GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

JOHN D. GODFREY

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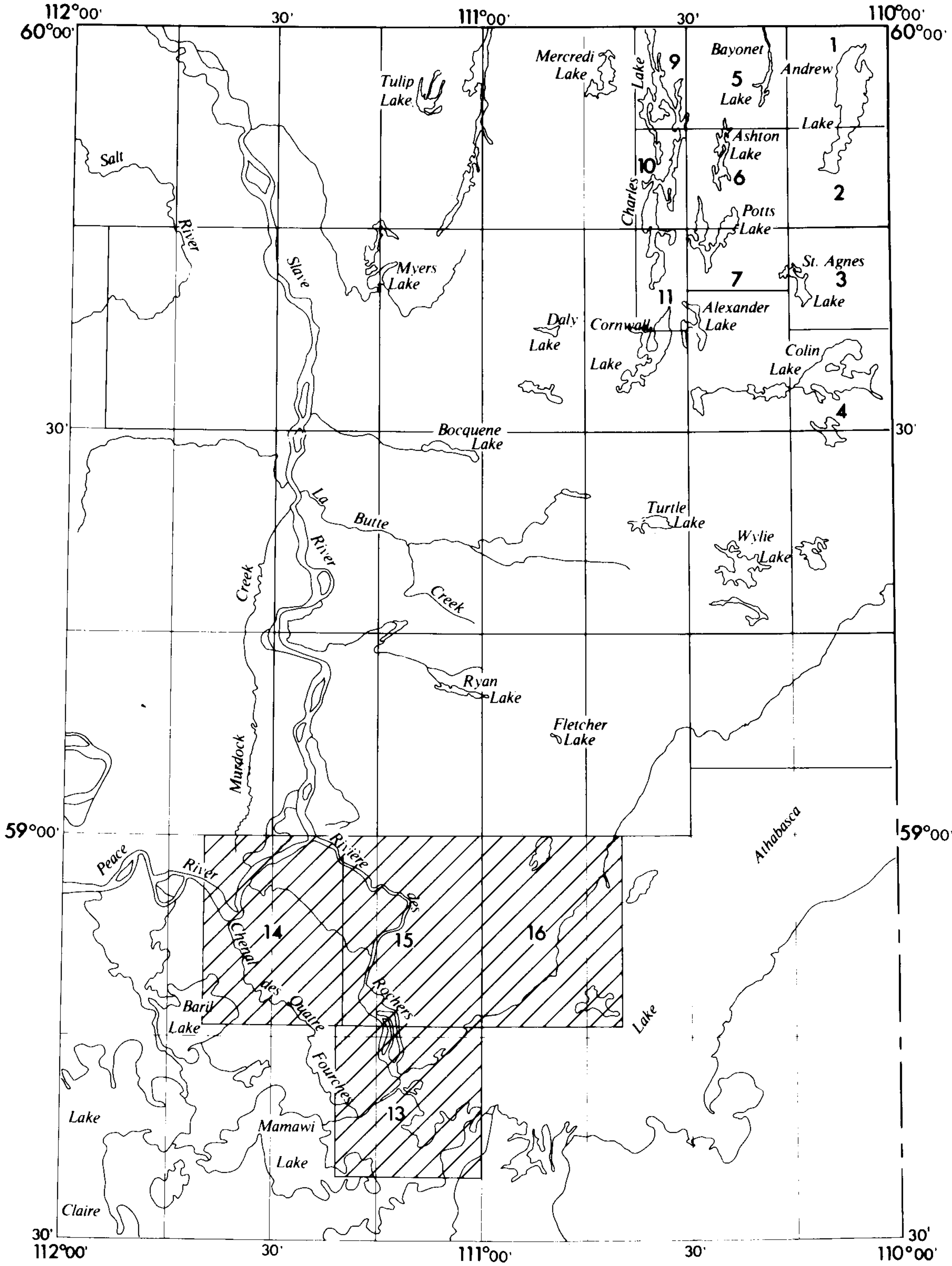


FIGURE 1. Location of Map Area, Maps 13, 14, 15, 16, Geology of the Fort Chipewyan District, and index to previously published map sheets.

GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

ABSTRACT

The geology of 432 square miles (1110 km^2) of Precambrian Shield in northeastern Alberta is presented on four map sheets at a scale of 2 inches to 1 mile.

Eleven main rock groups or rock types, and several sub types, are distinguished on these maps. Their characteristics, both in outcrop and in hand specimen, are described and modal and chemical analyses of representative, standard samples are presented.

The Precambrian Shield exposed in northeastern Alberta forms part of the Churchill Structural Province, the oldest (age-dated) rocks being of Archean age. The Archean rocks formed under granulite metamorphic conditions, and subsequently were overprinted by amphibolite conditions imposed during the Hudsonian (orogenic) Event. Granitoid rocks were intruded during the Aphebian under amphibolite metamorphic facies conditions. A late Hudsonian retrograde greenschist facies metamorphism affected all Shield rocks exposed in Alberta.

The oldest rocks consist of a basement migmatite complex of para- and ortho-gneisses which was later intruded by several granitoid plutons. This basement complex probably represents multiple cycles of sedimentation, intrusion, deformation and metamorphism. All rock units in the basement complex and younger granitoids have been affected by either plastic or brittle deformation. A regional mylonitic fault zone cuts the basement complex parallel to the predominant northeasterly structural trend within the map area.

The gneissic basement complex and younger granitoids are overlain (unconformably?) by low-grade metasedimentary rocks of the Burntwood Group of probable late Aphebian age. The shoreline of Lake Athabasca in the Fort Chipewyan area approximately coincides with the erosional edge of unmetamorphosed sandstones of the Athabasca Formation (Helikian age), the youngest consolidated rocks to crop out in the map area.

Minor sulfide and uranium mineral showings are primarily related to bands or lenses of high-grade metasedimentary rocks within the basement complex.

INTRODUCTION

This report deals with the geology of a portion of the 3600 square miles (9300 km^2) of Precambrian Shield in northeastern Alberta, north of Lake Athabasca. It describes the general geology and mineral occurrences in 432 square miles (1100 km^2) of the most southerly part of this area of exposed Canadian Precambrian Shield.

LOCATION AND ACCESS

The study area immediately adjoins the settlement of Fort Chipewyan in northeastern Alberta (Fig. 1) and is shown on four 1:31,680 scale map sheets, all of which are within NTS map area 74L. The map area lies between latitudes 58° 36'N and 59°N and between longitudes 111° 40'W and 110° 40'W.

The map area is accessible through Fort Chipewyan which is linked to Edmonton, Alberta by regularly scheduled airline service.

PHYSIOGRAPHY

Elevations in the study area range from 700 feet (210 m) (Lake Athabasca water level) to just over 1000 feet (330 m) above sea level. Scouring by Pleistocene glaciers has left numerous rock-basin lakes, low-rounded hills, and a locally rugged surface having a maximum relief of about 250 feet (80 m). Evidence indicates two directions of ice advance in the area; the main continental advance (Wisconsin) was from the east possibly followed by a local readvance from the northeast. Glaciofluvial sandy plains, kames, crevasse fillings, and outwash deposits (Bayrock, 1972) are particularly abundant in the eastern part of the map area and have been utilized as a source of sand and gravel for construction purposes.

In northeastern Alberta, the surface of the Precambrian Shield slopes gently towards the west and is overlapped by Paleozoic limestones and dolostones west of the Slave River. The Paleozoic rocks generally underlie low ground and are covered in part by recent freshwater deltaic sediments of the Peace and Athabasca Rivers. The extensive Peace-Athabasca delta area is characterized by numerous muskegs, lakes, and both active and inactive distributory channels. Under high-water conditions the Peace River partly flows southeast through its delta distributory channels into Lake Athabasca. At other times, the delta drains northwards from Lake Athabasca through several channels that connect with the north-flowing Slave River. The eastern part of the low-lying Peace-Athabasca River delta surface is interrupted by protruding, steepsided, rounded knobs of Precambrian rock.

Precambrian bedrock crops out over approximately two thirds of the map area, with the highest elevations found along a subdued ridge which trends approximately northeast, just inland and parallel to the northwest shoreline of Lake Athabasca. Within the Shield terrain the distribution, sizes, and shapes of lakes are primarily related to bedrock structural and lithological features which have influenced erosion by glaciers and minor streams. Many narrow, elongate bays owe their origin to the erosion of fault zones, and straight portions of lake shorelines suggest fault-line features, especially where they are transverse to the local metamorphic foliation. Fracture zones and mechanically weak metasedimentary rocks tend to have been selectively plucked out by glacial erosion, particularly on west and south lakeshores, thereby giving rise to irregular shorelines. Exceptionally clean, unweathered bedrock surfaces are found along the shorelines bordering many rock-basin lakes, and are suitable places for the detailed examination of bedrock geology.

PREVIOUS WORK

J.B. Tyrrell (1896) made the initial geological traverse along the north shore of Lake Athabasca in 1892 and 1893, and subsequently F.J. Alcock (1915, 1917) worked in this general area. In 1929 and 1930 A.E. Cameron and H.S. Hicks (Cameron, 1930; Cameron and Hicks, 1931; Hicks, 1930, 1932) conducted a reconnaissance geological survey of the Shield area within Alberta north of Lake Athabasca.

After gold was discovered at Goldfields, Saskatchewan, Alcock (1936) returned to map the Precambrian Shield in the extreme northwest corner of Saskatchewan (which adjoins Alberta to the east) at a scale of 1 inch to 4 miles. Geological mapping at a scale of 1 inch to 4 miles of the Fort Smith, Northwest Territories area (which adjoins Alberta to the north) was completed in 1938 by J.T. Wilson (1941).

In the early 1950's, uranium prospecting activities centered in northern Saskatchewan spread to the Precambrian Shield of Alberta where low-grade uranium mineralization was found in the course of this exploration activity (for example, Ferguson, 1953). As a result of this prospecting activity, G.A. Collins and A.G. Swan (1954) spent several weeks examining mineral occurrences at a number of points in the northeastern corner of the Province.

In 1957, the Alberta Research Council (formerly the Research Council of Alberta) began mapping the Precambrian Shield in northeastern Alberta, and some maps of this series, at a scale of 2 inches to 1 mile, have been published (Godfrey, 1961, 1963, 1966; Godfrey and Peikert, 1963, 1964). Results of geochronological studies carried out in collaboration with H. Baadsgaard, University of Alberta, have been published for the portions of the Shield mapped first by the Alberta Research Council (Godfrey and Baadsgaard, 1962; Baadsgaard and Godfrey, 1967, 1972; Baadsgaard *et al.,* 1964, 1967). Mineral showings encountered in the Andrew, Waugh, and Johnson Lakes area were reported in a separate publication (Godfrey, 1958b). A geological structural interpretation from vertical stereoscopic air photographs of the Shield in Alberta, north of Lake Athabasca, was made by Godfrey (1958a).

In 1959, the Geological Survey of Canada conducted a reconnaissance geological survey of the Precambrian Shield in Alberta north of Lake Athabasca and published a map (at a scale of 1 inch to 4 miles) with marginal notes (Riley, 1960).

The Saskatchewan Department of Mineral Resources (Koster, 1961, 1962, 1963, 1967, 1971) mapped, on a scale of 1 inch to 1 mile, the northwestern corner of Saskatchewan both immediately adjacent and near to the Alberta boundary.

Aeromagnetic surveys of northeast Alberta have been published by the Geological Survey of Canada (1958a, 1958b, 1958c, 1958d). The pattern of aeromagnetic anomalies and contours outlined in the aeromagnetic surveys can be directly correlated with both the bedrock structures and principal rock groups in the Fort Chipewyan map area.

A number of theses discussing various aspects of the bedrock geology have been completed during the course of the Alberta Research Council mapping program. Peikert (1961, 1963) worked on a group of porphyroblastic granitoids near Colin Lake; Watanabe (1965) studied a mylonite belt in the Charles Lake area, which extends southwards into the Fort Chipewyan district. Klewchuk (1972) studied several granitoid rock types from the map area.

PRESENT STUDY

Fieldwork for the Fort Chipewyan map area was carried out during 1970. The four accompanying maps are based on parallel, pace- and compass-controlled traverses on foot, spaced ½ to 1 mile apart, depending on the complexity of the bedrock geology.

