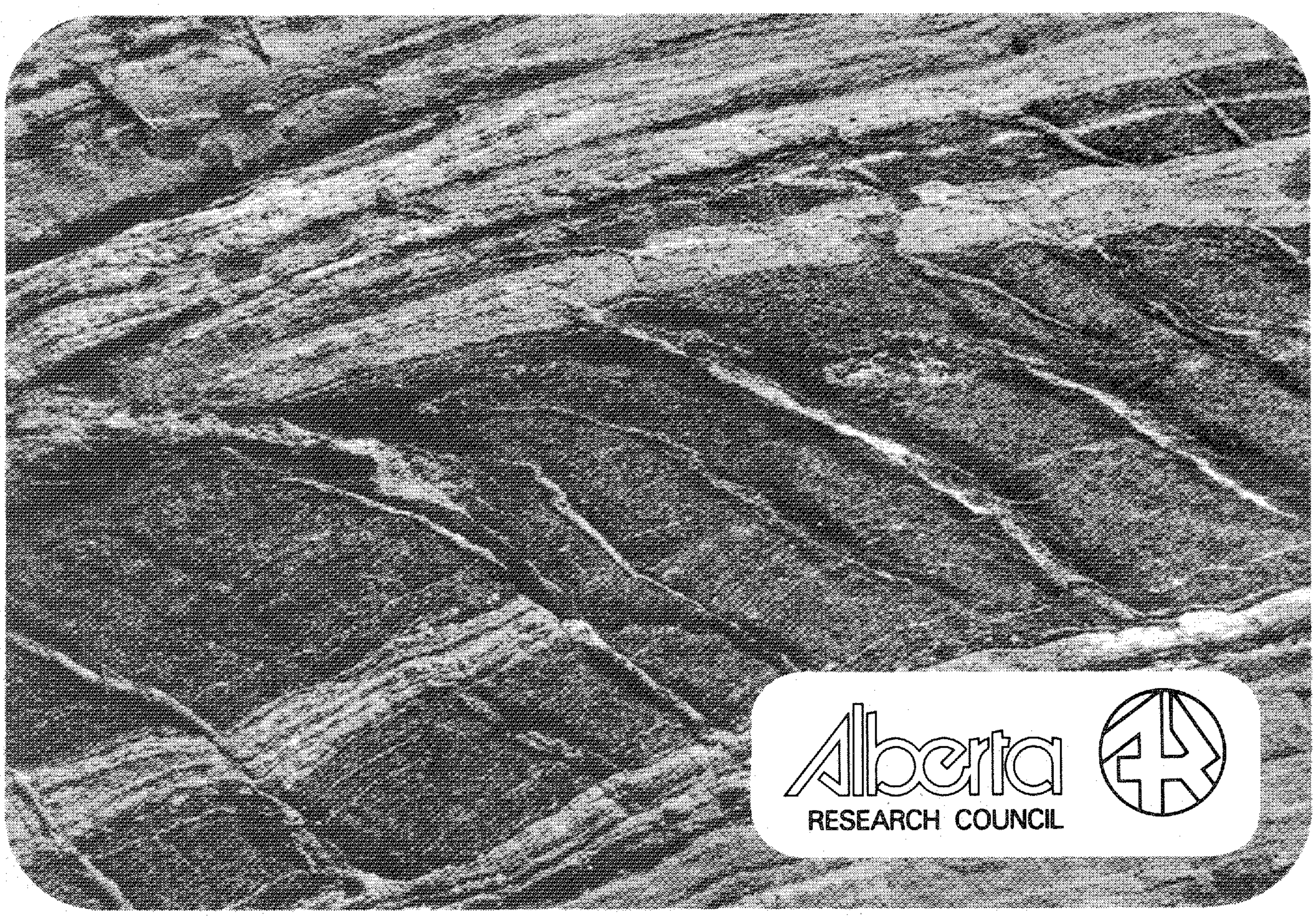
GEOLOGY OF THE ALEXANDER-WYLIE LAKES DISTRICT, ALBERTA

JOHN D. GODFREY

Earth Sciences Report 78-1



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Alberta Research Council
1980

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Price: $3.00

Editing: A. Campbell
Manuscript Production: D. Palting, J. Brataschuk, J. Cole
Design: L. Chesko
Drafting: C. Parent

