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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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COPPERMINE AND DISMAL LAKES MAP-AREAS

(Report and Maps 1337A and 1338A)

W. R. A. Baragar and J. A. Donaldson

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ABSTRACT

The copper potential of the area has been investigated many times, most recently in 1966-69, but none of the deposits discovered has yet proven to be exploitable.

Most bedrock is of Proterozoic age and includes sedimentary and volcanic successions, older granite intrusions, and upper Proterozoic gabbro and diabase sills.

Pleistocene deposits are widespread. Ice flow was generally from the southeast. Marine deposits that mark an advance of the sea in the immediate postglacial period are about 350 feet above present sea level.

RESUME

La région a été explorée à différentes reprises, et tout récemment en 1966-1969, en vue d'évaluer son potentiel en cuivre, mais aucun des gîtes découverts ne s'est révélé exploitable.

La majeure partie de la roche en place date du Protérozoïque et comporte des successions sédimentaires et volcaniques, des intrusions anciennes de granite et des filons-couches de gabbro et de diabase du Protérozoïque supérieur.

Les gîtes de l'âge du Pléistocène sont largement répandus. Le mouvement des glaces s'est fait en général par le sud-est. Les dépôts marins, indiquant une avance de la mer dans la période immédiatement postglaciaire, se trouvent à environ 350 pieds au-dessus du niveau actuel de la mer.

INTRODUCTION

Since Samuel Hearne's expedition (1769-1772) to the Coppermine River region in search of copper on behalf of the Hudson's Bay Company, the copper potential of the region has been investigated many times. During this century, five episodes of exploration are noteworthy: in 1911-12 by G. M. Douglas and A. Sandberg (Douglas, 1913); in 1929-31 by Northern Aerial Minerals Exploration Ltd. (N. A. M. E.) and Dominion Explorers Limited (Gilbert, 1931; Duncan, 1931; and Norrie, 1931); in 1943-45 by American Metals Limited (Jenney, 1954); in 1955-57 by Pan American Ventures and Pickle Crow Gold Mines Limited; and finally in 1966-69 by a large number of mining companies, most notably Coppermine River Limited and Hearne Coppermine Limited. Numerous copper prospects were located during these explorations, but none have yet proved to be commercially workable.

Previous geological work includes reports and sketch maps by Sandberg (Douglas, 1913), Gilbert (1931), Duncan (1931), Norrie (1931), and Jenney (1954) and a geological map of North-Central Mackenzie District at 8 miles to the inch by Fraser et al. (1960). The Muskox Complex, which is partly in the southern part of Coppermine map-area, has been intensively studied by Smith, Irvine, Findlay, Chamberlain, and others and their results reported in a number of publications, for example Smith et al. (1967), Irvine and Smith (1967), Chamberlain (1967), and Irvine (1970b).

The present map is the result of a helicopter-supported survey in the summer of 1969. Most traverses were spaced at intervals of 3 to 4 miles throughout the two map-areas and were supplemented by ground traverses in a number of critical areas. Previous work by the writers (Baragar, 1969; Donaldson, 1969) has been incorporated in the present map. The geology of the Muskox Complex was adapted from the detailed map of Smith et al. (1967).

Acknowledgments

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TABLE OF FORMATIONS

Eon	Era	Period or Sub-era	Group	Formation	Thickness (in feet)	Lithology
	Pleistocene					Marine silts
						Glacial deposits
	Paleozoic	lower Paleozoic (undefined)				Dolomite
		Cambrian?				Crossbedded, white quartz sandstone and conglomeratic siltstone
		Unconformity				
Proterozoic	Hadrynian		Coronation sills and dykes			Gabbro, diabase
			Intrusive contact			
			Rae Group		300 300 300 1,500 300 100 1,200	Dolomite Red and green shales; minor gypsum Massive sandstone Stomatolitic calcilutites, dololutites Shaly sandstone, siltstone, shale Red and green sandstone, siltstone, mudstone Sandstone, siltstone, shale
		Unconformity				
	Helikian	Neohelikian	Coppermine River Group	Husky Creek Fm.	4,000	Red sandstones, siltstones, and intercalated basalt flows
				Copper Creek Fm.	10,000	Plateau basalts and associated dykes and sills
			Dismal Lakes Group		900 600 600 400 1,000	Laminated dolomite Massive dolomite Laminated dolomite Tan-weathering dolomite, red mudstone Sandstone, intercalated black shale
		Unconformity				
		Paleohelikian	Muskox Complex Dykes			Ultramafic-mafic-granophyre; differentiated intrusion Diabase
			Intrusive contact			
			Hornby Bay Group		500 1,000 2,000 3,000	Sandstone; minor conglomerate Sandstone, siltstone, shale Dolomite Sandstone; minor conglomerate
		Unconformity				
	Aphebian		Echo Bay Group?		500	Porphyritic felsite
			Unconformable (and intrusive?) contact			
						Granites
			Intrusive contact			
			Epworth Group	Recluse Fm.	5,000	Greywacke, shales
				Rocknest Fm.	7,000	Dolomite, chert
				Odjick Fm.	5,000?	Sandstones, siltstones, shales
				Correlation with above uncertain		Phyllites, dolomites Pillowed metabasalts

