pale green and grey, pebbled and ripple-marked quartzite, in part carbonate-speckled; minor shale	50	60
Green, grey, and pale pink, fissile argillite; thinly bedded, ripple-marked siltstone and subordinate, thickly bedded mauve to grey quartzite	50	120
Thinly to thickly bedded, pale grey to greenish grey, quartzite; minor thinly bedded siltstone, greenish grey, fissile argillite, and conglomerate	100	30
Shale and argillite; thin-bedded grey and green, crossbedded siltstone containing carbonate lenses and beds of conglomerate; minor coarse-grained quartzite	70	100
Thinly to thickly bedded, white, grey, red and mauve quartzite, in part carbonate-speckled, and containing carbonate lenses; minor fissile variegated argillite	70	90
Thick-bedded to massive, fine-grained, pale green and green and grey quartzite	10	290
Red and green slate; concretionary argillite intercalated with thinly bedded carbonate and thick-bedded stromatolitic dolomite; large blocks composed of quartzite boulders in carbonate matrix probably derived from concealed bedrock	10	260
Unconformable contact (not exposed)		
Total		2,100

Takiyuak Lake Region

Sections of the Odjick Formation were examined south of Takiyuak Lake, near Cowles Lake (Table 2), and near Impostor Lake north of Takiyuak Lake (Table 3). Strata east of Morel Lake, displaced from the Cowles Lake section along the Redrock fault are also included in Table 2. An average dip of 10 degrees was used in calculating the total thickness of the southern section and a dip of 6 degrees for the northern section. In neither section are upper and lower contacts exposed. The limited amount of outcrop in both regions, possibly reflecting a much higher proportion of argillite than is shown in Tables 2 and 3, permits only crude stratigraphic comparisons. Argillite appears to predominate in the lowermost and uppermost parts of each section. Similar thin-bedded and thick-bedded quartzites[1] are found in both localities but pink to red quartzite are more abundant south of Takiyuak Lake. In both areas conglomerates occur over a thousand-foot interval in the middle part of each section and in both, lenses, layers, and nodules of carbonate occur chiefly below and above the conglomerate zones.

Rocknest Lake - Carousel Lake Region

In the south-central part of the Epworth basin the Odjick Formation may be as much as 7,500 feet thick. Unfortunately drift cover and structural dislocation in this region combine to render thickness estimates unreliable, and the construction of a composite section impractical. The basal part of the formation, best exposed northwest of Carousel Lake, comprises white and pink glassy quartzite more than 30 feet thick cut by veins of milky white quartz and traversed by hematite-stained fractures. Outcrops of quartzite and granite-gneiss of the Archean basement are found in close proximity but contacts are not exposed. Above the quartzite is thin-bedded to fissile greyish green argillite up to 100 feet thick. In some places the quartzite is missing and the argillite appears to lie directly on the basement rocks. Andesitic flows, which conformably overlie the argillite and have a total thickness between 100 and 500 feet, may belong to more than one succession. The volcanic rocks are succeeded by white, massive ripple-marked quartzite followed by about 1,200 feet of dark green to grey argillite containing, at some horizons, layers of limestone from 7 to 15 cm thick and grading upwards into silty argillite. The overlying strata chiefly comprise alternating sequences of thin-bedded to thick-bedded white to grey, buff or mauve quartzite with much less than 50 per cent interbedded argillite, and greenish grey argillite and siltstone. The upper part of the formation, observed north of Ambush Lake, consists of thick-bedded mauve to pink, coarse-grained graded, ripple-marked and crossbedded quartzite overlain by white and buff pebbled quartzite capped by more than 30 feet of thin-bedded, mudcracked argillite. Dolomite of the Rocknest Formation lies directly on the argillite. In the vicinity of Carousel Lake the uppermost 1,500-foot interval of Odjick strata is dominated by massive to thickly bedded buff and white quartzites overlain by a few beds of quartz-pebble conglomerate. The contact with the Rocknest Formation in this area is concealed but from the relatively high proportion of argillaceous beds exposed in the lower Rocknest section, the uppermost Odjick beds are inferred to be principally argillite.

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[1] In this report the terms thin-bedded refer to beds from one to ten centimetres thick, and thick-bedded to beds thirty or more centimetres thick.

Rocknest Formation

The Rocknest Formation (4), named after Rocknest Lake, overlies the Odjick Formation and is overlain by the Recluse Formation. It is well exposed across the map-area in a series of ridges which follow the limbs of northerly trending folds. Good outcrop is found east of Carousel Lake where a type section 5,500 feet thick was measured (Table 4). Along the eastern margin of the Epworth basin, where the total thickness is about 2,300 feet, the formation is less well exposed.