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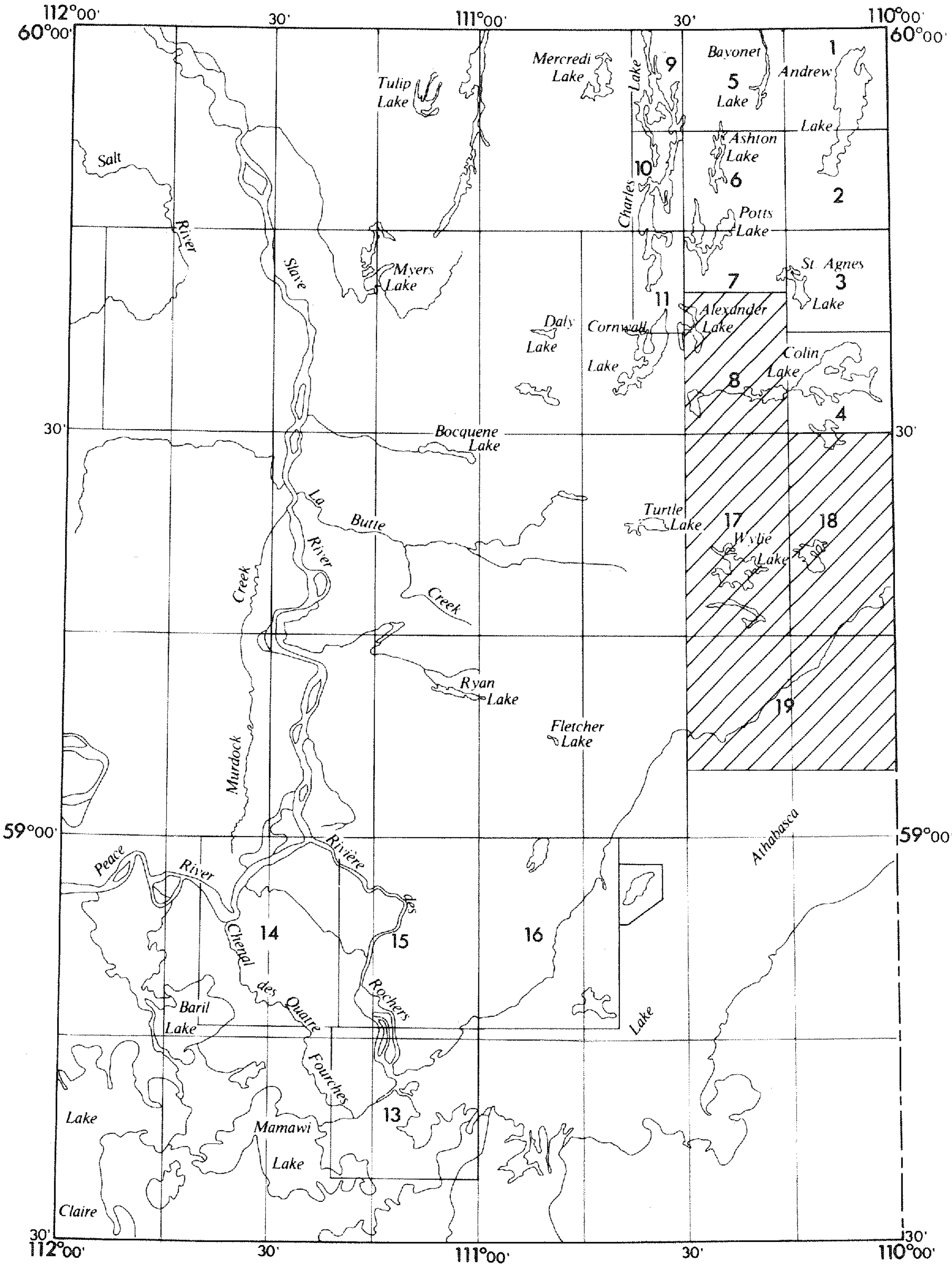


FIGURE 1. Location of Study Area, Map Sheets 8, 17, 18, 19 and index to Alberta Research Council Canadian Shield geology map series

GEOLOGY OF THE ALEXANDER-WYLIE LAKES DISTRICT, ALBERTA

ABSTRACT

The geology of 486 square miles (1254 km^2) of Precambrian Shield in northeastern Alberta is presented on four colored map sheets at a scale of 2 inches to 1 mile.