GENERAL GEOLOGY

Rocks underlying the two map-areas span Proterozoic time. In the southeast corner of Coppermine area, Aphebian sedimentary and volcanic rocks of the Epworth Group are severely folded about north-northwest-striking axes. South of Dismal Lakes, massive granites and closely associated quartz-feldspar porphyries, presumably related to the Hudsonian orogeny, are overlain unconformably by gently folded sandstones and dolomites of the Helikian Hornby Bay Group. These in turn are overlain unconformably by Neohelikian dolomites, sandstones and mudstones of the Dismal Lake Group (newly defined), and by the conformably succeeding basalts and red sandstones of the Coppermine River Group. Both the Dismal Lakes and Coppermine River Groups dip chiefly northward at angles between 5 and 10 degrees, but a gently folded syncline is evident in places along the northern part of the Coppermine River Group. Thus, the succession possibly is repeated under the younger rocks farther north. Sedimentary rocks of the Rae Group (newly defined) succeed the Coppermine River Group unconformably and dip consistently northward at angles of 2 to 5 degrees. They are profusely intruded by the Coronation Sills (newly defined) which yield K-Ar dates ranging from 605 to 718 m.y. and are assumed to be Hadrynian in age. The Rae Group is overlain unconformably by essentially flat-lying Paleozoic limestones.

The Pleistocene geology of the region has been described by Craig (1960). Ice flow was generally from southeast to northwest and is recorded in numerous striae and _roches moutonnées_ throughout the areas. Two major swarms of drumlinoid ridges are recognized. One forms a broad arc that swings from a northwesterly trend in the fault wedge north of Dismal Lakes to westerly between the Coppermine River lavas and Richardson River. The other covers a broad area in the east-central part of Coppermine map-area and trends north-northwesterly. In both regions the bedrock geology is greatly obscured by these deposits. Marine deposits of white silt are present along the coast of Coronation Gulf and in the valleys of Rae and Richardson Rivers for much of the distance across Dismal Lakes map-area. They mark the marine advance of the immediately postglacial period and along Richardson River extend to about 117° 30'W where they stand at an elevation of about 350 feet above sea level.

DESCRIPTION OF FORMATIONS

SEDIMENTARY AND VOLCANIC ROCKS

Epworth Group

The Epworth Group occupies the southeastern corner of Coppermine map-area. Included within the group are metavolcanic rocks and meta-argillites formerly classed as Yellowknife Group (Fraser _et al._, 1960; Baragar and Donaldson, 1970).

Metavolcanic and metasedimentary rocks

The metavolcanic rocks (Unit 1) are uniformly green, moderately, schistose, metabasalts or possibly meta-andesites. They are commonly pillowed and locally are slightly feldspar-phyric. In thin section they are seen to be completely recrystallized to an assemblage of actinolite, sodic plagioclase, epidote-zoisite, chlorite, and sphene. Thus they are typically in the greenschist-facies grade of metamorphism. Just south of Melville Creek the metavolcanic rocks are intruded by a gabbroic mass of similar metamorphic grade which is probably part of the same assemblage.

Meta-argillites and associated phyllitic metasediments (Unit 2) are found on both sides of the strip of metavolcanic rocks but outcrop poorly and their relationship to the metavolcanic rocks is uncertain. Included with the metasediments are quartz-mica schists, slates and minor amounts of quartzite and dolomite. What appears to be a discrete dolomite layer (Unit 3) intervenes between the phyllites and metavolcanics along their eastern boundary in the southern part of the belt. The sediments are for the most part highly and complexly deformed.

Subsequent to original designation of the metavolcanic and metasedimentary rocks as Yellowknife Group (Fraser et al., 1960) Fraser and Tremblay (1969) reassigned them to the Epworth Group on the basis of further studies south of Coppermine map-area. The present writers originally classed these rocks as Yellowknife Group on the basis of lithology and their much more deformed and metamorphosed character compared with adjoining rocks. Subsequently Hoffman et al. (1971) concluded that they are eugeosynclinal equivalents of parts of the Epworth Group farther east. The abrupt change in deformation and metamorphism that takes place in passing from known Epworth to the metamorphosed belt is attributed to the presence of a "tectonic front" that separates the two facies of the geosynclinal deposits. We have tentatively reassigned the metavolcanics and metasediments to the Epworth Group in accordance with these views, and a fault (probably a fault zone) is placed between the metasediments and the relatively unmetamorphosed Recluse Formation immediately to the east.

Odjick Formation

The Odjick Formation (unit 4) is the oldest known unit in the area and appears in the cores of complexly folded anticlinoria. Its minimum thickness may be 3,000 to 5,000 feet, but because of the complexity of the structure and the lack of continuous observation, there is considerable uncertainty in these figures.

The rocks characteristically are poorly bedded, fine-grained, quartzitic sandstones and siltstones. Shales seem to be subordinate except locally. In the western anticlinorium the rocks are predominantly deep purplish red; in the eastern anticlinorium they are mainly grey or black. Crossbedding and intraformational conglomerate were observed at one locality in the western anticlinorium. Minor beds of dolomite are interlayered with the sandstones in a few places.

Correlation of the Odjick and the two succeeding formations of the Epworth Group with those in the type areas farther south is based upon reconnaissance mapping by Fraser et al. (1960) and the general similarity of lithology and stratigraphy with that described for these formations by Fraser and Tremblay (1969).

Rocknest Formation

The Rocknest dolomite (Unit 5) is about 7,000 feet thick near the eastern border of Coppermine map-area where it appears on the west limb of the eastern anticlinorium between the Odjick and Recluse Formations. Near its westernmost exposures a much less reliable minimum-thickness estimate of about 6,000 feet is obtained.

The rock is typically a thick-bedded (2 to 10 feet) dolomite, commonly with 10 to 30 per cent chert distributed in bedding layers and vein networks. In most places the dolomite is light grey and pale buff-weathering but in its westernmost exposures it is generally pink. Slump structures were noted in a few places, particularly in the western part of the formation. Stromatolite-rich zones are present throughout the area and evidently occur at many stratigraphic levels. In four widely separated localities, columnar stromatolites show distinct elongation in the plane of the bed; in three of these they are oriented in the direction 050 to 070 degrees and in the fourth, in a north-south direction. If these elongations represent current directions as interpreted by Hoffman (1969) for the Great Slave Group, and if such currents were related to ebb and flow of the tides, then north-northwesterly shoreline trends are suggested for this formation.