ACKNOWLEDGMENTS

The 1970 field party consisted of Peter Klewchuk, Assistant Geologist, and Maurice B. Dusseault and John Beimer, field assistants; their contributions are acknowledged and appreciated. The assistance of Mr. and Mrs. L. Yanik, Mrs. L. Matthiessen, Mr. W. Lindsay, Mr. J. Whiteknife, and Mr. G. Lister of the Fort Chipewyan community is gratefully acknowledged.

An effort has been made to determine and retain locally used geographic names, especially for the larger lakes, islands, and delta channels. We are grateful to Mr. L. Yanik and Mrs. M. Clarke for their help in this regard. I should like to acknowledge the useful discussions held with my colleague C. Willem Langenberg.

GENERAL GEOLOGY

A Precambrian Shield complex of igneous, metamorphic, and sedimentary rocks underlies the study area. The geologic history involves multiple cycles of sedimentation, metamorphism, and deformation, accompanied by remobilization and plutonic intrusion. It seems most likely that Archean-Aphebian age supracrustal gneisses rest on Archean granitoid rocks. All of these granulite-amphibolite facies rocks form part of the Churchill Structural Province and have been thoroughly recrystallized during the Hudsonian Orogenic Event. This major thermal event effectively reset the radiometric K-Ar age of mica, and a large number of biotite and muscovite K-Ar age determinations fall in the narrow age bracket of 1.74 to 1.83 billion years (late Aphebian).

The principal rock types of the Fort Chipewyan area compose four natural lithological groups (Tables 1 and 2), which in the field are found in three geologic terrains.

GEOLOGIC HISTORY

The oldest group of rocks (Table 3), the basement granite gneiss complex, consists of crystalline para- and orthogneisses, minor amphibolites, high-grade metasedimentary rock bands and lenses, and small plutons. The formation of these gneisses has probably entailed multicycle sedimentation, polyphase metamorphism and deformation, along with the addition of primary magmatic material in the form of minor plutons and basic dykes, most likely during several phases of intrusion. In the course of such deep-seated events, major parts of the granite gneisses were migmatized, mobilized, and subsequently mylonitized. Mineral assemblages in metasediments of the basement complex contain hypersthene, green spinel, and sillimanite, which indicate granulite facies conditions of formation. Cordierite and almandine typically either enclose or replace these granulite facies minerals, showing that the rocks were subsequently subjected to amphibolite facies conditions (Godfrey and Langenberg, 1978).

Major plutons, such as the Slave Granitoids, are mantled and walled by basement gneisses as a result of the intrusion and doming by the plutons. The migmatized-granitized metasedimentary belt adjacent to the east side of the Slave Granitoid Pluton was also intruded by several moderately sized plutons, including the Chipewyan Red Granite. All of the granitoid plutons probably originated as remobilized infrastructure materials.

Extensive erosional stripping must have accompanied the intense deformation and uplift during the Hudsonian Orogenic Event. Complementary sedimentation probably of late Aphebian age (the Burntwood Group) took place in a restricted, tectonically controlled basin, now represented by a small area of low-grade metasedimentary rocks situated along the Lake Athabasca shoreline. These sediments probably rested unconformably on the older gneissic-granitoid basement, and were later subjected to cataclastic deformation and greenschist facies metamorphism.

Uplift and erosion continued, resulting in continental sedimentation within the Athabasca sedimentary basin (Helikian age), which rests unconformably on the gneissic-granitoid basement rocks.

Pleistocene continental glaciation was a significant recent event in the geologic history of the region. Glacial erosion has produced a terrain with a large proportion of exposed bedrock and only minor amounts of glacial deposits.

TABLE 1

The Principal Rock Groups and the Geologic Terrains in which they are found in the Fort Chipewyan District

Rock Group	Geological Terrain	Distribution
(1) granite gneisses (2) cataclastic rocks	(1) granite gneiss belt, partly migmatized and mylonitic;	East
(3) high-grade metasedimentary rocks (4) granitoid rocks — minor masses	(2) intervening zone of mixed lithologies, including granitized metasedimentary rocks and small plutons;	Central
(4) granitoid rocks — major masses	(3) major Slave Granitoid pluton.	West

TABLE 2

Principal Rock Groups, Constituent Rock Types and their Field Associations, Fort Chipewyan District

Cataclastic Rocks	Basement Complex: Granite Gneisses	Basement Complex: High-Grade Metasedimentary Rocks	Granitoid Rocks	Low-Grade Metasedimentary and Sedimentary Rocks
				Athabasca Formation
				Burntwood Group
←	*Hornblende Granite Gneiss *Biotite Granite Gneiss	(- - →)	Arch Lake Granitoids Chipewyan Red Granite Thesis Lake Granite	
←		* Granitic Metasedimentary Rocks Metasedimentary Rocks →	Wylie Lake Granodiorite Fishing Creek Quartz Diorite Slave Granitoids	
←	*Amphibolite ↑ ←	*Amphibolite ↑ ←	Amphibolite ↑	

* Parent materials of cataclastic rocks
- - → Close field, and possible genetic, relationships
↑ Intrusive relationship

TABLE 3

Summary of Geologic History of Shield in Fort Chipewyan District, Alberta

Geologic Age	Rock Units/Groups	Predominant Rock Type(s)	Process/Event	
Recent	Fluvial lacustrine, deltaic deposits	Sand, silt, mud	Sedimentation	
Pleistocene	Glacial/fluvial /lacustrine	Till, sand, silt	Continental glaciation	
Helikian	Athabasca Formation	Sandstone	Continental sedimentation	
Aphebian	Burntwood Group	Arkose, phyllitic argillite	Retrograde, metamorphism (greenschist facies)	Hudsonian Event
		Sandstone, shale	Sedimentation	
			Regional Faults (e.g. Allan Fault) and mylonitization established	
	Wylie Lake Granodiorite	Granodiorite, (quartz diorite)		
	Fishing Creek Quartz Diorite	Quartz diorite, (granodiorite, granite)		
	Chipewyan Red Granite	Granite	Basic dykes Metamorphism (amphibolite facies) Remobilization Granitization Migmatization Plutonic intrusion	
	Arch Lake Granitoids	Granite, (granodiorite)		
	Thesis Lake Granite	Granite, (granodiorite)		
	Slave Granitoids	Granite		
Archean	Basement Complex	Amphibolite Metasedimentary Rocks Hornblende Granite Gneiss Biotite Granite Gneiss	Basic dykes Plutonic intrusion Granitization Metamorphism (granulite facies) Sedimentation	Kenoran Event

ROCK TYPE CLASSIFICATION AND DESCRIPTION

Metamorphism, intrusion, and deformation have obscured many of the primary sedimentary and igneous structures and textures which are assumed to have been present. Mixed-rock assemblages and wide contact zones have been produced which are visible on both outcrop and regional scales. Thus, most map units depicted on the accompanying four map sheets indicate only the predominant rock type within an outcrop area, and the minor, smaller-scale lithologic variations are omitted.

In order to allow comparisons of rock type descriptions and classifications, certain hand specimens are designated as *standard reference samples.* These standard samples are intended to represent as nearly as possible the typical lithology of each map unit as seen in the field. Granitoid, gneissic, and metasedimentary rock standard samples are listed in tables 4, 5, 6, 7, and 8 along with their modal and chemical analyses; their field locations are shown on the accompanying geological maps.

MAP UNITS

THE GRANITE GNEISSES

Biotite and hornblende granite gneisses are characteristically banded in outcrop. This banding displays a range in distinctness of development, depending in part upon the mafic mineral content of the gneisses. The metamorphic banding may be planar, or wavy to contorted as in a migmatitic structure. The individual bands may be discontinuous or streaky, and well developed or poorly developed (as in the case of felsic phases and ortho-gneisses).

TABLE 4
Modal and Chemical Analyses of Standard Samples for the Granite Gneisses

	Granite Gneisses												
Standard Sample Number	220[2]	221[1]	225[2]	232[2]	233	238	246[2]	247	250[1]	252[3]	253[2]	254[3]	255[2,3]
Quartz	31.1	29.4	38.7	37.5	37.4	73.2	33.4	42.0	35.5	74.0	32.8	37.0	30.7
Potash Feldspar	47.0	45.3	17.4	18.5	28.2	0.4	34.2	3.0	33.6	0.1	30.1	28.0	33.8
Plagioclase	20.0	20.8	32.3	36.9	32.9	21.4	25.9	12.6	23.9	21.8	21.1	23.0	26.5
Biotite	-	-	7.4	6.5	-	-	5.0	-	-	-	1.8	-	4.2
Chlorite	1.2	1.1	2.2	0.2	0.7	3.0	-	26.7	2.1	2.6	4.4	3.5	0.8
Hornblende	0.1	1.6	-	-	-	-	-	-	1.2	0.3	-	-	0.5
Epidote	-	-	0.3	-	-	-	-	13.4	3.2	0.4	8.8	6.5	-
Muscovite	0.1	-	0.4	-	-	0.6	-	-	-	0.1	0.2	1.5	1.5
Garnet	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcite	0.2	1.5	-	-	-	0.7	-	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-	-	-	-	-	-	-	-
Accessories	0.3	0.3	1.3	0.4	0.8	0.7	1.5	2.3	0.5	0.7	0.8	0.5	2.0
NUMBER OF POINTS	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	Estimate	2000
SiO_2	74.24	73.88	70.67	73.40	78.65	73.07	73.19	52.46	74.62	75.56	70.93	68.60	69.96
TiO_2	0.12	0.17	0.63	0.22	0.10	0.25	0.35	0.81	0.15	0.17	0.25	0.58	0.39
Al_2O_3	12.48	11.67	12.22	13.43	11.34	12.66	12.52	19.37	11.91	12.66	14.34	13.60	14.01
Fe_2O_3	0.56	1.96	4.44	1.36	0.89	1.59	2.58	9.77	1.16	1.34	1.96	3.85	2.50
MgO	0.17	0.22	0.90	0.59	0.12	0.56	0.45	3.91	0.35	0.43	1.44	0.78	0.63
CaO	0.57	1.15	1.72	1.30	0.69	1.55	1.03	2.99	1.16	0.34	0.48	2.99	1.14
Na_2O	2.74	3.28	3.02	3.71	3.73	6.05	2.89	5.55	2.94	6.82	3.55	2.50	4.76
K_2O	6.22	5.29	2.94	4.12	3.37	0.77	4.78	1.03	5.36	0.60	4.76	4.46	5.20
MnO	0.03	0.04	0.55	0.03	0.02	0.03	0.06	0.09	0.03	0.02	0.04	0.07	0.03
P_2O_5	0.08	0.07	0.28	0.02	0.03	0.08	0.24	0.39	0.07	0.07	0.03	0.20	0.01
LOI	0.63	0.90	0.84	0.84	0.11	1.65	0.13	2.92	0.30	0.30	0.70	1.11	0.80
H_2O	0.04	0.12	0.09	0.17	0.06	0.01	0.16	0.22	0.17	0.10	0.06	0.10	0.17
TOTAL	97.88	98.75	98.30	99.19	99.11	98.27	98.38	99.51	98.22	98.41	98.54	98.84	99.60

[1]Hornblende granite gneiss

[2]Biotite granite gneiss

[3]Cataclastic granite gneiss

The granite gneiss terrain is intruded by minor amounts of small plutonic bodies. Their composition may be similar to the granitoids, (Chipewyan Red, Thesis Lake, Fishing Creek, and Wylie Lake units) or intermediate between the granitoids and granite gneisses.

Biotite granite gneisses (11)[1] are typically composed of quartz-feldspar felsic layers alternating with mafic layers or foliae which are biotite-rich and occasionally contain minor hornblende (Table 4). The gneisses are typically medium grained, with felsic mineral layers being noticeably coarser grained than the intervening mafic-rich layers. Chloritization of biotite is very typical, and is commonly associated with epidote veinlets. Quartz veins, pods, and pegmatites are fairly common. Isolated grains of allanite and concentrations of magnetite in streaks paralleling the foliation have been noted.

Hornblende granite gneisses (12) are much less abundant than the biotite granite gneisses. They are similar in petrologic character. Hornblende-bearing gneisses are rarely without some biotite in the mafic layers; however, the reverse is not necessarily true. Magnetite is more likely to be found in the hornblende gneisses than in biotite granite gneisses. Amphibolite and metasedimentary rocks are commonly observed as minor masses within the granite gneiss terrain.