Sixteen main rock types and several sub-phases are distinguished on these maps. Their characteristics 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 rocks in the Wylie Lake area consist of a migmatitic complex of para- and ortho-gneisses, with minor amphibolite and high-grade meta-sedimentary rocks which are probably of Archean age. This basement complex probably represents multiple cycles of sedimentation, intrusion, deformation, and metamorphism, where ductile or brittle deformation has affected all rock units. The Archean rocks formed under granulite facies conditions and were subsequently overprinted by amphibolite facies conditions during the Hudsonian Orogenic Event. Aphebian granitoid rocks were formed under amphibolite facies metamorphic conditions, possibly from basement complex parent materials. All of these rocks were subjected to a late Hudsonian retrograde greenschist metamorphism. A regional mylonitic fault zone cuts the basement complex in a northerly direction along the west side of the study area.

Anomalous radioactivity was found in granitoid bodies, especially in the coarse-grained and pegmatitic phases, over large areas north of Fidler Point.

The gneissic-granitoid basement complex is unconformably overlain by Athabasca Formation sandstones at several points along the shoreline of Lake Athabasca. A well-developed regolith has been mapped beneath the Athabasca sandstone at Greywillow Point.

The area was glaciated during the continental glaciation of Pleistocene Age and features of glacial erosion and deposition are common.

INTRODUCTION

About 3,600 square miles (9,300 km^2) of Precambrian Shield are exposed in northeastern Alberta, north of Lake Athabasca. This report describes the general geology and mineral occurrences of 486 square miles (1,254 km^2) in the southeast part of this Shield area.

LOCATION AND ACCESS

The study area, which lies within NTS map area 74M, extends west from the Alberta-Saskatchewan provincial boundary to 110°30′W longitude and lies between latitudes 59°05′N and 59°49′43″N (Fig. 1). The geology of this area is depicted on the four accompanying maps at a scale of 1:31,680.

The study area is accessible from both Fort Chipewyan and Uranium City, Saskatchewan, both of which are serviced by regularly scheduled commercial airline flights from Edmonton, Alberta.

PHYSIOGRAPHY

Pleistocene glaciers scoured the area, producing a landscape characterized by numerous rock-basin lakes, low rounded hills, and a locally rugged surface having a maximum relief of about 250 feet (80 m). Elevations above sea level in the area range from 700 feet (210 m), the water level of Lake Athabasca, to just over 1200 feet (360 m) in the northeastern part of Wylie Lake map area (map 18). Evidence indicates two directions of ice advance in the area. The main continental ice sheet (Wisconsin) advanced from the east, followed by a later local readvance from the northeast.

Glaciofluvial sandy plains, drumlinoid masses, kames, kettles, crevasse fillings and extensive outwash deposits are found in the southern part of the Alexander Lake map area (map 8) and in the northern parts of Wylie Lake map areas (maps 17 and 18). Farther south, large areas of sand are associated with a zone of well-defined raised beaches just inland from Lake Athabasca. These beach sands were formed by reworking of glacial deposits during the late-glacial period when water levels were much higher in Lake Athabasca. A ridge of esker deposits, located in map 18, which terminates in a delta fan, also formed during late-stage deglaciation. Meltwater flowed southward from the study area and emptied into Lake Athabasca at a time when the lake level was higher and the lake covered a larger area than at present.

Precambrian bedrock crops out over approximately two-thirds of the map area. The nearly level surface of the Precambrian Shield is dissected by relatively straight valleys occupied by lakes, muskegs, and streams. In the southeastern part of the map area, the Shield's surface slopes down towards Lake Athabasca, where Athabasca Formation sandstones and conglomerates unconformably overlie the basement Shield rocks in the shore and nearshore area. Waters from the study area drain principally to the south, either directly towards Lake Athabasca, or indirectly through Colin Lake and Colin River.