The dolomites rest conformably on Odjick sandstones and shales. In one place where the contact is visible they are finely interbedded for a distance of 20 feet. Within this distance the dolomite is pink and chocolate-weathering and near the contact with the underlying sandstones contains abundant jasper clasts.

Reclus̄e Formation

The Recluse greywackes and shales (Unit 6) are at least 4,000 to 5,000 feet thick on the eastern limb of a syncline along the upper Nipartoktuak River just south of the Dismal Lakes dolomites. Observations elsewhere are not sufficiently detailed to permit reliable estimates.

In the Coppermine map-area the Recluse Formation is characteristically composed of thick, massive greywacke beds with subordinate grey to black shale. It is nearly unmetamorphosed in most places. Greywacke beds range from 2 to 30 feet thick and are extremely massive. Commonly they are more than 10 feet thick and grading is inconspicuous. The rocks are coarse to medium grained, generally rich in potash feldspar, and most weather a pinkish buff colour. Black shales and slates compose less than half the rock in most places but may be dominant in the poorly exposed eastern parts of the map-area. Purplish shales that were observed in two places in the eastern synclinorium may be fairly extensive.

The Recluse Formation appears to succeed the Rocknest dolomites conformably.

Echo Bay(?) Group

Varicoloured felsites (Unit 7) cap several prominent hills south of Dismal Lakes. Most contain abundant phenocrysts of feldspar and quartz; lesser amounts of biotite, amphibole, and pyroxene occur in some varieties, particularly where the quartz content is low. The mafic minerals are altered in part to chlorite and epidote. Potash feldspar typically exceeds plagioclase, phenocrysts commonly are resorbed, some feldspars are megascopically zoned, and both broken and euhedral phenocrysts are abundant. Fresh surfaces range from brick red to pink and mauve; weathered surfaces tend to be light pink, pinkish brown or dull orange. Subhorizontal flow layering can be recognized in some exposures, but massive textures predominate. The colour variations appear to be due largely to content and oxidation state of finely disseminated iron oxides. The groundmass is typically aphanitic to very fine grained, and shows vague to well-defined textural differences suggestive of fragmental origin. In a study of similar and possibly correlative porphyries about 50 miles to the south in the Hunter Bay area, Mursky (1963) suggested an ignimbritic origin.

The porphyritic felsites together with associated, but in part older, granites (Unit A) form the basement of the Hornby Bay Group. Assuming that they are correlative with the porphyries of the Great Bear Lake region, an age of about 1750 m.y. is indicated for the rhyolites here described.

Hornby Bay Group

The name, Hornby Bay Group, was applied by Kidd (1932) to gently dipping beds of sandstone and conglomerate that rest on acidic volcanic rocks of the Echo Bay Group (possibly equivalents of the rhyolites and associated acid volcanic rocks of Dismal Lakes and Coppermine map-areas), along the shores of, and on islands in, Hornby Bay, Great Bear Lake. Fraser et al. (1960) extended the name to include not only correlative sandstones and conglomerates traceable from Great Bear Lake to Dismal Lakes, but also the overlying strata, mainly dolomite, up to the base of the Coppermine River Group. Because we have, on the basis of the present work, recognized an unconformity within the Hornby Bay Group as thus defined, we here propose redefinition of the Hornby Bay Group to include only the clastic rocks originally described by Kidd, plus those overlying strata that are in apparent conformity with them, i.e. up to the unconformity marking the base of the newly defined Dismal Lakes Group.

At the base of the group, exposed along stream cuts near the central part of the southern border of Dismal Lakes area, quartz-pebble conglomerates (not differentiated on the map) rest directly on felsitic volcanic rocks which show evidence of pre-Hornby Bay weathering. Within less than 20 feet, the conglomerates give way upward to sandstones (Unit 8) that contain only scattered lenses of conglomerate. Crossbedding is abundant, as are ripple-marks of both symmetrical and asymmetrical form. The basal conglomerates and associated sandstones are coloured deep red, largely due to hematite coatings around clasts; sandstones higher in the section are cream, buff, pink, and mauve. Because of the lack of marker beds, the total thickness of this unit cannot be accurately estimated, but it probably exceeds 3,000 feet.

Dolomite (Unit 9) of the Hornby Bay Group is exposed north and south of Lac Le Roux, south of Kendall River, and between Dismal Lakes and Lac Rouvière. In the latter area, the dolomite is seen to lie with apparent conformity over the sandstone, but in the other three areas, faulting and folding have obscured relationships. Particularly complex folding and chaotic brecciation in the exposure adjacent to Kendall River is suggestive of significant soft-sediment slumping rather than tectonic deformation.

The Hornby Bay dolomite is predominantly light grey, and weathers yellowish buff to buff grey. Exposures typically are well bedded to thinly laminated. Layers and irregular nodules of chert, as well as beds of oolites, intraformational conglomerates, and stromatolites, are common. Among the stromatolite varieties are laterally linked domal types of low amplitude, oncolites, unbranched columns, and large domes containing digitate microdomes less than 4 cm in diameter. Total thickness of the dolomite unit is about 2,000 feet.