AMPHIBOLITE (20)

Amphibolite is found in a variety of host rocks within each of the major geologic terrains - the granite gneisses, the metasedimentary rocks, and both major and minor plutons. This widespread occurrence suggests that the amphibolites were emplaced at different times. Amphibolite lenses and bands are common in the granite gneisses where they typically range from 2 to 10 feet (0.7 to 3 m) in thickness and 5 to 20+ feet (2 to 7+ m) in length, and are usually aligned parallel to, and plastically or semi-plastically deformed within, the gneissic structure. Major masses of amphibolite have not been found within the map area. Nowhere do amphibolites develop thicknesses indicative of a volcanic pile; consequently they are considered to be intrusive in origin. Chilled contacts have not been observed, probably because of obliteration by post-intrusion deformation and metamorphism. Most bodies are discontinuous and probably represent either boudinage fragments of dykes and sills, or an agmatitic complex with pegmatite, within granite gneiss or metasedimentary rocks. Amphibolites are relatively uncommon in the major plutonic masses, the Slave Granitoids, and the Chipewyan Red Granite in the western part of the map area.

Amphibolites appear dark green on a freshly broken surface, weathering to greenish-gray, whereas gneissic banded varieties weather to alternating green and white to pink layers. Feldspars tend to stand out disproportionately in high relief on weathered surfaces, giving amphibolite the appearance of a more felsic-rich rock. Hornblende and plagioclase feldspar are the principal minerals, with minor amounts of biotite and chlorite. Veinlets of epidote and quartz may be present.

As the proportion of hornblende decreases, amphibolite grades to either hornblende granite gneiss or amphibolitic metasedimentary rock. The grain size of amphibolite ranges from fine to coarse, hornblende crystals 5 mm and larger being relatively uncommon. The texture ranges from massive, to foliated, to banded, the latter two textures being most commonly encountered. Some of the banded varieties consist of alternating, 10- to 25-mm thick bands which exhibit a contrast in the hornblende to feldspar ratio.

Many of the amphibolites, particularly in the granite gneiss terrain, weather noticeably rusty, a phenomenon probably related in part to the common occurrence of pyrite in small amounts.

The less recrystallized, less deformed amphibolites probably are the youngest igneous rocks in the map area, in particular those which have dyke-like relationships to host rocks such as the Chipewyan Red Granite.

THE METASEDIMENTARY ROCKS

The high-grade metasedimentary rock masses have an elongated form in plan view. Their long axes are aligned parallel to the regional structural trend, a direct expression of the tectonic pattern for this terrain. The outcrops show intricate, steeply dipping isoclinal folds, locally crenulated (due to flow folding) and migmatitic, enclosed within less deformed granite gneisses. These structural relationships indicate greater mobility (plasticity) of the metasedimentary rocks than the host gneisses, possibly a result of water released during prograde metamorphism of the sediments as compared to the relatively dry, adjacent gneisses.

The metasedimentary rocks (31) are typically quartzites with minor amounts of schist and phyllite. These rocks are of high metamorphic grade, and although almandine is commonly found in outcrop, hypersthene, green spinel, sillimanite and cordierite are visible under the microscope. The metasedimentary rocks are commonly pyritic and generally have a rusty weathered appearance which locally may be sufficiently thick in outcrop to be termed a rusty zone, or even a gossan.

The outstanding feature of metasedimentary rocks in outcrop is the fairly regular banding. However, the banding is more disrupted and less continuous as the amount of metamorphic quartzo-feldspathic material increases, and the rock becomes granitoid in appearance. Where the

[1] Numbers refer to map unit indices used in the accompanying geological maps.

TABLE 5

Modal and Chemical Analyses of Standard Samples for the Amphibolite and Thesis Lake Granite

	Amphibolite			Thesis Lake Granite					
Standard Sample Number	216	228	244	218	237	245	248	249	251
Quartz	-	-	0.3	26.0	22.5	27.3	21.7	22.7	21.2
Potash Feldspar	-	-	0.1	10.6	27.9	4.1	31.2	18.8	28.6
Plagioclase	36.6	-	28.2	38.9	22.7	33.3	26.5	24.5	27.1
Biotite	-	-	9.3	15.9	16.1	29.6	9.3	20.3	13.8
Chlorite	1.1	6.8	7.4	2.7	0.3	0.9	1.6	3.1	0.5
Hornblende	60.2	84.5	51.8	2.4	9.2	0.1	5.2	8.5	-
Epidote	-	5.7	1.7	2.1	-	0.6	2.3	0.9	0.3
Muscovite	-	1.4	-	-	-	-	-	-	-
Garnet	-	-	-	-	-	-	-	-	-
Calcite	-	-	-	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-	-	-	6.5[1]
Accessories	2.1	1.6	1.2	1.4	1.3	4.1	2.2	1.2	2.0
NUMBER OF POINTS	2000	2000	2000	2000	2000	2000	2000	2000	2000
SiO_2	48.76	47.18	45.95	65.24	63.28	64.28	63.20	61.16	61.43
TiO_2	1.15	1.16	1.90	0.52	0.53	0.48	0.56	0.7	0.65
Al_2O_3	12.88	9.77	13.16	14.71	13.73	14.44	14.50	13.7	14.26
Fe_2O_3	12.60	11.30	16.30	5.08	4.82	4.98	5.53	6.76	5.98
MgO	7.56	15.82	7.09	3.20	3.34	3.58	3.55	4.60	3.80
CaO	10.26	10.01	9.34	3.20	3.45	2.91	3.38	4.23	4.25
Na_2O	3.12	1.38	2.12	2.98	2.52	2.80	2.73	2.68	4.67
K_2O	1.03	0.49	1.64	3.13	5.09	3.00	4.78	3.92	4.31
MnO	0.23	0.18	0.27	0.10	0.11	0.07	0.18	0.13	0.11
P_2O_5	0.07	0.11	0.18	0.16	0.35	0.30	0.07	0.13	0.02
LOI	0.89	2.07	1.09	1.06	0.86	1.19	0.89	0.63	0.54
H_2O	0.46	0.11	0.29	0.10	0.05	0.25	0.17	0.09	0.08
TOTAL	99.01	99.58	99.33	99.48	98.13	98.82	99.54	98.80	100.10

[1]Ortho- and clino-pyroxene

TABLE 6
Modal and Chemical Analyses of Standard Samples for Chipewyan Red Granite

	Chipewyan Red Granite					
Standard Sample Number	226	234	241	242	243	256
Quartz	29.8	37.2	34.1	30.9	29.9	25.0
Potash Feldspar	34.6	32.2	35.8	22.2	42.1	39.6
Plagioclase	30.2	29.3	22.3	40.4	25.0	28.1
Biotite	-	-	6.9	3.5	1.1	4.8
Chlorite	3.1	0.3	0.1	1.0	0.5	0.4
Hornblende	1.1	-	-	-	-	-
Epidote	-	-	-	0.1	0.2	-
Muscovite	-	-	-	0.3	0.1	-
Garnet	-	-	-	-	-	-
Cordierite	-	-	-	-	-	-
Calcite	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-
Accessories	1.2	1.0	0.8	1.6	1.1	2.1
NUMBER OF POINTS	2000	2000	2000	2000	2000	2000
SiO_2	73.47	74.28	72.61	73.43	73.90	69.49
TiO_2	0.17	0.10	0.43	0.18	0.28	0.47
Al_2O_3	12.62	13.01	12.87	14.28	12.49	14.74
Fe_2O_3	1.51	0.79	2.48	1.21	1.24	2.72
MgO	0.39	0.23	0.79	0.41	0.35	0.83
CaO	0.63	0.78	1.04	1.15	0.55	1.15
Na_2O	3.19	3.28	2.84	4.29	2.92	3.35
K_2O	5.42	5.05	4.42	3.55	5.57	5.22
MnO	0.15	0.02	0.02	0.03	0.05	0.04
P_2O_5	0.05	0.02	0.10	0.01	0.11	0.15
LOI	0.63	0.86	0.22	0.66	0.27	0.97
H_2O	0.21	0.26	0.22	0.13	0.22	0.05
TOTAL	98.44	98.68	98.04	99.33	97.95	99.18

TABLE 7

Modal and Chemical Analyses of Standard Samples for Slave Granitoids and Fishing Creek Quartz Diorite

	Slave Granite								Fishing Creek Quartz Diorite	
Standard Sample Number	217	219	224	230	231	236	239	240	229	235
Quartz	23.9	30.4	28.6	24.4	35.0	28.6	36.1	29.2	29.2	13.0
Potash Feldspar	45.7	31.2	44.0	42.0	21.2	38.9	22.2	43.6	18.4	3.8
Plagioclase	27.5	30.8	21.0	30.6	36.9	28.3	30.6	23.6	32.9	52.2
Biotite	1.0	3.0	0.4	-	3.4	0.7	4.2	0.1	15.9	29.6
Chlorite	0.3	2.8	4.1	1.0	0.6	2.2	2.9	0.8	1.7	0.4
Hornblende	-	-	-	-	-	-	-	-	-	-
Epidote	0.4	1.4	0.4	-	-	0.1	0.1	0.3	0.6	-
Muscovite	0.4	-	0.5	1.1	0.1	0.6	0.6	0.1	-	-
Garnet	0.3	-	-	0.5	2.5	0.4	0.6	1.3	-	-
Cordierite	-	-	-	-	-	-	2.0	0.5	-	-
Calcite	-	-	-	-	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-	-	-	-	-
Accessories	0.5	0.4	1.0	0.4	0.3	0.2	0.7	0.5	1.1	1.0
NUMBER OF POINTS	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
SiO_2	72.60	70.35	73.50	70.38	70.75	73.14	72.74	72.86	64.51	58.99
TiO_2	0.16	0.39	0.15	0.21	0.37	0.18	0.18	0.26	0.38	0.63
Al_2O_3	14.62	13.74	12.87	13.69	15.39	14.47	13.66	14.27	17.01	18.06
Fe_2O_3	0.68	2.58	0.64	3.12	1.87	1.16	2.05	1.16	3.48	5.09
MgO	0.17	1.10	0.37	0.93	0.81	0.43	0.78	0.34	2.70	2.30
CaO	1.01	0.63	0.46	0.41	1.15	0.92	2.13	0.92	2.14	4.27
Na_2O	3.83	3.14	2.45	2.52	4.24	3.41	3.36	4.67	2.82	3.16
K_2O	5.50	5.12	6.46	5.39	4.23	5.01	3.10	4.86	3.57	4.52
MnO	0.02	0.25	0.04	0.30	0.20	0.02	0.06	0.04	0.02	0.06
P_2O_5	0.09	0.17	0.13	0.09	0.01	0.08	0.12	0.01	0.11	1.09
LOI	0.21	0.94	0.89	0.78	0.62	0.61	0.64	0.46	1.39	0.67
H_2O	0.11	0.48	0.34	0.08	0.04	0.11	0.37	0.31	0.11	0.23
TOTAL	99.00	98.89	98.30	97.90	99.68	99.54	99.19	100.16	98.24	99.07

granitic component is not prominent, the metasedimentary rocks are typically well-foliated or color-banded.

Prograde metamorphism of the sediments to granulite facies conditions is indicated by hypersthene, green spinel, and sillimanite (Godfrey and Langenberg, 1978). Granitization of the metasediments is expressed in a variety of ways: isolated feldspar porphyroblasts; quartzo-feldspathic concentrations in clusters, pods, and irregular patches; conformable and cross-cutting pegmatites; migmatitic to gneissic phases; and minor granitoid bodies with or without schlieren of either biotite concentrations or granitized metasedimentary rock. The end products cover a lithologic range that is transitional from banded metamorphic rocks of obvious sedimentary parentage to rocks containing a high proportion of recrystallized quartzo-feldspathic material which appear as gneissoid migmatites and granitic-pegmatitic masses.

Metasedimentary and associated granitized rocks are found as bands and lenses, principally within the granite gneiss terrain, but minor patches are also found in the Slave Granitoid rocks. An exceptionally large band of metasedimentary rocks, up to 6 miles (10 km) wide and about 12 miles (19 km) long (extending to the northern boundary of the study area), lies on the west side and beneath Loutit Lake. This band is structurally complex and consists of quartzite with minor amounts of schist and phyllite. It is well-layered, with minor amounts of metamorphic quartzo-feldspathic material.