Within the Shield terrain the distribution, sizes, and shapes of lakes, and the pattern of glacial and minor stream erosion, are primarily controlled by structural and lithological features of the bedrock. Many narrow, elongated lake bays are found in eroded fault zones, and straight portions of lake shorelines (especially where they are transverse to the local metamorphic foliation) suggest fault lines. Glacial erosion has been selective: fracture zones and mechanically weak rocks (metasedimentary rocks) tend to be plucked out, particularly on the west and south sides of lakes, giving rise to indented shore outlines. Exceptionally clean, fresh bedrock surfaces are found along the shorelines bordering many rock-basin lakes. Such water-washed surfaces are particularly suitable 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 at a scale of 1 inch to 4 miles. Geological mapping of the Fort Smith area, Northwest Territories, at the scale of 1 inch to 4 miles, 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 (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 systematic mapping of the Precambrian Shield in northeastern Alberta. Some maps in this series have been published, at a scale of 2 inches to 1 mile (Godfrey, 1961, 1963, 1966, in press; Godfrey and Peikert, 1963, 1964). Geochronological studies of the earliest mapped portions of the Shield, carried out in collaboration with H. Baadsgaard, University of Alberta, have been published (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 publication by Godfrey (1958b). A summary of the metamorphic history of the Precambrian Shield exposed in Alberta was recently published by Godfrey and Langenberg (1978a, 1978b).

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 (scale: 1 inch to 4 miles) with marginal notes (Riley, 1960).

The Saskatchewan Department of Mineral Resources (Koster, 1961, 1962, 1963, 1967, 1971) has published geological maps at a scale of 1 inch to 1 mile, which deal with the geology of northwestern Saskatchewan, both adjacent and near to the Alberta boundary.

In 1958, Godfrey (1958a) published an interpretation of the geological structure of the Shield in Alberta, north of Lake Athabasca, based on vertical stereoscopic air photographs.

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

A number of theses based on various aspects of the bedrock geology have been completed in the course of the Alberta Research Council's mapping program. Peikert (1961) worked on a series of granitoid rocks in the Colin-Waugh Lakes area, and later published part of this study (1963).

Watanabe (1961, 1965) studied a band of interbedded low-grade metasedimentary and metavolcanic rocks in the Waugh Lake area and a mylonite belt in the Charles Lake area. Klewchuk (1972) studied several granitoid rock types in the Fort Chipewyan district.

PRESENT STUDY

The principal part of the fieldwork, on which the accompanying maps are based, was completed in 1971. Field data in areas peripheral to the Alexander-Wylie Lakes study area were obtained in 1958, 1959, 1961, 1963, 1972, and 1973.

The four accompanying geological maps are based on sub-parallel foot traverses oriented across regional strike (pace and compass controlled), spaced from ½ to 1 mile (0.8 to 1.6 km) apart. The traverse spacing depended on the complexity of the bedrock geology and on the availability of outcrop.

ACKNOWLEDGMENTS

Acknowledgment and appreciation is extended to each member of the 1971 field staff which consisted of: Peter Klewchuk and Maurice B. Dusseault — assistant geologists; Malcolm Fraser, Rae Runge, Bruce Skripnek, and Godfrey J. Walton — field assistants. Special thanks are extended to Betty Dusseault who cooked for the field crew. C. Willem Langenberg has provided helpful discussion and suggestions in the preparation of this manuscript.

GENERAL GEOLOGY

The Precambrian Shield complex of igneous, metamorphic, and sedimentary rocks that underlies the study area forms part of the Churchill Structural Province. The geologic history of this area involves multiple cycles of sedimentation, metamorphism, and deformation, accompanied by remobilization and plutonic intrusion. It seems most likely that during Archean times supracrustal gneisses rested on granitoid rocks. Based on metamorphic mineral assemblages, these Archean gneisses show evidence of having been subjected to granulite facies conditions, but were subsequently thoroughly recrystallized under amphibolite facies conditions during the Hudsonian Orogenic Event. This later major thermal event effectively reset the mica K-Ar system; a large number of biotite and muscovite K-Ar dates fall in the narrow age bracket of 1.74 and 1.83 billion years (late Aphebian).

The study area consists of two main terrains: the mantling granite gneisses, which occupy the Alexander Lake map area and extend along the western margin of the Wylie Lake map area, and the Wylie Lake granitoid complex which makes up the major part of the Wylie Lake map area. Rocks of these terrains comprise four natural groups which are presented in table 1 along with their constituent rock types. Their relative age relationships are set out in table 2.

The Wylie Lake granitoid complex terminates on the west side against a major regional fault, the Allan Fault, which primarily cuts granite gneisses. These mantling granite gneisses are exposed north of the granitoid complex. The geology to the east in Saskatchewan has been published recently by Harper (1978). To the south the complex is overlain unconformably by Athabasca Formation sedimentary rocks, largely obscured by the waters of Lake Athabasca.