Conformably overlying the dolomite are 1,000 feet of well-bedded but poorly exposed intercalations of fine-grained sandstone, siltstone, and shale (Unit 10). The sandstone beds typically contain fragments of the shales and both ripple-marks and desiccation cracks are abundant. Most exposures are maroon to deep red, but some beds are locally pale green or mauve. These beds give way to a further 500 feet of massive white to buff quartzose sandstone with minor conglomerate interbeds (Unit 11) similar to the lower unit (Unit 8) of the group.

Dismal Lakes Group

The name "Dismal Lakes Group" is here proposed for Proterozoic strata which unconformably overlie the redefined Hornby Bay Group, and which are conformably overlain by basalts of the Coppermine River Group. Although the basal unconformity is not exposed, its existence is indicated by structural relationships north of Lac Rouvière, and by abrupt truncation of Hornby Bay strata east of Coppermine River.

The basal unit (Unit 12) consists for the most part of buff to white quartzose sandstones containing rare quartz-pebble layers. Sandstones in the lower part are mainly thick bedded and medium- to coarse-grained; stratigraphically higher they are finer grained, well bedded, and commonly are crossbedded.

The upper part of the basal sandstone unit (Unit 12) grades to a distinctive member consisting of white sandstone beds of similar lithology, rhythmically intercalated with black carbonaceous shales. Beds range from 1 to 10 cm and are lenticular to tabular. They are replete with desiccation and vermiform structures. The latter, where examined in detail, appear to have formed by soft-sediment injection along fractures that range from sinuous to polygonal, as seen in sections parallel to bedding.

Red mudstones overlain by tan-weathering dolomite are grouped together as a single map-unit (Unit 13). These lithologies are poorly exposed because of susceptibility to weathering, but nevertheless can be traced through areas of shallow drift by distinctive coloration of the soil, and in places, by frost-heaved blocks. Bedding is slabby to platy. Ripple-marks, desiccation cracks and small-scale crossbedding are abundant, as are casts of halite. Bladed pseudomorphs that appear to be after gypsum, are locally abundant in the tan-weathering dolomite.

The overlying buff- to light grey-weathering dolomites (Units 14, 15, 16), composing a section at least 2,100 feet thick, are the most continuous and best exposed strata of the Dismal Lakes Group. These units, recognized earlier in the vicinity of Dismal Lakes (Donaldson, 1969), have now been traced across the two map-areas.

The lower member (Unit 14) is well-laminated and contains abundant zones of chert nodules and lenses, intraformational conglomerates, oolites, oncolites, and stromatolites. Most of the stromatolites are laterally linked domal varieties of low amplitude. Rare beds of black shale and beds that contain "molar tooth structure" form distinctive markers. In some sections parallel to bedding, the latter structures show polygonal patterns suggestive of an origin related to desiccation.

The thick-bedded central member (Unit 15) exhibits massive weathering, with bedding most readily observed well back from the outcrop. Distinctive conical stromatolites are abundant, but other varieties occur, especially domal and bulbous forms, which are most abundant in the lower part of the member.

The upper member (Unit 16) is similar to the lower laminated member in a variety of primary structures: intraformational conglomerates, oolites, oncolites, stromatolites, ripple-marks, crossbeds, and desiccation structures. Chert nodule zones and black shale beds also form distinctive markers. The stromatolites show a greater variety, with both domal and columnar-branching forms occurring in mappable units. The contact with the overlying Coppermine River basalt is sharp, with little or no metamorphic effect other than a slight bleaching to form local chalky layers. East of Coppermine River, a thin septum of bedded carbonate occurs within the lavas in apparent conformity with, but about 30 feet above, the main contact. The intervening basalt appears to be a flow rather than a sill, and hence the occurrence seems to record a brief renewal of sedimentation following an initial surge of volcanism in this area.

Coppermine River Group

This group comprises a lower volcanic formation, approximately 10,000 feet thick, and an upper, mainly sedimentary formation with a minimum thickness of 4,000 feet. The group dips generally northward at angles of 5 to 10 degrees. Its upper limit is the unconformity that separates it from the overlying Rae Group. This is a redefinition of the original Coppermine River Series named by Sandberg (Douglas, 1913; O'Neill, 1924) which included both Coppermine River and Rae Groups as defined in this report. The type section of the redefined Coppermine River Group is a north-south section at approximately 115° 45W which includes the excellent exposures of the sedimentary division along Coppermine River.

Copper Creek Formation (Unit 17)

The Copper Creek Formation is named for a small creek on the north side of Coppermine River that is approximately on the type section of the Coppermine River Group. It consists of about 150 flows with thicknesses ranging from 10 to 300 feet. Most flows are in the range 25 to 75 feet thick. The flows are plateau basalts that maintain nearly constant thicknesses for many miles. Individual flows are typically composed of a massive base and a highly amygdaloidal top, commonly in a ratio of about 3 or 4 to 1. The base is formed of little-altered black or grey basalt. Upward it grades into a reddish altered top rich in amygdules of red orthoclase, calcite, epidote, and chlorite.

The basalts are chiefly saturated tholeiites and are generally microporphyritic. They were previously divided, on the basis of lithology, into lower, middle, and upper members (Baragar, 1969). Subsequent experience has shown that only the lower member can be consistently recognized in the field and, therefore, the division into middle and upper members should be abandoned as a field distinction.

The lower member is commonly about 2,000 feet thick but may be much less. It is distinguished from the rest of the lava sequence by the presence of sparse phenocrysts 1 to 2 mm long, of augite, still lesser amounts of plagioclase, and rare orthopyroxene or pigeonite. The upper flows contain no macrophenocrysts but are otherwise very similar and generally contain microphenocrysts of augite, plagioclase or both.