At the lower contact, best exposed north of Ambush Lake, dolomite with interbedded argillite is in sharp contact with argillite of the underlying Odjick Formation. The contact between the Rocknest Formation and the overlying Recluse Formation is drift covered, but observations made at Recluse Lake and north of Morel Lake indicate that the transition from dolomite containing interbedded argillite, to the thinly bedded argillite and shale of the Recluse Formation takes place within a few tens of feet.

The Rocknest Formation is composed mainly of dolomite with subordinate interbedded argillite and minor limestone. Pillowed, fragmental, and amygdaloidal andesite similar to that found in the Odjick Formation outcrops near Vaillant Lake where it is interbedded with dolomite assumed to belong to the upper part of the Rocknest Formation, the thickness of this andesite is probably not more than a few hundred feet.

Dolomite of the Rocknest Formation is finely crystalline, dark grey to pale grey and white, weathering grey, buff, brown, and pink. Most of the rock is evenly and distinctly stratified in beds that range in thickness from 10 to 100 cm. A ribbing observed on the weathered surfaces of many beds reflects a fine bedding lamination. Beds of dolomite containing rounded to angular clasts of dolomite up to 7 cm in diameter are abundant in some parts of the section. Thin lenses and laminae of black and white chert are common, particularly in stromatolite cores. The dolomite beds are traversed in many places by stringers of quartz and dolomite up to 1 cm thick in which comb structures are well developed.

Stromatolites are found throughout most of the formation. They range in diameter from 5 cm to 100 cm and include hemispherical, columnar, undulatory, and detached forms.[1] In general only one variety characterizes a particular bed. Closely spaced, slender, conical stromatolites which taper very slightly upwards, perpendicular to bedding planes are distinctive in form and association. They are about 15 cm long and range from 1 to 2 cm in diameter although at any one locality the dimensions are fairly uniform. In almost every occurrence these forms are replaced or partly replaced by black chert and in some cases, by white chert masses, which project above weathered surfaces, and in plan exhibit concentric structure. Commonly four or five beds of such stromatolites are found together overlying a zone of large columnar stromatolites which in some beds, attain a diameter of 4 feet or more. The spatial association with the conical stromatolites of massive, dull grey limestone in beds from 3 to 25 feet thick is also typical.

Throughout much of the formation beds of greenish grey argillite and rarely, red, mudcracked argillite from 2 cm to 60 cm thick are cyclically interlayered with the dolomite, and constitute almost 50 per cent of some sections. In argillite-rich zones the dolomite is dominantly buff to brown weathering and at several horizons includes beds of clastic origin.

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[1] For form-classification terms, see Donaldson (1963) and Hofmann (1969).

Table 4

Rocknest Formation
Section measured east of Carousel Lake

Lithology	Thickness (feet)
Conformable contact (not exposed)	
Buff, brownish, and greyish weathering, grey dolomite; interbeds of thinly to thickly bedded argillite near top of sequence; columnar, hemispherical, and undulatory stromatolites; a few beds containing conical stromatolites with white chert cores and a few containing concretions of white chert	1,040
Grey to white-weathering, dark grey dolomite; undulatory and hemisperical stromatolites; laminae of black and white chert	90
Medium grey to dark grey dolomite, weathering grey, and less commonly, orange and pink; minor interbedded argillite; rare beds of grey limestone; laminae of black and white chert; concretions of white chert at base of sequence; a few undulatory and hemispherical stromatolites	140
Ash grey-weathering, medium grey to dark grey, massive dolomite; subordinate buff-weathering dolomite; minor intraformational conglomerate near top of sequence; rare undulatory stromatolites	500
Grey-weathering, grey dolomite, and subordinate buff-weathering grey dolomite that includes a few beds of dolomite breccia; minor interlaminated argillite; several dull grey, massive, limestone beds with associated beds of conical stromatolites; hemispherical, columnar, and large, corrugated stromatolites; scattered oncolites near top of sequence; numerous laminae of black and white chert; sequence is cut by longitudinal fault of undetermined displacement	1,270
Grey-weathering, grey dolomite, alternating with zones of interbedded, orange- to brown-weathering, pale grey and white, thinly to thickly bedded dolomite, and grey, thinly bedded argillite; clastic dolomite near the base; columnar stromatolites in lower part of sequence, oncolites in upper part; laminae of white chert occur throughout	840
Brown-weathering, white and grey, thinly to thickly bedded dolomite containing a few beds of coarsely clastic dolomite, interbedded with grey and red, thin- to thick-bedded mudcracked argillite; columnar and hemispherical stromatolites abundant in non-argillaceous zones	420
Pink and buff-weathering, grey to white, thinly to thickly bedded, dolomite; minor laminae of argillite and white chert; rare undulatory stromatolites	160
Mainly buff-weathering, pale grey, thickly bedded dolomite interbedded at several horizons with thinly to thickly bedded grey argillite; undulatory and columnar stromatolites	1,040
Conformable contact (not exposed)	
Total	5,500

The Rocknest Formation is not well enough exposed along the eastern margin of the Epworth basin to permit construction of a detailed composite section, or correlation with the section measured east of Carousel Lake (Table 4). In the latter area the total thickness, based on calculations using an average dip of 23 degrees, is about 5,500 feet but neither the bottom nor top of the formation is exposed and the actual thickness may be greater. Subdivision of the section into the nine zones shown in Table 4 is based on differences in dolomite colour, percentage of argillite, shape, size and abundance of stromatolites, and occurrence of limestone. These parameters are only partly interdependent and vary in a gradual manner so that in most cases the positioning of zone boundaries is somewhat arbitrary.