Pleistocene age continental glaciation forms a significant recent event in the geological history of this region. However, glacial deposits cover a minor part of the study area, leaving a large proportion of bedrock outcrop.

TABLE 1
Principal rock groups, constituent rock types, and their field associations, Alexander-Wylie Lakes District, Alberta

Mylonites	Basement Complex: Granite Gneisses	Basement Complex: High-Grade Metasedimentary Rocks	Granitoid Rocks	Sedimentary Rocks
				Athabasca Formation
			Leucocratic Granite	
221 ←	*Hornblende Gr. Gneiss Biotite Granite Gneiss	- - - - - - - - →	Wylie L. PQ Granite Chipewyan Red Granite	
222 ←		*Granitic Metasedimentary Rocks - - →	Granodiorite D Fishing Creek Q.D. Granodiorite E Wylie L. Granodiorite Quartz Diorite C	
223 ←		Metasedimentary Rocks		
221 ←	*Amphibolite ↑ ←	*Amphibolite ↑ ←	Amphibolite ↑	

× Parent materials of mylonites

⇄ Close field, and possible genetic, relationships

↑ Intrusive relationship

TABLE 2
Summary of geologic history of Shield in Alexander-Wylie Lakes District, Alberta

Geologic Age	Rock Units/Groups	Predominant Rock Type(s)	Process-Event	
Recent	Fluvial, lacustrine deposits	Sand, silt, clay	Sedimentation	
Pleistocene	Glacial, -fluvial, -lacustrine	Till, sand, silt	Continental glaciation, deglaciation	
Helikian	Athabasca Fm.	Sandstone	Continental sedimentation	
Aphebian	Regional cataclastic zones	Recrystallized mylonite	Regional faults and cataclasis under retrograde metamorphism (greenschist facies)	Hudsonian Event
Aphebian	Amphibolite	Amphibolite		Hudsonian Event
Aphebian	Leucocratic Granite	Granite		Hudsonian Event
Aphebian	Wylie Lake PQ Granite	Granite (quartz diorite)		Hudsonian Event
Aphebian	Chipewyan Red Granite	Granite	- basic dykes	Hudsonian Event
Aphebian	Granodiorite D	Granodiorite (granite, quartz diorite)	- plutonic intrusion - migmatization	Hudsonian Event
Aphebian	Fishing Creek Quartz Diorite	Quartz diorite, (granodiorite, granite)	- granitization - remobilization	Hudsonian Event
Aphebian	Granodiorite E	Granodiorite, (granite)	Metamorphism	Hudsonian Event
Aphebian	Wylie Lake Granodiorite	Granodiorite, (quartz diorite)	(amphibolite facies)	Hudsonian Event
Aphebian	Quartz Diorite C	Quartz diorite		Hudsonian Event
Archean	Basement Complex	Amphibolite Metasedimentary Rocks Hornblende Granite Gneiss Biotite Granite Gneiss	- basic dykes - plutonic intrusion - granitization Metamorphism (granulite facies) Sedimentation	Kenoran Event

MAP UNITS

Repeated sedimentation, metamorphism, intrusion, and deformation have obscured many of the primary sedimentary and igneous structures and textures. One result has been the generation of mixed-rock assemblages and wide intertonguing contact zones, evident both in outcrop and at a regional scale. Therefore, most map units depicted on the accompanying four map sheets indicate only the predominant rock type, and the minor, smaller-scale lithologic variations are of necessity omitted.

In order to standarize, clarify, and allow comparisons of rock type descriptions and classifications, certain hand specimens were 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, cataclastic, and metasedimentary rock standard samples are listed in tables 3,4,5, 6, and 7 along with their modal and chemical analyses; their field locations are shown on the accompanying geological maps.