The flows are composed essentially of plagioclase, pyroxene, and magnetite. Minor interstitial potash feldspar is generally present and in places, quartz is also present. Small pegmatitic segregations in the upper parts of some flows are enriched in potash feldspar, iron oxides, and quartz. Native copper is a very minor constituent of many flows in the middle and, particularly, upper parts of the succession but it has not been found in the lower member. It occurs both in tiny amygdules and in intimate association with the rock-forming minerals and undoubtedly is a primary constituent of the rock. Sulphide minerals are essentially absent.

Most basalts are altered to some degree; plagioclase is generally moderately saussuritized but pyroxene is mainly fresh; magnetite is invariably partly hematized, no doubt because of its reaction with the atmosphere at the time of extrusion.

Pyroclastic rocks have been seen in a few places but form a negligible part of the entire assemblage. A thin pillowed flow observed in two widely separated places low in the stratigraphic succession testifies to at least one episode of submarine eruption but the overwhelming proportion of flows are subaerial.

The geochemistry of the lavas has been described previously (Baragar, 1969).

Thin beds of red sandstone are intercalated with the lavas of the Copper Creek Formation, particularly in its upper part, but because of their susceptibility to erosion they rarely outcrop. Drillholes reveal a few inches to a few feet of fine-grained red sandstone at a number of flow contacts and it can probably be assumed that sedimentary interlayers are fairly common in the formation. Nevertheless, the rate of eruption was sufficiently high during accumulation of the lower part of the Coppermine River Group that deposition of interflow sediments was negligible.

The age of the Copper Creek flows is about 1200 m.y. Potassium-argon ages range from 740 to 1200 m.y. but have probably been updated during intrusion of the Coronation Sills. A Rb-Sr isochron gives an age of 1210 m.y. A full discussion of the age of the flows is given by Baragar _in_ Wanless and Loveridge (in preparation).

Husky Creek Formation (Unit 18)

This formation is named for Husky Creek which flows into Coppermine River from the west. The name is of geographic significance only as the type section is along Coppermine River. The formation typically consists of crossbedded red sandstones and siltstones with subordinate intercalated basalts. The sediments are mostly friable and rarely outcrop except along Coppermine River and beneath cappings of lava.

In thin section they are seen to consist of angular to subrounded grains of quartz and chert (15 to 30 per cent), rounded to ellipsoidal grains and granules of hematite (10 to 30 per cent), carbonate grains and cement (20 to 50 per cent), chlorite, plagioclase, and murky indeterminate material.

The red sandstones are partly contemporaneous with Coppermine River flows but were deposited principally during the declining phase of volcanism and overlie the major part of the volcanic deposits. Intercalated basalt flows, mainly in the upper part of the red bed succession, are generally similar to those forming the bulk of the volcanic deposits in the Copper Creek Formation.

Rae Group

The name "Rae Group" is here proposed for Proterozoic strata that overlie the redefined Coppermine River Group and which are in turn unconformably overlain by Paleozoic strata. The Rae Group thus includes the homoclinal, gently northward tilted, sequence of sedimentary rocks, that overlie the unconformity, and which were formerly included in the Coppermine River Group.

Because of extremely poor exposure, a type area rather than a continuous type section is designated. Discontinuous sections within the eastern part of Dismal Lakes map-area and the western part of Coppermine map-area have been combined to provide a composite section of seven as yet unnamed units. Total thickness of the Rae Group is at least 4,000 feet.

The lowermost unit (Unit 19) consists of fine-grained, greenish grey and greyish brown sandstone interbedded with dark grey to black shales. Beds show ripple-marks, crossbedding and less commonly, graded bedding. Load casts and flow casts occur as do intraformational shale fragments. Some beds are glauconitic, some contain abundant sulphide crystals and nodules, and some contain small amounts of disseminated chalcocite.

Next in the succession is a distinctive unit (Unit 20) of red and green sandstone, siltstone, and mudstone. This unit is thinly laminated, locally crossbedded, and in places is ripple-marked. The coloration ranges from bedding controlled and alternated on a scale of a few centimetres, to highly irregular and variegated. Beds are typically soft and friable.

Rusty and greenish grey to black shaly sandstone, siltstone, shale, and argillite (Unit 21) overlie the red and green shales and closely resemble the basal unit in lithology. Some beds are lenticular, but most are tabular, particularly the soft and fissile shales, which tend to split readily into thin flat sheets. Calcareous beds occur near the base of the unit, but typical sandy beds are fine grained and quartzose. Most sandstones and argillaceous beds are rhythmically alternated in units less than 5 cm thick, and some adjacent sandstone and shale layers form graded couplets. Ripple-marks and crossbedding are abundant, most ripples being asymmetric and internally crosslaminated. Load casts and flow casts occur at the base of some beds.

The middle calcareous unit (Unit 22) is composed of well-bedded calcilutites and dololutites. Beds typically are tabular, and marked by partings spaced at 1 to 5 cm intervals. Faint laminations are common, as are stylolites parallel to bedding. Fresh surfaces are white, light grey, or bluish grey; weathered surfaces are light grey, white, and buff-grey. Layers and lenses of chert occur in the upper part, and minor pale green serpentine is developed near contacts with the sills. Zones of stromatolites are locally abundant, particularly in the upper part of the section. Laterally linked domal, and discrete branching-columnar varieties predominate in these zones. Towards the top, black shale layers a few centimetres thick occur as interbeds spaced at three- to six-foot intervals. Transition to the overlying sandstone unit is marked by interbedded black and grey siltstones and platy white sandstone. Intraformational conglomerates, ripple-marks, and crossbedding are common throughout the calcareous unit.