Amphibolite bands up to several feet across are fairly common in the metasediments, and are generally aligned parallel to the metasedimentary foliation.

Sulfide mineralization is common in the metasedimentary rocks with pyrite by far the most abundant sulfide mineral typically associated with gossan and rusty zones. Copper mineralization is found locally (for example, 2 miles (3 km) north of Fort Chipewyan), as is molybdenite and uranium mineralization. Narrow, milky white quartz veins and pods, single or grouped in the metasedimentary rocks are usually barren of sulfides.

THE GRANITOID[2] ROCKS

This group includes all the granitoid rocks, ranging from the large Slave Granitoid pluton (greater than 12 miles (19 km) across) to the smaller-sized bodies a fraction of a mile (or less than 1½ km) across. These plutons probably represent a range of ages but all are elongated parallel to the north-northeast to northeasterly regional tectonic trend that is prevalent in the basement gneissic terrain. Small plutons tend to be concentrated within a zone of metasedimentary rocks on the east side of the Slave Granitoid pluton.

[2] The term granitoid is used in a broad, field sense, insofar as the granitoid plutons and rock units collectively, and in some cases individually, represent a range in composition, such as granite to quartz diorite or to granodiorite. Some granitoid plutons have a restricted compositional range, for example, granite (see Table 3 for details).

Slave Granitoids

The Slave Granitoid pluton, named after the Slave River, dominates the geology in the western portion of the map area. The lithologic and structural character of the pluton is relatively simple compared to that of either the granite gneiss group or the main metasedimentary rock bands.

Slave Granite Phase (101) displays a relatively limited textural and compositional range; it is characterized by a fairly light overall color, commonly gray to white, ranging to pink or mauve-pink. The characteristic massive, medium-grained texture locally exhibits fine- and coarse-grained variations. The rock is typically garnetiferous, with small amounts of biotite (up to 4 percent), the latter most commonly occurring as mafic knots 5± mm across with a chloritic biotite envelope wrapped around a garnet core. The typically uniform grain size of the rock is locally megacrystic, with 15- to 30-mm long white feldspars comprising up to 15 percent of the rock.

Green spinel, seen under the microscope, places this rock in the high-grade granulite facies.

Mafic Slave Granite Phase (102) is a mineralogically distinguishable sub-type which is similar and gradational to the normal Slave Granite (101) described above but contains up to 10 percent dispersed biotite.

Minor masses of Arch Lake Granitoids are found within the Slave Granitoids. Spatial and contact relationships in adjacent map areas suggest that the Arch Lake Granitoids were emplaced before the Slave Granitoids, and therefore small bodies of Arch Lake Granitoid material within the Slave Granitoids can be interpreted as either xenoliths or interfingering contacts between the two major intrusions. However, metamorphic mineral assemblages and textures show that the Slave Granitoids were formed under granulite facies conditions which were superceded by amphibolite facies conditions. This sequence of events suggests that the Arch Lake Granitoids (showing only amphibolite facies) are younger than the Slave Granitoids. Contact relationships in the field are interpreted as being the result of granitoid remobilization during amphibolite facies conditions.

Thesis Lake Granite (110)

The Thesis Lake Granite is so named because it was studied as a thesis project by P. Klewchuk (1972) during 1971 and 1972.

This unit is typically of dark appearance, showing mottled pink feldspar grains in a mafic-rich (13 to 20 percent) matrix. This rock consists of megacrystic feldspars from 6 to 13 mm long, within a foliated medium-grained matrix of feldspar, quartz, and chloritized biotite and hornblende. The foliation is due to a mildly cataclastic fabric of microcline augen in aligned biotite and lens-shaped aggregates of quartz grains. Very few xenoliths are present in this rock, but it is mixed with or cut by minor amounts of leucocratic aplite, granite, and pegmatite, present as pods, patches, and dykes, which locally make up to 90 percent of individual outcrops. The aplo-pegmatites are typically plastically deformed, their structural form being harmonious with the metamorphic fabric and structure of the host rock.

The Thesis Lake Granite is interpreted as having formed under granulite facies conditions (as shown by the presence of hypersthene) and intruded into a weak zone of metasedimentary rocks and basement gneisses just east of the Slave Granitoid pluton.

The Wylie Lake Granitoids

The two granitoid lithologies described in this section are most widely distributed in the Wylie Lake district (maps and report in press) of the Shield in Alberta. Although map units established in the Wylie Lake district have been lithologically extended into the Fort Chipewyan district, a strict correlation is not intended at this time. Affinities and field associations of these two granitoid map units with granitized, high-grade metasedimentary rocks are similar in both areas and they appear to have very similar genetic relationships.

Wylie Lake Granodiorite Phase (131) is lithologically equivalent to the Wylie Lake Granodiorite of the Wylie Lake map area, situated to the northeast.

Overall, this rock appears dark, having either a greenish or brownish-red color, and it may exhibit a mottled pattern in hand specimen. The rock is typically of medium-grain size and equigranular except for rare 13 mm-long pink to red potash feldspar grains. The texture is generally poorly foliated to massive. The principal minerals include: pink to red feldspar, quartz and biotite; the feldspar coloration is due to hematite inclusions.

The Wylie Lake Granodiorite tends to occur in field association with the Fishing Creek Quartz Diorite. This rock unit is present in the major metasedimentary rock band peripheral to the Slave Granitoid and Chipewyan Red Granite plutons, and in the Fishing Creek Quartz Diorite mass at Shelter Point.

Fishing Creek Quartz Diorite (133) is lithologically equivalent to the Fishing Creek Quartz Diorite of the Wylie Lake map area which is found to the northeast.

It has a light (gray) overall color, but in hand specimen is mottled grayish white on a medium gray background. The texture is typically almost megacrystic, and locally ranges from distinctly megacrystic to equigranular. It is typically poorly foliated, but locally can be either gneissic (with wisps of biotite concentrations or metasedimentary rocks) or massive. Megacrystic white feldspar crystals range in size from 7 to 10 mm in length with a (greenish) gray matrix of feldspar, quartz, and (chloritic) biotite. Separate small, irregularly shaped, leucocratic granitic masses are common; they are white, fine-grained, and made up of massive aplite to microgranite, and may be locally pegmatitic.

The Fishing Creek Quartz Diorite is found in association with the metasedimentary group of rocks. It is characteristically found in the principal zone of metasedimentary rocks peripheral to the Slave Granitoid pluton and in other metasedimentary rock patches within the granite gneiss belt bordering Lake Athabasca.

Chipewyan Red Granite (150)

The name Chipewyan Red Granite is proposed because of the proximity of the main pluton to the settlement of Fort Chipewyan.

This rock is of medium-grained texture, is locally fine grained and massive to faintly lineated (mainly rodded quartz), with pink to red feldspars, quartz, minor chloritic biotite, and locally contains minor amounts of garnet. It is fairly free of inclusions (xenoliths) towards the south end of the largest pluton. However, the alignment of mafic schlieren produces a crude banded structure which becomes prominent both towards the north end in the main plutonic body and also in the smaller body just northeast of Shallow Lake. Minor quartz veins and pegmatites up to 3 or 4 inches (7 to 10 cm) thick cut the Chipewyan Red Granite. The main pluton is also cut by narrow (2 to 10 feet, or 0.6 to 3 m, thick) amphibolitic dykes within shear zones which trend approximately north 10° west and dip steeply to the west. The west boundary of the main pluton appears to be in fault contact with the Slave Granitoid pluton.

A number of small plutons (Chipewyan Red Granite and Thesis Lake Granite) occupy a zone that regionally extends northeasterly from the mud flats at the entrance to the Rivière des Rochers. The spatial distribution of these plutons suggests that they were injected along a regional weak zone occupied by metasedimentary rock. This zone is situated between basement gneisses to the east and the main Slave Granitoid pluton to the west.

Arch Lake Granitoids

Arch Lake Granitoids are present as small patches and blocks within the major Slave Granitoid pluton in this map area. The name Arch Lake Granite was introduced by Godfrey (1966).

Arch Lake Granite Phase (161) has an overall reddish color in outcrop and commonly is distinctly foliated both in outcrop and in hand specimen. The foliation appears as a penetrative shear accompanied by a mild cataclasis. The rock is fairly homogeneous in texture, of medium-grain size, and locally coarse, with up to 25 percent feldspar megacrysts ranging from 15 to 30 mm in length. The matrix consists of pink to red feldspar, biotite, and blue quartz. The rock composition varies from a strongly predominant granite to granodiorite and quartz diorite.

Arch Lake Granite Transition Phase (162) is a sub-type of the Arch Lake Granite Phase (161) distinguished mineralogically and texturally by the absence of the large 15 to 30 mm long potash feldspar megacrysts. However, up to 5 percent of 15 ± mm potash feldspar megacrysts may be present.

LATE METASEDIMENTARY AND SEDIMENTARY ROCKS

Burntwood Group rocks (201, 202) are cataclastically deformed, low-grade metasedimentary rocks which occupy a 100 foot-wide band along the north shore of Lake Athabasca towards the northern edge of the map area. The principal rock types are dark gray-green, chloritic, phyllitic argillite beds about 1 inch (25 mm) thick, interbedded with mauve, arkosic sandstone beds, averaging about 4 inches (100 mm) thick. The parent sedimentary rocks appear to have been silty shales and arkosic sandstone, with minor pebble bands. Milky white gash quartz veins are locally numerous. Primary bedding, prominent in the sandstone phases, strikes northeasterly and dips steeply to the northwest.

The cataclastic nature of the phyllitic argillite fits in well with a structural position adjacent to the mylonitic belt of the Allan Fault zone. The degree of cataclasis in these rocks increases westward, towards the fault zone. The only other rocks in the Shield of Alberta that may be related to these deformed, greenschist facies, metasedimentary rocks were mapped in the Waugh Lake map area (Godfrey, 1963), approximately 60 miles (96 km) northwards along the regional structural trend. These rocks were referred to as low-grade Waugh Lake metasedimentary and metavolcanic rocks (Watanabe, 1961; Godfrey, 1963). Primary sedimentary structures (bedding and graded bedding) commonly seen at Waugh Lake are also present in metasedimentary rocks of the Fort Chipewyan map area, but to a lesser extent.

The Burntwood Group metasedimentary rocks of the Fort Chipewyan district are of low metamorphic grade, exhibit primary sedimentary structures, are cataclastically deformed, and do not contain segregated recrystallized quartzo-feldspathic masses, so typical of the high-grade metasedimentary rocks. (Evidently the metamorphic temperatures for the Burntwood Group were inadequate to promote granitization.) As a consequence of the contrast in metamorphic grade, lithology, and deformational style, a substantial time break and an unconformable relationship is assumed between Burntwood Group rocks and the presumed underlying basement gneisses. If the suggested correlation with rocks at Waugh Lake is valid, then it should be also noted that a K-Ar biotite age date (metamorphic) from lavas in the Waugh Lake band was 1.78 b.y. (Godfrey and Baadsgaard, 1962). Thus, the Burntwood Group rocks were affected by the Hudsonian Event, probably during a late stage of that orogenic episode.

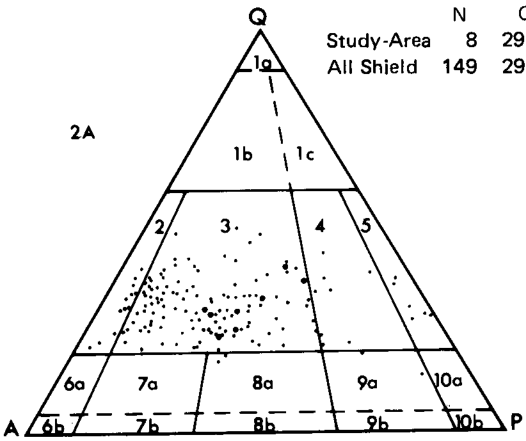
Rocks similar to those of the Burntwood Group and the Waugh Lake band (which also extends into Saskatchewan; Koster, 1961) have been described in the Gulo-Thluicho Lakes area (Saskatchewan) by Hale (1954), Fahrig (1961), and Scott (1978). Hale assigned these Gulo-Thluicho Lakes rocks to the "Athabasca Series, Lower Part" and considered them to be equivalent to the Martin Formation of Martin Lake and Taz Bay (Tazin Lake). However, Fahrig felt that the Gulo Lake rocks are a low-grade metamorphosed remnant of Tazin rocks. The term "Tazin" here refers to all those rocks older than, and lying unconformably beneath, the Martin Formation.