THE GRANITE GNEISSES

The granite gneisses form a heterogeneous terrain. Variable characteristics are: the nature and degree of cataclastic deformation; degree and type of metamorphic foliation; grain size; mineralogical composition; the local presence of scattered small leucocratic to felsic granitoid bodies, pegmatites, quartz veins, and epidote veinlets; and the local occurrence of amphibolite and metasedimentary rock bands and lenses. The gneissic terrain includes areas of migmatite, agmatitic associations of amphibolite blocks in a pegmatitic matrix, chaotic to crenulated folds, boudinaged amphibolite, pinch and swell pegmatites, both plastically deformed and undeformed pegmatites, and xenoliths with or without zoned reaction rims. Most of these textural and structural features blend into a plastic flow mélange whose elongation direction parallels that of the local regional metamorphic foliation. These features suggest a complex evolutionary history for the basement granite gneisses.

Biotite and hornblende granite gneisses are characteristically banded, both in hand specimen and in outcrop. The degree in perfection of metamorphic banding development varies insofar as the bands may be discontinuous or streaky, well developed, or poorly developed (as in the case of orthogneisses). The geometric form that banding takes may be dominantly planar, or wavy to contorted, as in migmatitic structures.

The granite gneiss terrain is intruded by minor granitoid bodies (too small to be represented on the map) whose composition may be either similar or gradational to: Chipewyan Red Granite and the Wylie Lake granitoid rocks (that is, granites, granodiorites, and quartz diorites).

In addition to the well-delineated regional zones of mylonitization, patches of cataclastic deformation are also evident in many parts of the granite gneiss terrain.

Biotite Granite Gneiss (11)

Biotite granite gneisses are typically composed of quartz-feldspar felsic layers alternating with biotite-rich (occasionally with minor hornblende), mafic layers or folia. 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 common, and may be accompanied by epidote veinlets. Quartz veins, pods, and pegmatites are fairly common. Isolated grains of allanite and concentrations of magnetite in streaks parallel to the metamorphic foliation have been noted. The biotite granite gneisses range in composition from the predominant granite to the subordinate granodiorite, quartz diorite, and quartz-bearing monzodiorite (Fig. 4F).

Hornblende Granite Gneiss (12)

Hornblende granite gneisses are much less abundant than biotite granite gneisses. They are similar in petrological and structural character. Hornblende-bearing gneisses are rarely without biotite in the mafic layers; however, the converse is not true. Magnetite is more likely to be found in the hornblende-bearing gneisses rather than in the biotite gneisses. Composition ranges from the predominant granite to lesser amounts of granodiorite and quartz diorite.

AMPHIBOLITE (20)

Amphibolite is found in a variety of host rock units, throughout the major rock groups. Such widespread occurrences strongly suggest that the amphibolites are likely to be of several ages and possibly of diverse origins. 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. The lenses and bands are usually plastically or semi-plastically deformed, and elongation directions are aligned parallel to the gneissic structure. Large bodies of amphibolite have not been found in the map area. None of the amphibolites appear to be of volcanic origin; their limited thicknesses and lateral extents do not fit this mode of origin. Most bodies appear fragmented and probably either represent boudinaged dykes and sills, or form part of an agmatitic complex with pegmatite, the complex being enclosed within granite gneiss or metasedimentary rock. Metamorphic differentiation and segregation may be responsible for the formation of some amphibolites.

TABLE 3

Modal and Chemical Analyses of Standard Samples for Granite Gneisses (11 and 12), in percent.*