The sandstone unit (Unit 24) is remarkably massive, forming beds more than one metre thick in which lamination is difficult to detect. Typical sandstones of this unit are quartzose, medium-grained, moderately well-indurated, and display prominent blocky jointing. Both fresh and weathered surfaces are dull pink to pale brown. Ripple-marks and crossbeds are the main sedimentary structures. The Rae River is confined on the north by scarps of this unit.

Red, green, and rusty-weathering shales, siltstones, and fine-grained sandstone (Unit 24) overlie the massive sandstones. These rocks are characterized by undulatory bedding and platy to flaggy fissility. Ripple-marks and desiccation cracks are abundant in some beds. Brown-weathering dolomite containing columnar-branching stromatolites occurs near the base of the unit. Halite casts and beds of massive orange gypsum occur locally; these may be more abundant than suggested by outcrops.

The uppermost exposed unit (Unit 25) of the Rae Group projects from beneath Paleozoic cover in two salients north of Rae River: near Richardson Bay in the Coppermine area, and northeast of Cox Lake in the Dismal Lakes area. At least 300 feet thick, this carbonate unit characteristically is cream-buff on fresh surfaces, yellowish buff on weathered surfaces and is platy- to flaggy-bedded. Thin siliceous ribs and zones are responsible for a rough weathered surface, and minor hematite stains follow some thin fractures. Vermiform to polygonal desiccation structures are abundant, and some intraclastic layers contain sparse quartz grains.

Paleozoic

Sandstone

Several isolated patches of unfossiliferous quartzose sandstone (Unit 26) that occur in the Dismal Lakes area are tentatively classified as Cambrian (?). They possibly are Precambrian, but if so are at least post-Rae Group, as is indicated by relationships of the largest outcrop, which rests as a flat-lying plate overlapping the contact between Coppermine River volcanics and Rae Group sediment, about 5 miles northeast of Bornite Lake. Smaller patches occur in the fault-bounded wedge about 6 miles south of Bornite Lake, and adjacent to the north-trending fault immediately west of Hope Lake.

Similar sandstones do not directly underlie known Paleozoic rocks north of Richardson River, and thus the sandstone patches could equally well be younger than Cambrian. They do however lithologically resemble known

Cambrian rocks (Fraser et al., 1960) in the Hornaday River Basin. The sandstones in both areas range from friable to very well indurated, commonly are medium- to coarse-grained, and in most places show abundant crossbedding.

North of Rae River, and unconformably above sediments of the Rae Group and associated sills, are flat-lying dolomites (Unit 27) of lower or middle Paleozoic age. No fossils were found in place, but middle Devonian fauna have been collected from strata higher in the section (Fraser et al., 1960).

The Paleozoic rocks are well exposed in flat ledges that rise gently northward beyond the map-area. Typical exposures are platy to flaggy bedded and commonly show indulatory or lensoidal bedding. Fresh surfaces range from greyish buff to pinkish buff and rarely cream-white; weathered surfaces are buff to yellowish buff. Dololutites predominate, but this lithology has been extensively reworked to form distinctive intraclastic beds, especially in association with beds that contain abundant ripple-marks and desiccation cracks. Vuggy beds occur, particularly in somewhat finely crystalline sections, and zones of laterally linked, low-amplitude domal stromatolites were observed in several exposures.

INTRUSIVE ROCKS

Granitic Rocks

Granitic rocks (Unit A) outcrop mainly in the area south of Dismal Lakes, forming hills of rugged aspect. As noted previously, these rocks form the basement to the Hornby Bay Group, but their relationship to the pre-Hornby Bay volcanic rocks is less clear. Although some acid flows appear to rest unconformably on the granitic rocks, exposures indicating such a relationship are rare, and because the granitic rocks undoubtedly are of several ages, some granitic bodies may be post-volcanic. South of the map-areas, detailed studies by Mursky (1963) suggest that similar granites are the intrusive equivalents of ignimbritic flows that possibly are correlative with the acid flows of Coppermine and Dismal Lakes map-areas. Such a genetic relationship is supported by relationships near Rocky Defile Rapids on Coppermine River, where gradations between flow-like felsites and phanerocrystalline granitic rocks are common. However, felsite dykes do cut the granites, and no exposures of the reverse relationship (aplites or pegmatites transecting the felsites) have yet been observed.

Although the granitic rocks range from granite to diorite, the most abundant rock type appears to be leucocratic granodiorite. Massive to slightly foliated varieties predominate, blocky jointing is characteristic, and typical exposures are medium to coarse grained. Some bodies are porphyritic, containing large phenocrysts of potash feldspar. The ferromagnesian minerals are mainly amphibole, biotite, and to a lesser extent, chlorite. Amphibole is particularly abundant in syenitic phases that occur immediately northeast of Lac Rouvière. Pink to dull red colours are common, the coloration being due more to hematite staining than to an abundance of potash feldspar.

Muskox Complex and Associated Dykes

The geology of the Muskox Complex shown on the map is adapted from Smith et al. (1967) with only three generalized subdivisions shown: the predominantly ultramafic, mafic, and granophyric units (Units B, C, D respectively). According to Irvine (1970a) the Muskox Complex was emplaced beneath not more than 4,000 feet of Hornby Bay sandstones, and prior to deposition of the Dismal Lakes dolomite. Emplacement of the intrusion probably occurred at the time of, or close to, disturbance of the Hornby Bay sandstones that resulted in the unconformity at the base of the Dismal Lakes Group. Thus, the Muskox Complex is somewhat older than the Coppermine River flows.