Fieldwork by Scott (1978) essentially confirmed the findings of Fahrig. However, Scott renamed the sequence (basal conglomerate, greywacke, arkose, and banded argillite [with graded bedding]) found between Thluicho and Gulo Lakes to "The Thluicho Lake Group". The Burntwood Group rocks appear to be lithologic equivalents of the banded argillite, Thluicho Lake Group.

The low-grade metasedimentary rocks in the Fort Chipewyan map area (Burntwood Group) are probably of late Aphebian age, and in the terminology of Christie (1953) and Tremblay (1972) they are "Tazin" rocks insofar as they predate the Martin Formation. All other gneissic, granitoid, and

2A

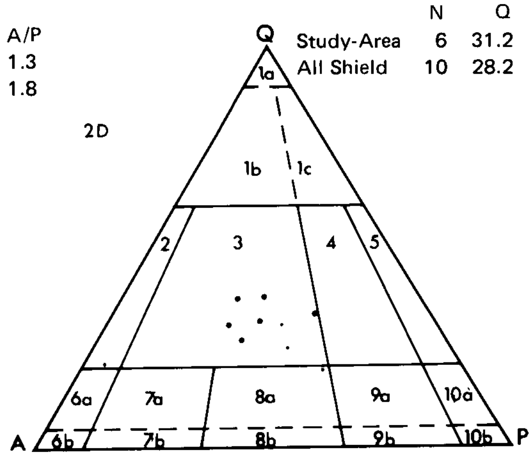
	N	Q	A	P	A/P
Study-Area	8	29.5	36.1	28.7	1.3
All Shield	149	29.1	41.2	22.9	1.8



Slave Granite (101, 102)

2D

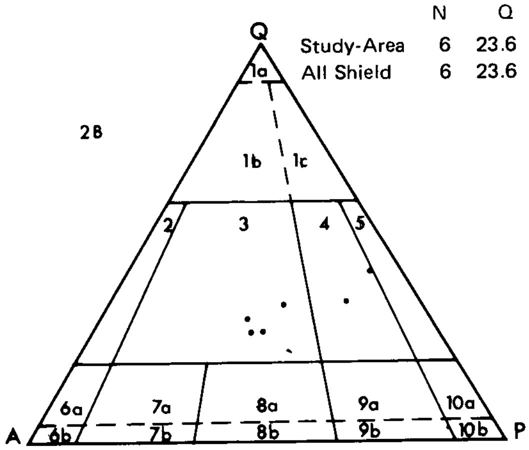
	N	Q	A	P	A/P
Study-Area	6	31.2	34.4	29.2	1.2
All Shield	10	28.2	37.7	30.7	1.2



Chipewyan Red Granite (150)

2B

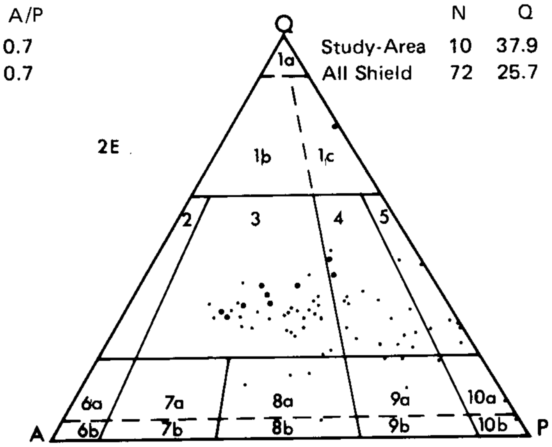
	N	Q	A	P	A/P
Study-Area	6	23.6	20.2	28.8	0.7
All Shield	6	23.6	20.2	28.8	0.7



Thesis Lake Granite (110)

2E

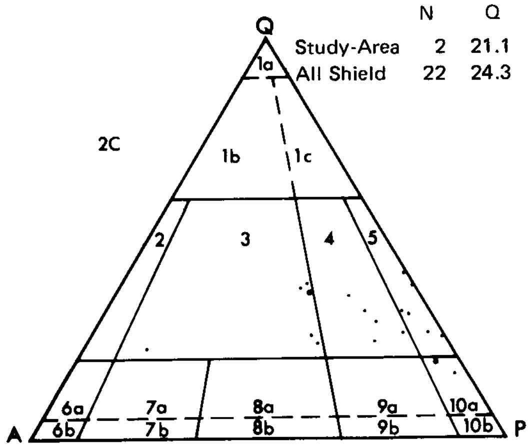
	N	Q	A	P	A/P
Study-Area	10	37.9	30.5	26.1	1.2
All Shield	72	25.7	22.2	38.7	0.6



Granite Gneisses (11, 12)

2C

	N	Q	A	P	A/P
Study-Area	2	21.1	11.1	42.5	0.3
All Shield	22	24.3	11.6	49.1	0.2



Fishing Creek Quartz Diorite (133)

1a Quartz rocks
1b Quartz granite
1c Quartz granodiorite
2 Alkali granite
3 Granite
4 Granodiorite
5 Quartz-diorite
6a Quartz-bearing alkali syenite
6b Alkali syenite
7a Quartz-bearing syenite
7b Syenite
8a Quartz-bearing monzonite
8b Monzonite
9a Quartz-bearing monzodiorite
9b Monzogabbro
10a Quartz-bearing (diorite, gabbro)
10b Diorite, gabbro, norite, anorthosite
• Samples from study area
· Samples from remainder of shield in Alberta
N Number of Samples

FIGURE 2. Ternary Q-A-P plots of granitoids and gneisses from study area, and from remainder of Shield in Alberta. Ternary field boundaries based on Streckeisen (1967).

high-grade metasedimentary rock units of this map area are still older, and therefore can be also designated "Tazin".

Athabasca Formation rocks (240) are typically brownish red (hematitic), bedded (locally cross bedded), variably indurated (though tending to be friable), silty sandstone with minor pebble beds. The sandstones are typically flat lying to gently dipping southeast towards the center of the Athabasca sedimentary basin (Fahrig, 1961). Athabasca Formation rocks can be seen at and just below waterline when Lake Athabasca water levels are low in the bay 3 miles (5 km) northeast of Fort Chipewyan. Athabasca Formation sandstone debris forms a significant part of the Lake Athabasca beach deposits at several places along the shoreline. Concentrations of Athabasca Formation rubble, and frost-shattered exposures which have been disturbed only slightly, are present along shorelines of the major islands in Lake Athabasca – Bustard, Lucas, and Burntwood. At all of these exposures the Athabasca sandstone appears to be flat lying or gently dipping. It is apparent that the north shore of Lake Athabasca essentially coincides with the present-day erosional margin of the Athabasca sedimentary basin and that Athabasca Formation sandstone underlies the lake. A northward extension of the former basin beyond the present lake shoreline is not indicated by regional geology, in the absence of Athabasca Formation outliers. However, an original Athabasca Formation basin of much wider extent seems highly probable from data recently presented by Ramaekers (1978).

Radiometric dates from the Athabasca Formation in northern Saskatchewan, have shown the age of sedimentation to be in the order of 1.35± 0.5 b.y. before present, Helikian age (Beck, 1976).

REGIONAL CATACLASTIC ZONES (220)

Wide zones of granulation within the Allan Fault zone (Godfrey, 1958a) have affected a large part of the eastern belt of granite gneisses.

Intensely crushed bands within the cataclastic zone are of ultramylonitic character; other areas within the zone grade into less crushed rock – flaser gneiss, cataclasite, and mylonite. Recrystallization has affected all of these rocks to some extent; blastomylonites have been formed and porphyroclastic-augen feldspars are common.

Compositional and textural layering in these mylonitized basement gneisses tends to be planar in form, a feature that seems to extend over a range of scales – from hand specimen, to outcrop, to belts several miles long in strike, as seen on aerial photographs.

The wide mylonitic zone which forms the principal surface expression of the Allan Fault takes a major swing of about 40 degrees as it nears the Lake Athabasca shoreline (to the northeast, beyond the map area). At this location, the strike of the Allan Fault turns from a southerly to a southwestern trend and enters the northeast corner of the Fort Chipewyan map area. Whether or not this southwesterly trend is merely a branch fault or essentially represents a swing of the full width of the Allan Fault is not entirely clear. Outcrop is lacking due to the proximity of Lake Athabasca. However, aeromagnetic survey data and field observations support the latter explanation.

MODAL AND CHEMICAL ANALYSES

Mineralogical and chemical data on the rock types in the map area are presented in tables 4, 5, 6, 7, and 8. Representative hand specimens have been selected for these laboratory studies from both the gneissic-granitoid map units and the high-grade metasedimentary rock group. All standard specimens were chosen as being representative on the basis of their megascopic character. The gneissic-granitoid map unit standard samples are represented by a single hand specimen. However, the high-grade metasedimentary rocks are represented by combinations of five to ten specimens because of the typically wide lithological variation within a single band. Standard metasedimentary rock samples were collected approximately perpendicular to the regional strike of the compositional banding.

Modal analyses for the granitoid and gneissic rock units are plotted on a series of ternary Q-A-P diagrams shown in figure 2. Plots of rock type modal data for this study area are distinguished from plots for the same rock type from other parts of the Shield in Alberta. Rock type boundaries have been incorporated into these diagrams according to the recommendations of Streckeisen (1967).

The compositional ranges of the granitoid units (based on figure 2) are listed in table 9 for comparative purposes.

This comparison shows a wide range of composition for the granitoid rock units: Fishing Creek Quartz Diorite, Slave Granitoids, and Thesis Lake Granite. In addition, field relationships and the occurrence of leucocratic components intimately mixed with each of these units suggest that these granitoids have a similar or common petrogenetic history. Such history indicates: regional granitization in the infrastructure, followed by remobilization and intrusion into the superstructure, and a later local metamorphic segregation of leucocratic components.

TABLE 8
Modal and Chemical Analyses of Standard Samples for Metasedimentary Bands 36, 37, 38, 39, 40, 41, 42

	Metasedimentary Band Number						
	36	37	38	39	40	41	42
Quartz	40.9	36.8	30.3	38.6	37.4	38.0	45.7
Potash Feldspar	11.2	6.3	3.1	11.2	10.7	13.4	9.3
Plagioclase	18.7	25.8	35.5	31.1	30.4	37.0	21.1
Amphibole	tr	-	-	-	-	-	-
Biotite	12.0	14.8	17.5	13.3	11.0	6.7	6.7
Muscovite	6.4	6.2	7.9	1.0	0.7	2.6	0.8
Sericite	-	-	-	-	-	-	-
Chlorite	3.3	4.5	3.3	0.8	3.3	0.8	1.0
Epidote	tr	0.1	0.7	0.1	2.9	1.0	0.2
Andalusite	-	-	0.3	-	-	-	-
Sillimanite	0.1	0.1	-	-	tr	-	0.3
Cordierite	0.7	1.0	-	-	0.2	-	1.6
Garnet	4.3	3.3	-	2.9	2.5	0.1	12.0
Calcite	-	-	0.3	-	-	-	-
Pyroxene	0.9[1]	0.1	-	-	-	-	-
Accessories	1.5	1.0	1.1	1.0	0.9	0.4	1.3
SiO_2	69.40	72.33	56.70	69.99	69.06	71.98	66.54
TiO_2	0.74	0.77	0.72	0.46	0.54	0.26	0.51
Al_2O_3	12.42	10.44	20.88	14.06	13.62	14.98	16.99
Fe_2O_3	5.91	4.64	4.11	3.73	4.96	2.42	6.08
MgO	1.69	2.49	2.42	1.66	1.37	1.01	1.80
CaO	1.19	1.95	1.88	1.68	1.80	1.11	1.35
Na_2O	2.15	2.14	2.53	2.86	2.95	3.49	2.28
K_2O	3.84	3.52	4.00	3.23	2.48	3.00	1.53
MnO	0.08	0.01	0.03	0.08	0.11	0.05	0.59
P_2O_5	0.10	0.04	0.05	0.10	0.10	0.10	0.17
LOI	2.18	1.66	4.36	0.83	0.91	0.77	0.77
H_2O	0.15	0.44	0.77	0.16	0.11	0.17	0.19
TOTAL	100.21	100.43	98.45	98.84	98.01	99.34	98.80

[1] ortho-pyroxene

TABLE 9
Compositional Distribution of Granitoid Rock Types

	Alkaline Granite	Granite	Granodiorite	Quartz Diorite
Fishing Creek Quartz Diorite (135)	-	m	m	D
Slave Granite (101 + 102)	m	D	m	m
Thesis Lake Granite (110)	-	D	m	-
Chipewyan Red Granite (150)	(m)	D	-	-

Frequency of rock type compositions: D - major; m - minor; (m) - questionable data

On the other hand, Chipewyan Red Granite (150) has a very limited range in composition and does not show the later segregation of leucocratic components. Its petrogenesis is different from that of Fishing Creek Quartz Diorite, Slave Granitoids, and Thesis Lake Granite, and may have involved plutonic intrusion of magmatic material into the superstructure without subsequent significant metamorphic differentiation. Magmatic processes may have played a more dominant role in the formation of the Chipewyan Red Granite (150) than in the genesis of other granitoids in the Fort Chipewyan map area.