Recluse Formation

The Recluse Formation (5) overlies the Rocknest Formation. In the vicinity of Takiyuak Lake, it is overlain by the Cowles Lake Formation but in other parts of the map-area it is the youngest formation of the Epworth Group exposed. The formation is named after Recluse Lake, the locality of the type section. The base of the formation, comprising green and grey siltstones overlain by several hundred feet of black shale and slate, contrasts sharply with dolomite of the underlying Rocknest Formation. The top of the Recluse Formation is nowhere exposed but probably consists of interbedded limestone and argillite grading into the laminated limestone-argillite sequence typical of the overlying Cowles Lake Formation.

Like the underlying Rocknest Formation the Recluse Formation is exposed in a series of north-trending ridges that follow the limbs of northerly trending folds. At Cowles Lake, near the eastern margin of the Epworth basin, the Recluse Formation is about 2,000 feet thick. At Recluse Lake the thickness is at least 6,500 feet. Argillaceous and arenaceous strata underlying the westernmost part of the Epworth basin are tentatively assigned to the Recluse Formation because of lithologic similarity but possibly include some rocks belonging to older formations of the Epworth Group. Argillite with interbedded siltstone and quartzite that borders the eastern margin of Epworth basin north of Takiyuak Lake, formerly considered as Recluse equivalent (Fraser et al., 1960) is now known to belong to the Odjick Formation.

The Recluse Formation consists principally of argillite, siltstone, and greywacke, with minor limestone. The argillaceous rocks are mainly green and grey argillites, black shales and slate, minor red shale and argillite, and calcareous argillite. Red argillite is confined mainly to eastern sections. West of Rocknest Lake, however, interlaminated and graded red to maroon argillite and yellowish silty argillite occur near the base of the formation. In most cases argillite comprises mudstone interbedded with siltstone. The latter is typically composed of well sorted, angular to subrounded grains of feldspar (45%), quartz (30%), carbonate (20%), chlorite (5%) with traces of muscovite and opaque minerals. Conspicuous beds of green argillite containing numerous pale grey, ovoidal limestone concretions from 2 cm to 7 cm in diameter are characteristic of all lower Recluse sections in the central and eastern regions of the Epworth basin.

Greywacke, apparently of turbidite origin, is a prominent component of the Recluse Formation in the western part of the basin, but thins eastward with the result that in the Morel Lake and Takiyuak Lake regions greywacke is virtually unknown. At Recluse Lake where the greywacke occurs chiefly

in almost massive beds from 30 cm to 100 cm thick interlayered with thinner beds of green or black argillite or green shale, it is pale reddish to greenish grey and composed of feldspar (60%) quartz (30%) with muscovite, carbonate, and chlorite (10% or less). The grains are angular and very poorly sorted, ranging in size from less than 0.03 mm up to 2 mm in diameter. Near Vaillant Lake, northwest of Recluse Lake, the greywacke beds may be 10 feet or more thick and interbedded argillite is thin or absent.

South and west of Rocknest Lake massive and porphyritic andesite (unit 5d) may be interlayered with argillite near the base of the Recluse Formation. Contacts between these rocks were not observed. The total thickness of the andesite is unknown.

Recluse Lake Region

One of the best sections of Recluse strata in the map-area lies just east of Recluse Lake where Epworth sediments have been folded into a tight syncline from which the uppermost deposits, including perhaps the top of the Recluse Formation, have been eroded. The estimate of thickness, 1,720 feet of the basal part of the section (Table 5) is only an approximation of true thickness considering the scarcity of outcrop in the area of contact with the underlying Rocknest Formation and the possibility that the section has been displaced by dip-slip faults. Strata of the uppermost zones (Table 5) are particularly poorly exposed. Calcareous siltstone and argillite, and limestone, both as beds and concretions, clearly predominate, in this part of the section however, and the contact with the overlying Cowles Lake Formation is therefore judged to be gradational.