Northwest-trending dykes that intrude the Epworth Group are of at least two ages: an earlier set that are displaced by the northeast-trending faults and a later set that are not. At least some of the earlier dykes do not intrude the Dismal Lakes Group and must, therefore, pre-date the unconformity. The set of very thick dykes that lie along the boundary between the Recluse and meta-argillite formation to the west is an example. Such dykes are probably of the same age as the Muskox Complex. They are moderately metamorphosed gabbros (partly saussuritized plagioclase and relict pyroxene) in contrast to the mainly fresh diabase that comprises the latter dykes. Because ages cannot be established for all dykes, they are shown by a single symbol (Unit E).

Intrusions Contemporaneous With Coppermine River Flows

Intrusions (most of Unit E) contemporaneous with Coppermine River flows include dykes, a large sill within the lavas just east of the bend in Coppermine River, and the group of sills intrusive into the Dismal Lakes Group northwest of the Muskox Complex.

Dykes of this age penetrate the Dismal Lakes Group and die out within the volcanic assemblage. Like the earlier dykes, they have a north to north-northwest trend. Both sets of dykes are part of the Mackenzie swarm and despite the unconformity that separates them, must be of very similar age. Paleomagnetic pole positions for the Muskox Complex, the Coppermine River flows (Robertson, 1969), and the Mackenzie dykes (Fahrig *et al.*, 1965) are very similar, and the age of the Muskox Complex (about 1200 m.y. – T.N. Irvine, personal communication) and the Coppermine River flows (1210 m.y. – Baragar, *in* Wanless and Loveridge, in preparation) are essentially the same. The dyke swarm spreads across the two map-areas but is most concentrated in a belt, about 30 miles wide, that lies along the axis of the Muskox Complex.

The gabbroic mass interlayered with Coppermine River flows east of the bend in Coppermine River is assumed to be an intrusive phase of the flows. However, its boundaries are not well defined and it could equally well be a very thick, ponded flow. In its northern part it may interfinger with the flows, for in places fine- and coarse-grained rocks appear to alternate. Its age is uncertain but a single pair of oriented samples show a paleomagnetic pole position that falls within the same grouping as that of the flows; hence it is assumed to be the same age. The "sill" is about 900 feet thick just north of the bend in Melville Creek and is well differentiated. Near its base it is distinctly layered. Olivine, enclosed in hypersthene and plagioclase, forms about 20 to 25 per cent of the rock. Augite is an additional major constituent. In its upper part, particularly near the hook-shaped lake shown on the map, the "sill" is a coarse-grained granitoid rock. In thin section it can be seen to contain elongate, twinned augite, plagioclase, coarse subophitic iron oxide, and much interstitial potash feldspar, apatite, and chlorite. A distinctive rock, assumed to be a chilled phase of the "sill", was seen at two widely separated places along its lower contact. It is a black, devitrified glass crowded with white, skeletal plagioclase crystals. Other phenocrysts are augite, orthopyroxene, and pseudomorphs of possibly olivine.

The sills that intrude Dismal Lakes sediments northwest of the Muskox Complex form a coherent group of distinctive appearance. They are generally less than 50 feet thick and are chiefly of dark dolerite marked by the presence of abundant ilmenite plates, 2-4 mm across. Finely textured interstitial micropegmatite is typically present and may form as much as 15 to 20 per cent of some of the rocks. One of the sills is composed of a highly altered, buff-coloured rock that, in thin section, appears to have consisted of extremely elongated pyroxene phenocrysts in a groundmass of plumose feldspar and interstitial quartz. These dolerites, which cut the Dismal Lakes Group and are cut by the later dykes, must be essentially contemporaneous with the Coppermine River flows, yet are petrographically dissimilar. The iron oxide is predominantly ilmenite in contrast to magnetite in the Coppermine River flows and the alkali feldspar content is markedly higher. The relationship between the two sets of rocks is not clear.

Coronation Sills

Sills that intrude the Rae Group sediments are here named the Coronation Sills (Unit F) after Coronation Gulf where they prominently appear as islands and cuesta ridges. Fifteen separate sills can be recognized in the Coppermine map-area and nine in the Dismal Lakes map-area. They dip northerly at 3 to 5 degrees and because of the shallow dips, their thicknesses are not easily measured. Most sills appear to be between 150 and 400 feet thick; an estimate of their aggregate thickness at the west end of Coronation Gulf is 4,200 feet. They cap south-facing escarpments, ranging from a few tens of feet to 400 feet high, in the lower parts of which substantial sections of the easily eroded Rae Group sediments are preserved.

The sills are composed of fresh tholeiitic dolerite containing a few per cent olivine, or pseudomorphs of olivine. They show little evidence of differentiation either within or between sills.

The age of the sills in these and adjoining areas ranges from 604 m.y. to 718 m.y. and averages 647 m.y., as determined by K-Ar method (Wanless et al., 1966, 1970). Their paleomagnetic pole position (Robertson and Baragar, in press) is that of the Franklin Magnetic Interval (Fahrig et al., 1971) to which the latter authors assign a mean age of 675 m.y.

Dykes related to the Coronation Sills occur in three places in Coppermine map-area: just south of Richardson River, along Coppermine River about 15 miles from the coast, and near the mouth of Nipartoktuak River. In two of these localities the dykes approximately parallel the trend of the Mackenzie swarm. Three prominent north-northwest-trending dykes that cut sediments and volcanics of the upper Coppermine River Group may also be of this age. All these dykes have been included in Unit E for mapping purposes.

STRUCTURAL GEOLOGY

The Epworth Group has been moderately to severely folded along north-northwest-trending axes. The folds plunge generally northward but do not appear to be consistently overturned to either east or west. Some strike faults have been recognized within the sequence, others have been interpreted on the basis of stratigraphic relationships, and many more can be suspected.