The granite gneisses in the Fort Chipewyan area have a limited compositional range compared to the total variation in granite gneisses throughout the Shield in Alberta (Fig. 2E). The standard sample compositions are clustered in the granite field with only a minor spread into the granodiorite field. The unusually high quartz content of standard sample 252 (Table 4) is likely due to silification accompanying cataclasis. The granitic composition of gneisses in the Fort Chipewyan district suggests that they were the parent materials for the younger granitoids.

The amphibolites are believed to be derived by metamorphism of diabasic intrusions. The metasedimentary rock bands are principally quartzitic, but range to pelitic in character.

Further discussion and syntheses of these data will be presented when they are combined with similar data from adjacent map areas.

METAMORPHISM

Metamorphic grades are high, ranging from amphibolite to granulite facies (Godfrey and Langenberg, 1978). Occurrences of hypersthene have been noted in the Slave Granitoid (just north of the map area) and Thesis Lake Granite. Spinel, hypersthene, and sillimanite are typical of the metasedimentary rocks west of Loutit Lake, which means that these rocks have attained granulite facies conditions.

Almandine, and/or hornblende are widely distributed in the Arch Lake Granitoid, Fishing Creek Quartz Diorite, and some metasedimentary rock bands, whereas cordierite is common in the metasedimentary rocks. Therefore, these rock units are placed in the amphibolite facies.

Retrograde metamorphism is commonly expressed by the widespread occurrence of chlorite and epidote. Chlorite is usually seen as an alteration product of biotite, hornblende or garnet, whereas epidote occurs as veinlets.

STRUCTURAL GEOLOGY

Most rock masses in the map area show some degree of deformation, cataclastic and/or plastic, and more than one phase of deformation is evident in some places.

The basement granite gneisses may show two phases of plastic deformation, and locally three can be identified. The metamorphic foliation of the granite gneisses exhibits a regional northeast strike with dips predominantly steep (65 to 90 degrees) towards the west. The gneissic-granitoid basement formed in the course of repeated sedimentation, metamorphism, plutonic intrusion, and plastic deformation, – events which have generated an intimate mixture of rock types of plutonic association.

The Allan Fault mylonite zone (Watanabe, 1965), which cuts the granite gneisses, is the major structural break in the exposed shield of northeastern Alberta and can be traced for 200 miles (300 km) between Lake Athabasca and the East Arm of Great Slave Lake to the north.

Movement along the Allan Fault zone probably spans a wide range of geologic time, including specific adjustments during the Hudsonian and Elsonian Events (Watanabe, 1965). Episodic movements along the Allan Fault zone are suggested according to the following timetable:

1. Kenoran (2560 m.y.+) – possible initiation of major faulting, principally affecting the basement granite gneisses;

2. Hudsonian (1800 m.y.+) – main development of the mylonitic belts, followed by plastic deformation of the mylonitic rocks due to deep-seated crustal remobilization;

3. Elsonian (1400 m.y.+) – relatively minor reactivation at higher crustal levels expressed as brittle deformation, for example, brecciation of mylonitic rocks with quartz-filled openings and comb-quartz-lined vugs.

The generation of mylonitic zones up to 6 miles (10 km) wide and more than 200 miles (300 km) in length seem most likely to be explained by a major regional feature such as a plate tectonic suture or shear.

The granite gneiss terrain has been subjected to intense cataclasis within the major mylonitic zone of the Allan Fault (Godfrey, 1958a), which attains a maximum width of 6 miles (10 km). Within the cataclastic zone the granite gneisses have been altered to mylonites, ultramylonites, cataclasites, blastomylonites, and other less crushed phases such as flaser gneisses. Minor re-brecciation of the mylonites with quartz filling and quartz-lined vugs is found locally.

The metasedimentary rock bands, including those with intimately mixed metamorphic quartzo-feldspathic components, show degrees of plastic deformation which are locally migmatitic. Some amphibolite masses have a boudinage structure, whereas other narrow amphibolite bands may be harmoniously folded within the intricate flow folds of the enclosing granite gneissic terrain. Pegmatites display a range in the degree of folding, which probably reflects a variety of local conditions during periods of pegmatite formation and deformation. Individual fold forms are generally harmonious with the structures of the enclosing rock, whether it be metasedimentary rock, Thesis Lake Granite, or Fishing Creek Quartz Diorite.

The metamorphic fabric varies within each plutonic body, regardless of its size. Each intrusion includes a locally massive phase which grades into a more typically metamorphically foliated or lineated texture. An extensive, relatively mild cataclastic foliation is characteristic of many plutons in the Fort Chipewyan map area. Pluton margins are locally severely sheared, for example, the west margin of the main Chipewyan Red Granite pluton which is in fault contact with the Flett Lake Fault Zone (trending northeasterly through Flett Lake and Riviére des Rochers). Variations in metamorphic fabric between plutons suggest that the latter were emplaced over a period of time and at different times relative to tectonic activity.

The main Chipewyan Red Granite pluton measures about 5 by 22 miles (8 by 35 km) in outcrop, and its long axis conforms to the regional northeast structural grain of the area. This pluton is of relatively uniform lithology and is nearly free of xenoliths and gneissic phases towards the southwest end. A more xenolithic-gneissic character typifies the northeast end, which suggests that it may be closer to the original pluton roof. Consequently, there is an implication of unequal uplift subsequent to intrusion, with the southwest end of the pluton undergoing greatest uplift. The interpretation of a 'south end up' rotational uplift is in agreement with observations on the mylonites of the Allan Fault in the Charles Lake region (Godfrey, 1966). Plastic deformation at the south end of this mylonite belt also indicates uncovering of a deeper crustal level (as compared to the north end).

A representative selection of joint directions is presented on the accompanying maps. At least some of these joints are of tectonic origin (as opposed to those fractures developed as a consequence of decompression during erosional unloading) as evidenced by basic dyke intrusions along north 10° west joint systems in the Chipewyan Red Granite. Decompressional unloading is probably related to some of the minor, steeply dipping fractures and to the flat lying to gently dipping fracture surfaces whose orientations simulate the topographic slopes of the overlying outcrop.

The approximate rectilinear grid pattern of the major river channels, situated between Fort Chipewyan and the Peace River-Slave River junction, is bedrock controlled. The pattern fits in well with the observed northeast trend of the metamorphic foliation and principal faults (Allan Fault and Flett Lake Fault) plus an orthogonal set of fractures.

ECONOMIC GEOLOGY

The principal occurrences of ore minerals are associated with the high-grade metasedimentary rocks. Pyrite is a widely distributed sulfide mineral, commonly found in the metasedimentary and amphibolitic rocks, with minor amounts locally in quartz veins, granite gneisses, and the granitoid plutons.

Uranium mineralization, as indicated by the uranophane yellow bloom and confirmed by a positive geiger counter response, has been noted in several places within the high-grade metasedimentary rocks. Molybdenite has been noted in minor amounts in rocks of the metasedimentary group; it also has a yellow oxidation product (bloom) called powellite. For the prospector, positive identification of a yellow stain as indicating uranium in this terrain requires confirmation of radioactivity by instrument. Considerable interest and activity in uranium exploration has focussed on the Athabasca Basin and its margin in Alberta. An index to assessment reports resulting from exploration programs has been compiled and is available at the Alberta Research Council (Poruks and Hamilton, 1976).

Minor occurrences of copper mineralization (chalcopyrite) have been observed in a gossan patch within a high-grade metasedimentary rock band, just north of the microwave tower at Fort Chipewyan. This occurrence has been prospected by means of minor exploration trenches and pits.

The greatest potential for ore minerals is in the high-grade metasedimentary bands. Fault and shear zones also merit close examination.

The distinctive pink to red color of the Chipewyan Red Granite in outcrop, plus locally widely spaced fractures (3 to 8 feet, or 1 to 2½ m), makes the deep red color phase a particularly attractive building stone prospect. The possible utilization of this granite as a building stone has been under consideration (Godfrey, 1979).

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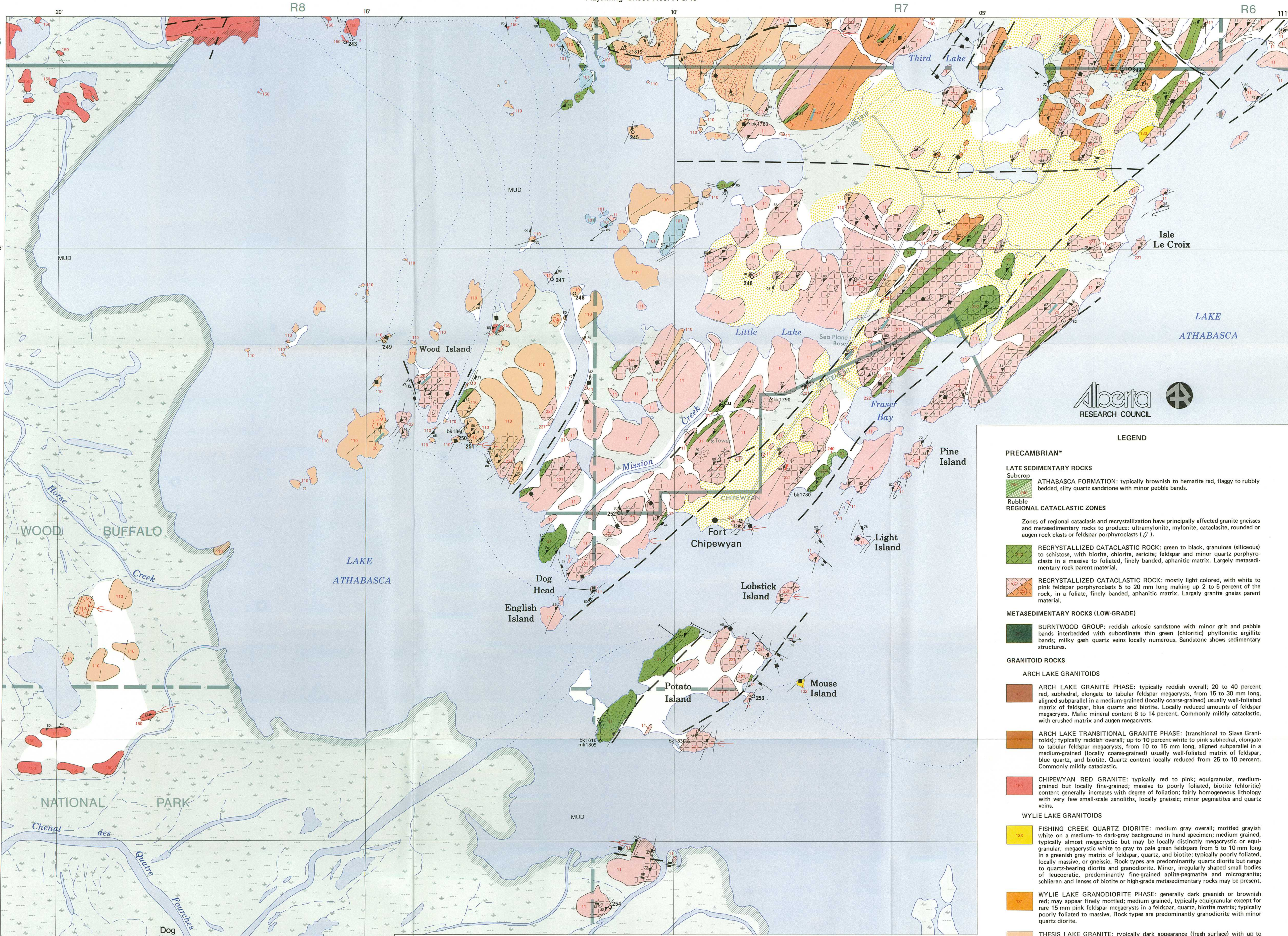