Morel Lake Region

Strata exposed north of Morel Lake (Table 6), considered representative of the easternmost occurrences of the Recluse Formation, are capped by a partly eroded diabase sill, which by analogy with the related sills outcropping at Takiyuak Lake and east of Cowles Lake, was probably emplaced between the Recluse and Cowles Lake formations. If this is so little or no material has been eroded from the upper part of the Morel Lake section. The total thickness (2,000 feet) of sediment, which is comparable to that of Recluse strata in the vicinity of Cowles Lake, further supports this conclusion. The section consists mainly of an alternating succession of argillites and siltstones, the latter being more abundant in the upper parts. Unlike the Recluse Lake section (Table 5) it contains red shale of several horizons, no greywacke, and except for beds containing carbonate concretions, little or no bedded carbonate.

Cowles Lake Formation

The Cowles Lake Formation (6), which overlies the Recluse Formation, and is overlain by the Takiyuak Formation is found only on the periphery of the structural basin southwest of Takiyuak Lake. The type section is on the west side of Cowles Lake, after which the formation is named. At Cowles Lake the thickness is about 2,600 feet.

The contact with the Recluse Formation is concealed. The lowermost Cowles Lake strata exposed, which may be as much as 100 feet above

the base, consist of a succession, 100 feet thick, composed principally of interlaminated limestone and argillite with minor interbedded laminated limestone, thick-bedded black shale and thinly bedded argillite containing limestone concretions. The interlaminated rock distinguishes Cowles Lake strata from the uppermost Recluse beds. The top of the Cowles Lake Formation comprises a dominantly argillaceous sequence of thick-bedded red and maroon argillite, made up of intercalated mudstone and siltstone containing thin lenses of limestone and layers of limestone breccia which is in sharp contact with basal red siltstone and sandstone of the Takiyuak Formation.

Table 5

Recluse Formation. Section measured east of Recluse Lake

Lithology	Thickness (feet)
Erosion surface	
Mainly drift-covered calcareous argillite and siltstone, and thick-bedded, fissile argillite containing carbonate concretions; thinly bedded, reddish weathering dark grey argillite intercalated with grey to brown-weathering grey limestone at top of section	1,500 +
Poorly exposed green siltstone and fissile argillite	280
Thickly bedded green siltstone, thinly to thickly bedded argillite, in part fissile, and thickly bedded concretionary argillite	2,370
Green, concretionary argillite with minor intercalated thick-bedded greywacke	70
Greyish to pale reddish weathering, greenish grey, thick-bedded greywacke with thin interbeds of grey argillite and shale; argillite beds near top of sequence contain limestone concretions	560
Mainly black shale and slate; concretionary argillite at top of succession, green to grey argillite and siltstone with thin interbeds of black shale at base	1,720
Conformable contact (not exposed)	
Total	6,500 +

Table 6

Recluse Formation. Composite section measured in Morel Lake region

Lithology	Thickness (feet)
Unroofed diabase sill	
Intrusive contact	
Pale green siltstone	30
Black slate, argillite, and concretionary argillite	110
Dark green, mainly thick-bedded, siltstone	100
Green argillite and concretionary argillite; minor red shale, black slate, and siltstone	110
Poorly exposed, thinly laminated black slate and shale, green concretionary argillite, and minor red, ripple-marked argillite	1,175
Poorly exposed, light to dark green argillite, slate, and siltstone	475
Conformable contact (not exposed)	
Total	2,000

The Cowles Lake Formation consists chiefly of interlaminated and interbedded limestone and argillite, minor limestone argillite-limestone breccia, and greywacke. Laminated beds are from 10 cm to 120 cm thick and are interlayered with beds of argillite and beds of limestone, and with other laminated beds of similar lithology in which laminae are of different thickness. Laminae range in thickness from 2 to 20 mm but in any one bed are commonly uniform. In section, argillite laminae are seriate or ridged and where ridges of adjacent laminae meet, they divide the intervening limestone laminae into discontinuous layers and lenses.

The limestone is grey, weathers buff to grey, and is recessive with respect to argillite. Limestone beds are from 10 to 75 cm thick and are massive or finely laminated. Where cut by diabase dykes (9) laminated limestone and interlaminated limestone and argillite beds are commonly deformed into conjugate folds having an amplitude of about 30 cm.

Argillite beds range in thickness from 10 to 100 cm; they are grey, green, and red, and weather grey to brown and red. Red argillite is found only in the upper half of the formation where it occurs in addition to the grey or greenish argillite common in the lower part of the section. Characteristic also of the upper part of the formation are beds of breccia consisting of tabular fragments of limestone up to 3 cm or more in diameter set in a matrix of