Hoffman et al. (1970) interpreted the structure of the Epworth Group in terms of its geosynclinal and orogenic relationships. In their view, two zones would be recognized in these map areas: a folded décollement zone (the eastern zone of recognizable Odjick to Recluse strata) and a tectonite or eugeosynclinal zone (the western zone of volcanics and phyllites). East of the map-areas is a third zone characterized by gently folded Epworth strata in structural continuity with the basement. These zones represent belts of successively more intensive deformation from east to west. Together they form a segment of the Coronation geosyncline (Hoffman et al., 1970). The granites and porphyries of Dismal Lakes map-area would be part of the orogenic core of the belt according to this view.

Only minor deformation succeeded the Hudsonian orogeny in these map-areas. Hornby Bay sediments were gently folded before deposition of the Dismal Lakes Group. Farther west they are more severely deformed, possibly in reponse to orogenic forces acting in the Helikian eugeosyncline of the Cordilleran region, as postulated by Fraser et al. (1970). Following this deformation, the Muskox Complex and associated dykes were emplaced.

The Coppermine River Group was gently warped along what may be a northeasterly-trending axis manifested now by synclinal axes in the red bed succession, a few miles west of Coppermine River, and in a fault block within the volcanic succession west of the Herb Dixon fault. Very gentle northward tilting followed deposition of the Rae Group.

At least three ages of faults can be recognized within the map-areas. The oldest are strike faults within the Epworth Group. They are followed by the northeasterly-striking faults which cut the Epworth Group with marked right-lateral offset. These displace only some of the north-northwest-striking dykes, and thus appear to have formed within the time span of the Mackenzie magmatic event (Fahrig and Jones, 1969). Northwest-striking faults that cut Epworth volcanics and phyllites may be of the same age. The youngest faults are those which cut the Coppermine River Group but not the overlying Rae Group. The most notable of these are the Herb Dixon and Teshierpi faults in the vicinity of Dismal Lakes, but they include numerous other faults within the Coppermine River Group. One of them, the Canoe Lake fault, severely dislocated part of the Muskox Complex but displaces the base of the Coppermine River flows very little. It may be related to the second group of faults and was reactivated following emplacement of the flows (Irvine, 1970a). Both the second and third groups of faults may be related to tectonic activity that accompanied the Mackenzie magmatic event.

A fourth, still younger set of faults may be present. The sandstones occurring in isolated remnants within the area of the Coppermine River Group and interpreted as Cambrian (?) seem to be partly fault-bounded. If so, and if the interpreted age of the sandstones is correct, such faults would be of Phanerozoic age.

Of special interest are the Herb Dixon and Teshierpi faults which appear to drop a wedge of lavas some distance into the underlying rocks.

Many copper prospects have been found within this wedge and the major copper deposit of the region, the "47 Zone", occurs along the Teshierpi fault. The latter offsets the base of the Coppermine River Group about 25,000 feet, but dies out in the red sediments in the upper part of the group. The movement of the fault wedge may be largely rotational. A counter-clockwise rotation of the wedge of 2 degrees, relative to the southeast wall, would be sufficient to produce the offset shown but would be all but indistinguishable in the dips observed on either side of the faults.

ECONOMIC GEOLOGY

Copper is the only metal of economic significance yet found within the map-areas. It occurs within the Coppermine River lavas and in the basal beds of the overlying Rae Group.

In the lavas, copper is present as sulphides, principally chalcocite and to lesser extent bornite, and as native copper. The sulphides are predominantly in fractures, but native copper is mainly a primary constituent of the lavas.

Most copper prospects have to date been found in the upper parts of the volcanic succession where the lavas themselves are richest in copper (Baragar, 1969). Allan (1971) found that the higher copper content of the upper lavas is reflected in the copper content of surface waters and thereby suggested a new technique for prospecting the flows. The major copper deposits found to date are the "47 Zone" of Coppermine River Limited reported to have reserves of 4.16 million tons grading 2.96 per cent copper and the "June Deposit" of Bernac Coppermine Exploration Limited with reserves of 1 million tons grading 2.5 per cent copper (Kindle, 1970). Both deposits are in fracture zones associated with major faults and the ore mineral is principally chalcocite. The locations of these deposits are shown on the map. Descriptions of the various types of deposits and of individual prospects within the flows are provided by Kindle (1970), Kindle and Kirkham (1970), and Thorpe (1970).

Native copper is present as tiny disseminated particles as fillings of amygdules and in minute veinlets within the lavas. An extraordinary type of occurrence observed in a few places is the association of native copper with small sedimentary dykes, generally less than 2.5 cm wide. In each case the native copper was seen to be concentrated in the lava along the margins of the dyke but not within the dyke itself. Occurrences of native copper such as these do not offer much promise for commercial development. However, at least one possibility exists. In a number of flows the particles of native copper can be seen to be concentrated near the base of the flow, probably as a result of gravity settling. This is particularly evident in one flow about 3 miles north of Hope Lake where a specimen from the basal part of the flow assayed 0.1 per cent copper. Presumably a sufficiently thick flow with the same average tenor of copper could produce a commercially workable deposit along its base by the settling of copper particles.

Copper occurs in at least two localities at the base of the Rae Group: on Coppermine River and 10 miles west of Coppermine River. It is in a dark shale or siltstone member within a few feet above the unconformity at the base of the group and is mainly present as chalcocite, bornite, and some chalcopyrite. These occurrences have been described in detail by

Thorpe (1970, p. 138) and Kirkham (1970, p. 57). They are not of economic importance at present but they do focus attention on the basal part of the Rae Group as a possible guide to future exploration for sedimentary copper deposits. Unfortunately the unconformity is heavily drift covered throughout most of the two map-areas.

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