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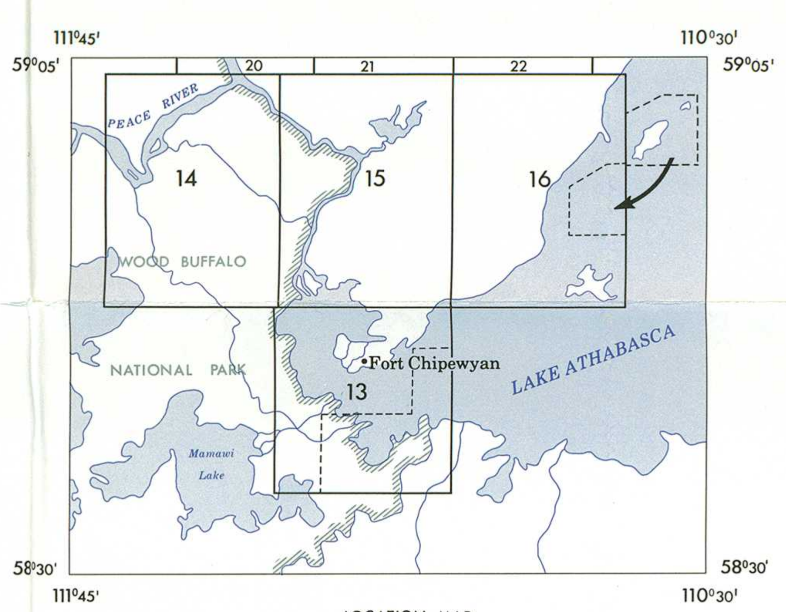
GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

Sheet No. 13

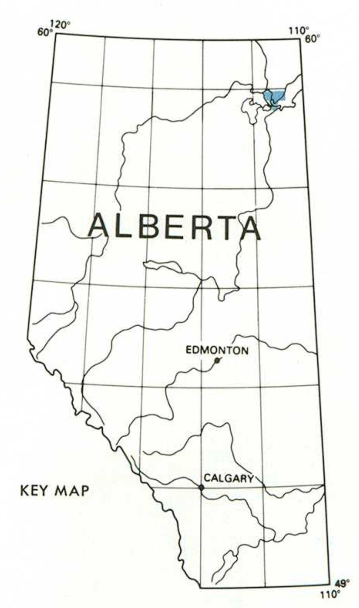
SCALE 1:31,680

Miles 1 0 1 2 Miles

Kilometres 1 0 1 2 3 Kilometres



LOCATION MAP



KEY MAP

Geological boundary (defined, approximate)

Foliation (defined: dip known, dip vertical; foliation assumed)

Foliation trend*

Lineation (combined with dip of foliation)

Extreme contortion (structural trend)

Tight fold (structural trend)

Local gneissosity in generally massive to foliated rock

Joint (dip known, vertical; unknown)

Fault (defined, dip known, assumed)

Shear (with dip)

Breccia

Mylonite (local)

Gossan

Rock alteration (possibly fault related) . . . A

Quartz vein

Granitoid standard sample . . . 259

Metasedimentary band standard sample . . . 46

Mineral occurrence (copper) . . . Cu

Radioactivity

Yellow stain, mineral . . . Y

Garnet . . . G

Chlorite (abundant) . . . C

Epidote (abundant) . . . E

Graphite . . . R

Isotopic age (millions of years); biotite (b), muscovite (m); K-Ar (k); U. of A. . . . Δ bk1740

Glacial stria (direction of ice movement indicated)

Wind-cut groove (wind direction indicated)

Raised beach (downslope direction indicated)*

Dune*

Esker*

Crevasse filling (ridge shown)*

Sand covered area

Drainage

Muskeg

Township boundary

National Park boundary

*Primarily aerial photographic interpretation

Geology by John D. Godfrey, 1970

LEGEND

PRECAMBRIAN*

LATE SEDIMENTARY ROCKS

Subcrop / Rubble (240)

ATHABASCA FORMATION: typically brownish to hematite red, flaggy to rubbly bedded, silty quartz sandstone with minor pebble bands.

REGIONAL CATACLASTIC ZONES

Zones of regional cataclasis and recrystallization have principally affected granite gneisses and metasedimentary rocks to produce: ultramylonite, mylonite, cataclasite, rounded or augen rock clasts or feldspar porphyroclasts ( ).

222 — RECRYSTALLIZED CATACLASTIC ROCK: green to black, granulose (siliceous) to schistose, with biotite, chlorite, sericite; feldspar and minor quartz porphyroclasts in a massive to foliated, finely banded, aphanitic matrix. Largely metasedimentary rock parent material.

221 — RECRYSTALLIZED CATACLASTIC ROCK: mostly light colored, with white to pink feldspar porphyroclasts 5 to 20 mm long making up 2 to 5 percent of the rock, in a foliate, finely banded, aphanitic matrix. Largely granite gneiss parent material.

METASEDIMENTARY ROCKS (LOW-GRADE)

201 — BURNTWOOD GROUP: reddish arkosic sandstone with minor grit and pebble bands interbedded with subordinate thin green (chloritic) phyllonitic argillite bands; milky gash quartz veins locally numerous. Sandstone shows sedimentary structures.

GRANITOID ROCKS

ARCH LAKE GRANITOIDS

161 — ARCH LAKE GRANITE PHASE: typically reddish overall; 20 to 40 percent red, subhedral, elongate to tabular feldspar megacrysts, from 15 to 30 mm long, aligned subparallel in a medium-grained (locally coarse-grained) usually well-foliated matrix of feldspar, blue quartz and biotite. Locally reduced amounts of feldspar megacrysts. Mafic mineral content 6 to 14 percent. Commonly mildly cataclastic, with crushed matrix and augen megacrysts.

162 — ARCH LAKE TRANSITIONAL GRANITE PHASE: (transitional to Slave Granitoids); typically reddish overall; up to 10 percent white to pink subhedral, elongate to tabular feldspar megacrysts, from 10 to 15 mm long, aligned subparallel in a medium-grained (locally coarse-grained) usually well-foliated matrix of feldspar, blue quartz, and biotite. Quartz content locally reduced from 25 to 10 percent. Commonly mildly cataclastic.

150 — CHIPEWYAN RED GRANITE: typically red to pink; equigranular, medium-grained but locally fine-grained; massive to poorly foliated, biotite (chloritic) content generally increases with degree of foliation; fairly homogeneous lithology with very few small-scale zenoliths, locally gneissic; minor pegmatites and quartz veins.

WYLIE LAKE GRANITOIDS

133 — FISHING CREEK QUARTZ DIORITE: medium gray overall; mottled grayish white on a medium- to dark-gray background in hand specimen; medium grained, typically almost megacrystic but may be locally distinctly megacrystic or equigranular; megacrystic white to gray to pale green feldspars from 5 to 10 mm long in a greenish gray matrix of feldspar, quartz, and biotite; typically poorly foliated, locally massive, or gneissic. Rock types are predominantly quartz diorite but range to quartz-bearing diorite and granodiorite. Minor, irregularly shaped small bodies of leucocratic, predominantly fine-grained aplite-pegmatite and microgranite; schlieren and lenses of biotite or high-grade metasedimentary rocks may be present.

131 — WYLIE LAKE GRANODIORITE PHASE: generally dark greenish or brownish red; may appear finely mottled; medium grained, typically equigranular except for rare 15 mm pink feldspar megacrysts in a feldspar, quartz, biotite matrix; typically poorly foliated to massive. Rock types are predominantly granodiorite with minor quartz diorite.

110 — THESIS LAKE GRANITE: typically dark appearance (fresh surface) with up to 10 percent hematized red to pink megacrystic augen feldspars 6 to 13 mm long (locally 20 mm), and bluish gray quartz, in a medium-grained, foliated matrix; biotite may be chloritized, lithology fairly homogeneous, very few small-scale xenoliths; minor, distinctive quartzo-feldspathic aplitic ( ) to pegmatitic bodies ( ) locally concentrated as pods, blocks and dykes, forming from 10 to 90 percent of individual outcrops within the Thesis Lake Granite.

SLAVE GRANITOIDS

101 — SLAVE GRANITE PHASE: typically whitish gray (locally white to greenish gray or pink feldspar mottled on a darker background); medium- to coarse-grained (locally fine-grained); up to 5 percent white feldspar megacrysts, 7 to 15 mm long, in a matrix of white feldspars, quartz, and biotite (<1 to 5 percent); massive to more commonly foliated (increase in biotite content tends to better define foliation); typically garnetiferous, may be locally gneissic; includes minor small-scale mafelsic lenses of metasedimentary appearance; minor gray white, fine- to medium-grained felsic dykes and quartz veins.

102 — MAFIC SLAVE GRANITE PHASE: similar to Slave Granite but with a notably higher biotite content (up to 10 percent); distinctly foliated.

MEGACRYSTIC COMPONENT: up to 15 percent white feldspar megacrysts 15 to 50 mm long, either randomly oriented or aligned with the foliation of map-units 101 and 102 (▮).

METASEDIMENTARY ROCKS (HIGH-GRADE)

31 — METASEDIMENTARY ROCKS: the high-grade metasedimentary rock types included in this map unit are lithologically and texturally gradational, and in part intermixed on outcrop scale. Typically impure quartzite, fresh surface is dark, greenish (bluish) gray; fine-grained, layered, with ferruginous and garnetiferous zones, locally scattered pyrite, gossans, and milky or bluish gray quartz pods and veins. Minor amphibolite may be present. Common local lithologic gradational variations to: (1) fine- to medium-grained, metamorphic quartzo-feldspathic (granitic and minor pegmatitic) phase ranging from individual white feldspar megacrysts, 5 to 15 mm long, to nebulous or distinct aggregations and masses; commonly foliated to locally gneissic ( ) (2) fine-grained, retrograde phyllite and schist (biotite, chlorite, sericite, and uncommonly hornblende), and phyllonite.

AMPHIBOLITE

20 — Dark brownish green (fresh surface) to grayish green; typically medium grained; biotite may be common; composition ranges from essentially amphibole pure or amphibole rich to a feldspathic biotite amphibolite; commonly foliated but may be banded where feldspar rich; minor pyrite common.

GRANITE GNEISSES

12 — HORNBLENDE GRANITE GNEISS: typically pink to reddish with dark green bands; quartz-feldspar bands interlayered with mafic-rich bands (hornblende, with biotite; generally chloritic) on hand specimen scale; fine- to medium-grained, typically equigranular, uncommonly megacrystic; typically well banded, uncommonly poorly banded, and rarely foliated. Composition is predominantly granite, with minor granodiorite, and quartz diorite. Large areas are migmatitic, particularly where intimately associated with minor lenses, pods, or bands of metasedimentary rocks, pegmatite, or amphibolite.

11 — BIOTITE GRANITE GNEISS: typically pink to reddish; quartz-feldspar bands interlayered with mafic-rich bands (biotite, possibly with subordinate hornblende; may be chloritic) on hand specimen scale; fine- to medium-grained, generally equigranular, rarely megacrystic; commonly well banded but may be locally poorly banded to foliated, and leucocratic phases may be nearly massive. Composition is predominantly granite, with minor quartz monzonite, granodiorite, quartz diorite, and monzodiorite. Large areas are migmatitic, particularly where intimately associated with minor lenses, pods, and bands of metasedimentary rocks, pegmatite, and amphibolite.