Table 7

Cowles Lake Formation
Composite section measured west of Cowles Lake

Lithology	Per cent interval exposed	Interval thickness (feet)
Conformable contact		
Thickly bedded, red and maroon argillite; subordinate red and grey limestone and limestone-argillite breccia	80	130
Mainly interlaminated grey limestone and argillite; minor thickly bedded limestone and argillite-limestone breccia	80	40
Thinly bedded red argillite intercalated with laminae of grey limestone and with thin beds of interlaminated red argillite and limestone; minor thinly bedded argillite-limestone breccia	15	190
Interlaminated, greenish grey argillite and grey limestone; maroon argillite at top of sequence	25	200
Limestone-dominant interlaminated grey argillite and limestone; red argillite and shale containing subordinate limestone laminae	30	175
Thickly to thinly bedded interlaminated grey limestone and red, reddish brown, and grey, argillite; minor thinly bedded argillite-limestone breccia	30	105
Laminated to thinly bedded red argillite interlayered with laminae of grey limestone	25	200
Drift covered	0	920
Thickly bedded, interlaminated grey argillite and limestone intercalated with subordinate thickly bedded greywacke	50	150
Thick-bedded, interlaminated grey limestone and argillite interlayered with thick-bedded grey limestone	3	185
Thick-bedded interlaminated grey limestone and argillite intercalated with grey, calcareous argillite	50	75
Thin- to thick-bedded, limestone and argillite, interbedded with calcareous argillite; concretionary argillite at top of succession	35	70
Mainly thin- to thick-bedded interlaminated grey limestone and argillite; minor thick-bedded black argillite; argillite in upper part of sequence contains limestone lenses and nodules	25	230
Conformable contact (not exposed)		
Total		2,670

red or grey argillite. Argillite containing limestone lenses or concretions from 2 to 15 cm in diameter occur near the base and near the top of the formation.

Beds of greywacke from one to three feet thick are intercalated with beds of interlaminated limestone and argillite just below the red argillite succession. A typical specimen of the greywacke is composed of very poorly sorted fine angular grains of quartz (25%), feldspar (45%), rock fragments (10%), chlorite, muscovite, carbonate and opaques (combined about 5%), and matrix (15%).

No conglomerate was observed in the Cowles Lake succession but an isolated outcrop of conglomerate capped by reddish calcareous shale that is situated near the contact of the Cowles Lake and Takiyuak formations, against the south branch of the Redrock Fault, probably belongs to the upper part of the Cowles Lake Formation. The conglomerate is at least 5 feet thick and is composed of rounded cobbles of limestone 12 cm in diameter along with angular fragments of finely laminated limestone, in a matrix of red argillite.

The type section consists principally of the interbedded and interlaminated limestone and argillite so typical of the Cowles Lake Formation but despite the over-all monotonous nature of the succession, and the scarcity of outcrop a crude rhythmic variation in lithology is evident (Table 7). Thus, zones in which argillite is dominant alternate with those in which limestone is dominant. The zones range in thickness from a few tens of feet to hundreds of feet and are separated by sequences in which both argillite and limestone are present in roughly equal proportions.

The most striking feature of the upper part of the section is the occurrence of red argillite, a feature that is clearly recognizable in Cowles Lake successions exposed elsewhere. The occurrence of beds of greywacke just below the lowermost red argillite is also characteristic of other exposures of the formation.

Takiyuak Formation

The Takiyuak Formation (7) is found only southwest of Takiyuak Lake where, as the uppermost formation of the Epworth Group, it overlies the Cowles Lake Formation and occupies the central region of the structural basin that forms the easternmost segment of the Epworth basin. The name Takiyuak is derived from Takiyuak Lake. At the base of the formation, reddish brown siltstone grading upward into reddish brown sandstone is in sharp contact with red argillite of the Cowles Lake Formation. The top of the Takiyuak Formation is unroofed and partly eroded. A section 1,200 feet thick is preserved. The original thickness is unknown.

Reddish brown sandstone grading in some places into siltstone constitutes the bulk of the Takiyuak Formation and throughout the formation presents a uniform appearance. Beds are commonly several feet thick and are finely laminated. Rarely the sandstone contains sparse clasts of dark brown argillite and beds up to 30 cm thick containing rounded pebbles of argillite, granite, quartz, quartzite, and carbonate from 2 to 7 cm in diameter. Thin beds of argillite were noted in one locality.

The sandstone comprises lithic and feldspathic arenites composed of about 25 per cent quartz, 55 per cent combined feldspar and rock fragments, up to 15 per cent calcite as cement and grains, and less than 5 per cent

combined muscovite, chlorite, tourmaline, and opaque minerals including hematitic films that follow grain boundaries. Rock fragments appear to be mainly argillaceous sediment and some, rich in epidote, are probably of volcanic origin. The grains range from 0.04 to 0.3 mm in diameter, and some to one millimetre, are angular to subrounded and well sorted. The almost ubiquitous lamination results from a cyclical alternation of fine and coarse grains in laminae 2 mm to 10 mm thick. Inverse grading is apparent in some of these.