	Granite Gneisses									
Standard Sample Number	259	261	263	264	268	273	275	284	285	262[1]
Quartz	26.6	31.3	44.8	16.4	16.4	25.9	26.9	18.4	15.0	2.5
Potash Feldspar	1.5	32.5	17.1	15.8	7.7	0.2	43.6	10.7	36.2	0.1
Plagioclase	64.9	33.1	35.2	48.1	64.1	61.1	25.0	54.6	43.4	62.0
Biotite	-	2.5	2.2	11.0	8.0	12.2	4.3	10.2	-	12.6
Chlorite	6.5	0.3	0.6	1.3	-	-	0.1	0.2	3.0	0.2
Hornblende	-	0.1	-	-	-	-	-	4.1	-	19.1
Epidote	0.1	-	tr	7.2	1.8	0.6	0.1	1.3	0.2	0.2
Muscovite	-	-	0.1	-	1.1	-	-	0.1	2.2[2]	0.2
Garnet	-	-	-	-	-	-	-	-	-	0.3
Calcite	-	-	-	0.1	0.1	-	-	0.4	-	-
Pyroxene	-	-	-	-	-	-	-	-	-	-
Accessories	0.3	0.2	-	0.1	0.7	-	-	-	-	2.8
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
SiO_2	69.22	71.25	75.11	64.10	67.15	65.38	70.89	64.21	67.39	66.71
TiO_2	0.55	0.30	0.10	0.47	0.43	0.55	0.24	0.46	0.32	0.53
Al_2O_3	15.21	14.55	14.18	15.33	14.19	15.66	14.65	14.11	15.15	14.87
Fe_2O_3	3.61	2.50	0.44	4.74	4.48	5.33	2.80	5.57	3.09	3.88
MgO	1.30	0.65	0.85	1.60	1.82	1.89	1.01	2.84	1.32	1.98
CaO	1.46	2.28	0.76	3.50	2.82	3.82	2.25	4.05	0.41	2.39
Na_2O	5.09	3.27	7.12	3.56	3.55	3.24	3.24	3.04	4.04	3.31
K_2O	1.93	4.88	1.27	4.61	3.91	2.92	4.26	3.94	5.97	4.33
MnO	0.04	0.04	-	0.09	0.05	0.07	0.03	0.07	0.05	0.06
P_2O_5	0.07	0.10	-	0.11	0.20	0.13	0.06	0.18	0.01	0.19
LOI	1.43	0.32	0.65	1.30	1.17	0.98	0.74	1.58	1.72	1.41
H_2O	0.16	0.15	0.20	0.11	0.12	0.12	0.17	0.19	0.22	0.17
TOTAL	100.07	100.29	100.68	99.52	99.89	100.09	100.34	100.24	99.69	99.83

[1] Hornblende granite gneiss (remainder are biotite granite gneiss)

[2] Sericite

*Chemical Analyses by J.R. Nelson

Amphibolites are relatively uncommon in the main plutonic masses of the Wylie Lake Granitoids.

Amphibolites appear dark green on a freshly broken surface and weather to greenish-gray, whereas banded amphibolites 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 and are accompanied by minor amounts of biotite (chloritic) and possibly magnetite. Veinlets of epidote and quartz may be present. The grain size ranges from fine to coarse, hornblende crystals 5 mm and larger being relatively uncommon. The texture ranges from massive to foliated to banded, with the last two being most common. Some of the banded varieties consist of alternating bands 10 to 25 mm thick which differ in their hornblende to feldspar ratio. Where the proportion of hornblende is lower, the amphibolite composition grades to either hornblende granite gneiss or amphibolitic metasedimentary rock.

Many of the amphibolites, particularly in the granite gneiss terrain, are noticeably rusty upon weathering, a feature probably related in part to the common occurrence of small amounts of pyrite.

THE METASEDIMENTARY ROCKS

High-grade metasedimentary and related granitized rocks are found as bands and lenses, principally within the granite gneisses, but minor patches are also found in the granitoid rocks. The long axes of these bands and lenses parallel local trends of the regional metamorphic foliation. Metasedimentary rocks show intricate, steeply dipping isoclinal folds, are locally crenulated (due to flow folding) and migmatitic, and are enclosed within less deformed granite gneisses. Such structural relationships indicate greater mobility (plasticity) in the metasedimentary rocks, possibly a consequence of water released during metamorphism of the sediments, as compared to the relatively dry, enclosing granitoid-gneissic materials.

The typical lithology of the metasedimentary rocks is impure quartzite (31) with minor amounts of schist and phyllite (retrograde). Almandine is commonly seen in outcrop. Metasedimentary rocks are pyritic and generally have a rusty, weathered appearance in outcrop. The rusty weathering may be sufficiently extensive locally to be termed a rusty zone, or even a gossan. Narrow, milky white quartz veins and pods, single or grouped, are usually barren of sulfides in the metasedimentary rocks.

The outstanding feature of the metasedimentary rocks in outcrop is a fairly regular banding, or at least a well-defined foliation. However, this banding (or foliation) becomes more disrupted and discontinuous as the amount of metamorphic quartzo-feldspathic material increases and the rock becomes more granitoid in appearance.

Metamorphism of the sediments initially under granulite and later under amphibolite facies conditions (hypersthene and sillimanite; Godfrey and Langenberg, 1978a) was accompanied by extensive granitization and recrystallization. Granitization of the metasediments and segregation and mobilization of the quartzo-feldspathic components are expressed in a variety of ways: isolated feldspar porphyroblasts; quartzo-feldspathic concentrations in clusters, pods, 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.