*NOTE: Rock groups are arranged in approximate chronological sequence. Nomenclature follows Streckeisen (1967): Classification and Nomenclature of Igneous Rocks; Neues Jahrbuch für Mineralogie, Abhandlungen, 107, No. 2, pp. 144-240.

Base maps compiled from planimetric sheets published by Alberta Department of Lands and Forests, Edmonton

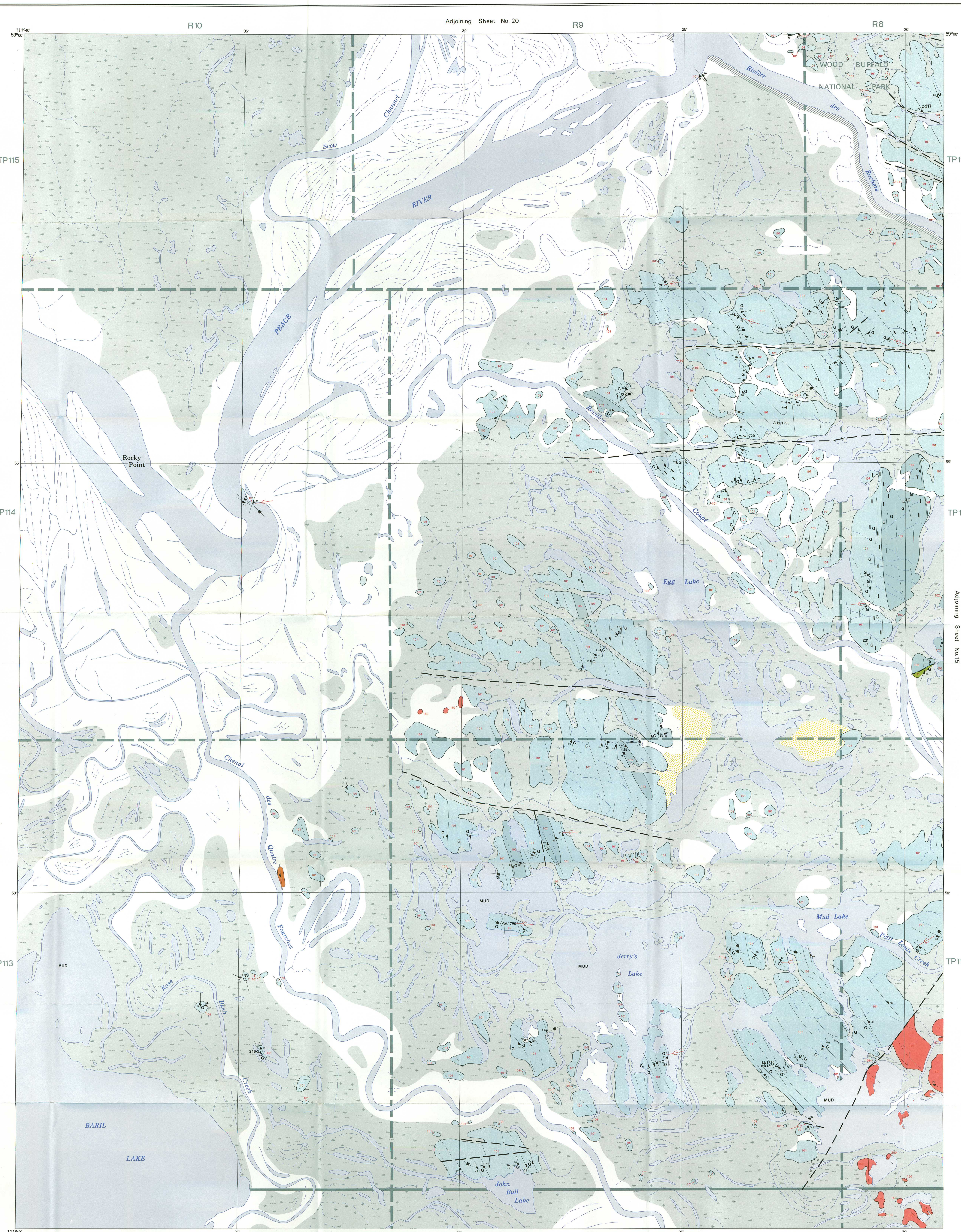
Air photographs covering this area are obtainable from the Technical Division, Alberta Department of Lands and Forests, Edmonton and the National Air Photographic Library, Ottawa

Approximate magnetic declination 24° 16' East in 1979, decreasing 6' annually.

Map drawn by C. Parent

Cartographic editing by A. Campbell

Published 1979



GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

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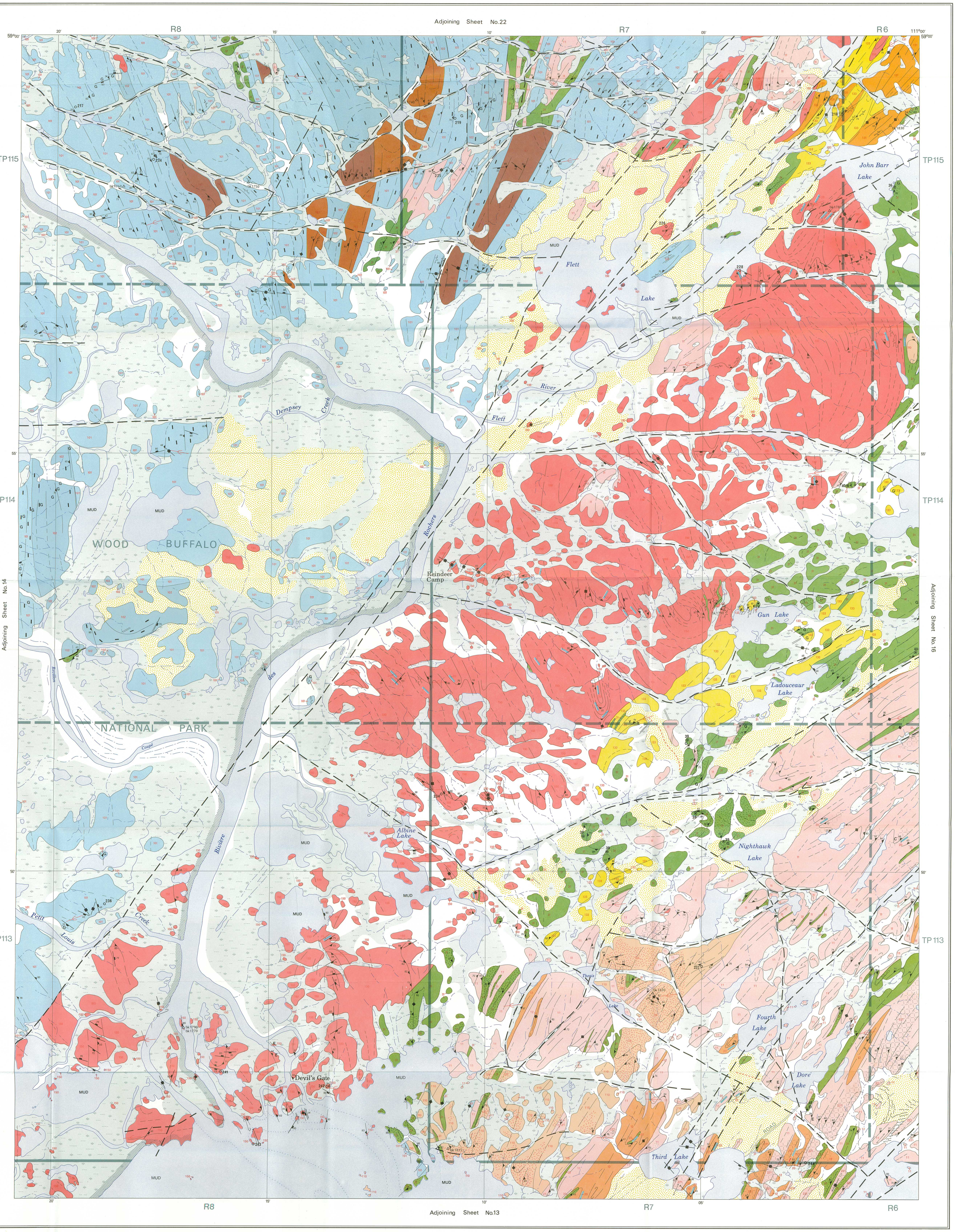

SCALE 1:31 680

Miles 1 0 1 2 Miles

Kilometres 1 0 1 2 3 Kilometres

GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

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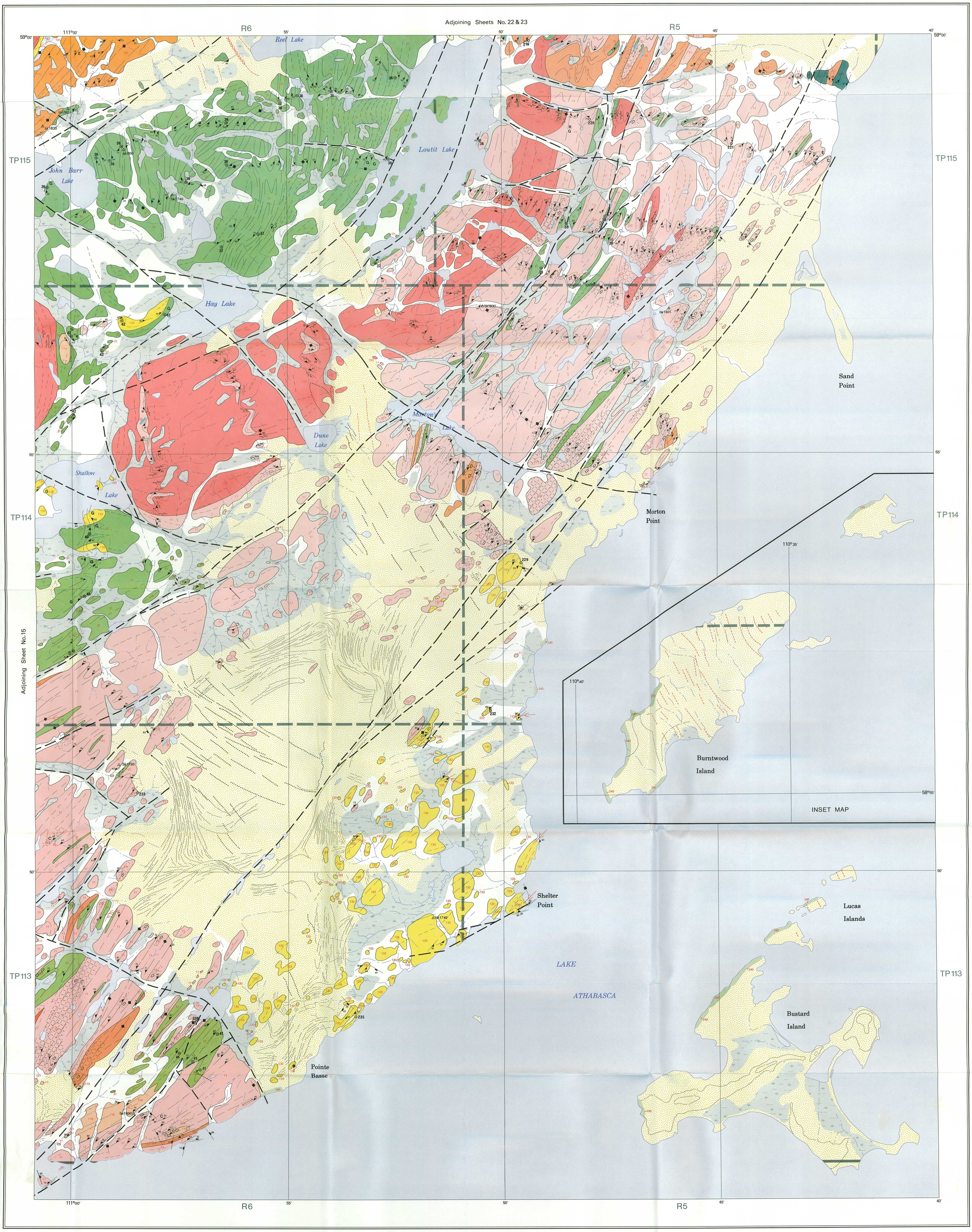

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GEOLOGY OF THE FORT CHIPEWYAN DISTRICT, ALBERTA

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