Ripple-marks are found at the base of the Takiyuak Formation in some places. Examples of crossbedding occur throughout. They include small wedge sets of crossbeds characteristic of pebbled sandstone beds, and more commonly, large tabular sets which may easily be mistaken for true bedding. The few dips recorded for these crossbeds indicate that the preferred direction of transport of sediment was eastward. The formation is cut by many joints. Near diabase dykes, where joint sets are particularly conspicuous, the joints, parallel the dyke walls, and the spacing between joints varies directly with the distance from the dyke.

POST-EPWORTH SEDIMENTARY ROCKS

No sedimentary formations younger than the Takiyuak have been recognized in the Epworth basin. At the north end of Cowles Lake, however, conglomerate erratics up to 6 feet in diameter are found in Takiyuak sandstone terrane. The conglomerate consists of closely packed rounded cobbles of Takiyuak-type reddish brown sandstone 20 cm in diameter and light grey quartzite, 15 cm in diameter, in a reddish brown calcareous sandstone matrix. No outcrops of this conglomerate have been found and its stratigraphic position with respect to the Epworth Group is unknown. Tentatively it is assumed that the conglomerate overlies or overlay the Takiyuak Formation, probably unconformably, having developed as a product of post-orogenic uplift.

MAP-UNIT 8

The Epworth basin is bordered on the west and southwest by massive granite, quartz monzonite, and granodiorite, and by migmatite with associated remnants of schists and gneisses, presumably derived mainly from sedimentary and volcanic rocks of the Epworth Group. Considerable variation in contact relationships is exhibited from place to place along the basin margin. In the southwest corner of the map-area, for example, where drift cover is thick, Epworth metasediments comprising chiefly argillaceous schists, pass along strike into biotite-hornblende granite gneiss (8b). In the Scotstoun Lake region to the north contacts between the metasediments and the granitic rocks are gradational and locally irregular. In general however there is a transition westward from phyllite and andalusite- and sillimanite-bearing schists (5c) into migmatite and garnetiferous gneiss (8b) interspersed with small bodies of massive granite. Also characteristic of this region are small outcrops of fine- to medium-grained amphibolite cut by granite stringers. The amphibolite is probably derived from Epworth Group andesite. Near Hepburn River the contact between coarse-grained, porphyritic biotite-muscovite

quartz monzonite (8a) and biotite-sillimanite schist (5c) although concealed, is judged to be sharp and concordant. In the vicinity of Marceau Lake, in the northwest corner of the map-area, granitic rocks comprising biotitic gneisses and stocks of massive granodiorite are concordant or subconcordant with adjacent sediments.

From the foregoing relationships, in particular the progressive metamorphism of Epworth strata westward, it is clear that the granitic rocks of unit 8 are younger than the adjacent Epworth formations. This conclusion is also supported by K-Ar analyses. Biotite from granite in the vicinity of Hepburn River yields an age of 1760 m.y. (GSC 64-59), a result comparable with ages obtained from granites elsewhere in the Bear Province, whereas the whole rock age of phyllite east of the granite contact is 1835 m.y. (GSC 66-73). The latter age, considering the metamorphic grade of the rock may be reasonably assumed to be less than that of unaltered sediment. The gradual transition westward from Epworth metasediments into migmatites suggests that the sedimentary and volcanic components of unit 8 are mainly derived from Aphebian deposits. The possibility, however that this unit also includes some updated Archean basement rocks must be considered.

MAFIC INTRUSIONS (9)

The youngest rocks in the map-area comprise diabase dykes and sills (9) and the mafic and ultramafics of the Muskox Intrusion (9a).

The dykes, which intrude all formations of the Epworth Group, are of two principal ages. Dykes of the Mackenzie swarm, the more numerous, trend N30° W, are steeply inclined, and have been dated at about 1200 m.y. (Fahrig and Jones, 1969). Traversing these are younger, northeasterly to easterly trending dykes, probably of Franklin diabase, dating about 675 m.y. (Fahrig et al., 1971). The dykes consist typically of roughly equal amounts of fresh or little altered labradorite, clinopyroxene, accessory magnetite and minor serpentine derived from olivine or orthopyroxene.

Diabase intrusions in the northern part of the map-area include sills of pre-Mackenzie age, which are concordant with steeply inclined, Epworth host rocks and like the Mackenzie dykes, strike approximately N30° W. Unlike the dykes, however, they are displaced by northeasterly trending strike-slip faults. The sills are coarse-grained, ophitic to subophitic, consisting generally of variable proportions of partly sericitized labradorite, and subordinate clinopyroxene with minor orthopyroxene, micropegmatite, biotite, chlorite, serpentine, and opaques. Possibly correlative with these sills are the gently inclined sills that cap strata of the Recluse Formation at Takiyuak Lake and near Morel Lake. These bodies are more than 100 feet and 80 feet thick respectively. The Morel Lake sill has yielded a K-Ar whole rock age of 1255 m.y. (GSC 66-74), but presumably related sills that intrude Aphebian sediments of the Goulburn Group east of the map-area have given ages of 1555 m.y. (GSC 65-68) and 1215 m.y. (GSC 63-27) so that the true age could be at least as old as 1555 m.y. Similar sills that occur in the region north of the map-area may, according to Hoffman (Fraser et al., 1972), have intruded Epworth Group strata prior to folding. If this is so the sills could be older than the emplacement of Aphebian granite with which the folding is associated, that is, older than 1760 m.y.

The Muskox Intrusion (9a) is a layered series of basic and ultrabasic rocks that follows the western margin of the Epworth basin for more

than 70 miles, extending beyond the northern limit of the map-area. Within the map-area it consists of picrite, bronzite, gabbro, and norite (Smith, 1962). Field relationships north of the map-area indicate that the intrusion post-dates adjacent Epworth deposits but slightly pre-dates basalts of the Coppermine River Group (Irvine, 1970), considered to be the extrusive equivalents of the Mackenzie dykes (Fahrig and Jones, 1969).

METAMORPHISM

Strata in the eastern and central regions of the Epworth basin are, for the most part, unmetamorphosed. Locally however argillite has been transformed to slate, clay minerals have been altered to chlorite and sericite, and near contacts with diabase sills limy concretions in argillite have recrystallized to concentrically layered amphibole, epidote, chlorite, quartz, and carbonate.

Strata in the western part of the Epworth basin, by contrast, exhibit metamorphic effects of progressively higher grade towards the contact with younger granite (8). Ten to fifteen miles from the granite argillite composed principally of fine-grained quartz and muscovite with minor biotite grades westward into phyllites containing abundant muscovite and biotite and these rocks in turn grade to muscovite-biotite-quartz schists. Within four miles of the granite the schists contain nodular porphyroblasts of andalusite. Near the granite andalusite gives way to sillimanite which may be accompanied either by cordierite or by garnet. In some places the contact with the granite is not sharp and sillimanite-bearing rocks pass westward into gneiss and migmatite rich in garnet and, locally, hornblende.

Typical mineral associations found in the westernmost part of the Epworth basin are quartz-microcline-plagioclase-biotite-muscovite-sillimanite-cordierite and quartz-microcline-plagioclase-biotite-muscovite-sillimanite-garnet. These assemblages are characteristic of the sillimanite-cordierite-muscovite-almandine subfacies of the cordierite-amphibolite facies as defined by Winkler (1967) and, following Miyashiro (1961) are considered to have formed at low to intermediate pressure.

A crude estimate of the age of metamorphism is provided by the age (about 1760 m.y.) of the associated granite (8). The relationship in time between metamorphism and folding is uncertain but it seems probable that emplacement of granite, metamorphism, and deformation are all in part at least contemporaneous. The growth of cordierite along cleavage planes oblique to bedding suggests that metamorphism continued during and perhaps, after the main episode of folding had ended. The local occurrence in schists in the contact zone of strained quartz, however, indicates some post-metamorphic deformation.

STRUCTURE

The Epworth Group has been folded around northerly axes and displaced along three sets of faults. In general the intensity of deformation as exhibited by bedding inclination, type and wave length of folds, and presence of cleavage increases westward along with the increase in metamorphic grade. Except in the most deformed and most metamorphosed regions primary

structures are preserved and recognition of bedding tops can be inferred from graded beds, mudcracks, crossbeds, ripple-marks, and stromatolites.

The easternmost Epworth deposits lie in a structural basin that extends from the north end of Takiyuak Lake, 40 miles to the south, and from the eastern margin of the Epworth basin, 20 miles to the west, where it is truncated by a north-trending dip-slip fault. East of this fault sediments are unmetamorphosed and bedding dips are nearly everywhere less than 15 degrees whereas west of the fault open folds in unmetamorphosed sediments plunge gently north and south and fold limbs are shallow to steeply inclined. Farther west, tighter, probably similar folds in phyllites and schists are accompanied by well developed axial-plane cleavage on which bedding traces reflect plunges north and south of zero to twenty degrees. Steeper plunges occur in the southwest part of the map-area. Schists and gneisses that comprise the westernmost Epworth deposits contain small intrafolial folds characteristic of foliation derived from transposed bedding.

Numerous kink bands are found in the schists and phyllites. They average 270 degrees in azimuth and with few exceptions are dextral. They post-date the development of the northerly trending foliation in the metasediments but their absolute age has not been established. Kink bands have been produced experimentally by compression at low angles to foliation (Donath, 1968). The origin of these structures in rocks of the Epworth Group has not been determined.

The major anticlinal structure northeast of Redrock Lake may be partly related in origin to uplift of the Archean basement inlier that forms its core. A strong subhorizontal cleavage in the basal argillite of the Odjick Formation suggesting movement of the basement relative to the superjacent strata, supports this inference. Furthermore, the granite, which is undoubtedly Archean, has been updated and yields an Aphebian K-Ar age of 1740 m.y. (GSC 64-47) despite the absence of a metamorphic aureole in the flanking formations. The age of uplift is uncertain but may be coeval with the Archean basement uplift at the north end of the Epworth basin described by Hoffman et al. (1971) which, in that area, post-dates Recluse deposition but pre-dates Hadrynian deposition.

Faults in the map-area strike northerly, northeasterly, and northwesterly. Along the prominent north-trending fault that truncates the west side of the structural basin at Takiyuak Lake, and separates the Cowles Lake Formation on the east from the Odjick Formation on the west, the western block moved up relative to the eastern. This fault and others of similar trend which are commonly marked by highly brecciated wall-rocks and topographic lineaments, may be thrusts. West-dipping thrust faults have been recognized by Hoffman (1970) in the Epworth basin north of the map-area.

Numerous northeasterly trending predominantly strike-slip faults displace the northerly trending faults. They also displace all Epworth formations, the sediment-granite contact at the western margin of the basin, and the large diabase sill (9) that caps Recluse Formation strata at Takiyuak Lake. On nearly all these faults the strike separation is dextral. On some it is evident that the north side has also moved downward relative to the south. The most pronounced northeasterly trending fault, termed here the Redrock fault, extends from Redrock Lake, the region where it was first mapped (Stockwell, 1933), more than 80 miles to the northeast and, passes into Archean terrane south of Takiyuak Lake. This fault offsets the structural basin at Takiyuak Lake so that the southern extension of the basin is found in

the vicinity of Odjick and Morel lakes. The total horizontal separation along the fault and along related parallel and subparallel faults south of Takiyuak Lake is about 20 miles. The Redrock fault is marked topographically, as are other similarly oriented faults in this region, by sharply defined linear valleys and steep cliff faces on abruptly terminated formations. Near faults bedding strike is commonly parallel or subparallel with fault strike and bedding inclinations are steep. Breccia and quartz veins are locally associated with these faults.

A minimum age of 1200 m.y. for the northeasterly trending faults is provided by the Mackenzie diabase dykes which cross the faults without offset. Northwesterly trending sinistral strike-slip faults occur in the northwestern part of the map-area. The age of these relative to other faults has not been determined but it seems probable that their development was complementary to that of the northeasterly trending faults.

AGE AND CORRELATION

The Epworth Group is younger than 2600 m.y., the approximate age of the underlying Archean basement and older than 1760 m.y. the age of granite (8) that intrudes and metamorphoses strata along the western margin of the Epworth basin. It is therefore Aphebian in age. Although neither the Cowles Lake Formation nor the Takiyuak Formation are found in direct contact with the granite it seems reasonable to assume that all five formations of the Epworth Group were deposited prior to granite emplacement because all are conformable, and further, that intrusion and folding, probably accompanied by normal or thrust faulting, were roughly contemporaneous.

The Epworth Group has been correlated with the lithologically and stratigraphically similar Goulburn Group of the Bathurst Inlet region which lies east of the map-area (Fraser and Tremblay, 1969) and both these groups have been correlated with the Great Slave Supergroup preserved in the East Arm of Great Slave Lake (Hoffman, 1969). Subsequent analysis of lithofacies and sedimentary transport direction distribution patterns in these groups led to the inference of the Coronation Geosyncline, which in late Aphebian time, extended in a broad northerly trending arc from Great Slave Lake to Coronation Gulf (Hoffman et al., 1970). The Odjick Formation, dominated by easterly derived clastics, and the succeeding Rocknest Formation, composed mainly of stromatolite dolomite, belong to the pre-orogenic phase of geosynclinal development. The Recluse Formation composed mainly of westerly derived clastics, and the Cowles Lake Formation, composed predominantly of shelf carbonates and shales belong to the flysch phase. The Takiyuak Formation, made up of westerly derived immature clastics represents the molasse phase.

ECONOMIC GEOLOGY

No mineral deposits of economic potential are known to occur in the Epworth basin. Small concentrations of sulphide minerals have been noted in a few places however and the possibility that more extensive mineralization exists can not at present be rejected. Near Scotstoun Lake, for example, narrow amphibolite lenses in phyllite contain pyrrhotite and chalcopyrite along

strike distances of a few feet. West of Impostor Lake a vein of calcite containing pyrite and chalcopyrite follows the contact between a diabase dyke and dolomite for more than 100 feet and dolomite adjacent to a prominent northeasterly trending fault contains much disseminated pyrite. Northwest of Itchen Lake brecciated quartzite at the base of the Odjick Formation is veined by quartz and hematite and the adjacent granite basement contains disseminated chalcopyrite.

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