In short, the metamorphic products cover a wide lithologic range that grades from banded metamorphic rocks of obvious sedimentary parentage to rocks with a high proportion of recrystallized quartzo-feldspathic material such as gneissoid migmatites and granitoid-pegmatitic masses.

Patches of metasedimentary rocks (and to a lesser extent also the granite gneisses) represent either erosional remnants of the mantling roof rocks (pendants), residual screens, or both. An interpretation of the history of the metasedimentary bodies depends upon an evaluation of the structural relationships and an assessment of the predominant processes (igneous versus metamorphic) involved in the formation of the composite Wylie Lake structure.

THE GRANITOID ROCKS

This division includes all the granitoid rocks, ranging from the main Wylie Lake Granitoid Complex, over 25 miles (40 km) long on its northeast axis, to smaller-sized bodies a fraction of a mile across. Although the structural relationships within the Wylie Lake Granitoids are complex, the bodies are generally elongated to the north-northeast, parallel to the regional metamorphic foliation.

Granitoid lithologies dominate in the adjoining districts of Colin Lake and Wylie Lake. Some of the granitoid lithologies are common to both districts, and others are characteristic of one or other of the two districts.

Colin Lake Granitoids

This group of granitoid rocks (Quartz Diorite C, Granodiorite D, and Leucocratic Granite) characterizes the Colin Lake region and also extends into adjoining parts of the Alexander Lake map area.

TABLE 4

Modal and Chemical Analyses of Standard Samples for Wylie Lake Granitoids, in percent.*

	Wylie Lake Granodiorite (131)						Granodiorite E (132)		
Standard Sample Number	271	286	290	292	294	295	269	270	277
Quartz	24.4	14.8	26.4	20.0	23.8	27.6	21.0	26.6	20.8
Potash Feldspar	12.3	1.1	3.0	18.7	0.1	-	24.6	10.0	8.6
Plagioclase	51.3	61.1	29.0	49.7	56.6	56.4	42.6	50.8	53.0
Biotite	9.9	20.5	33.0	9.9	13.3	15.9	9.8	10.5	12.5
Chlorite	0.3	0.2	1.0	0.6	2.1	0.1	0.3	0.4	-
Hornblende	1.5	-	-	-	-	-	-	-	5.0
Epidote	tr	0.6	-	-	3.7	-	0.8	0.6	-
Muscovite	-	1.7[1]	5.1	1.0	0.3	-	0.5	0.8	0.1
Garnet	-	-	-	-	-	-	-	-	-
Calcite	-	-	-	-	0.1	-	-	tr	-
Pyroxene	-	-	-	-	-	-	-	-	-
Accessories	-	-	-	-	0.3	-	0.3	tr	-
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000	1000	1000	1000
SiO_2	66.19	62.61	65.19	70.40	59.84	63.46	66.86	48.49	68.20
TiO_2	0.48	0.65	0.57	0.26	0.71	0.70	0.46	2.0	0.66
Al_2O_3	15.59	15.36	16.14	14.27	15.11	15.86	15.91	15.88	15.58
Fe_2O_3	3.44	5.90	4.48	3.12	7.03	5.45	3.55	17.50	5.31
MgO	2.64	3.11	2.15	1.39	4.10	2.45	1.83	2.54	4.32
CaO	2.37	2.14	2.45	1.05	4.19	2.95	2.53	5.57	3.57
Na_2O	2.86	4.02	3.07	3.57	2.75	3.09	3.18	3.64	2.83
K_2O	4.11	3.60	4.36	4.19	3.16	3.40	4.32	2.38	3.89
MnO	0.05	0.14	0.08	0.03	0.14	0.09	0.07	0.29	0.08
P_2O_5	0.10	0.18	0.10	0.04	0.48	0.36	0.25	0.74	0.40
LOI	2.08	1.60	1.10	1.25	2.26	1.38	1.31	0.66	1.06
H_2O	0.17	0.27	0.18	0.13	0.24	0.23	0.14	0.23	0.13
TOTAL	100.08	99.58	99.87	99.70	100.01	99.42	100.41	99.92	100.03

[1] Sericite

*Chemical Analyses by J.R. Nelson

Quartz Diorite C (123)

Very limited outcrops of this map unit are found south of Kettle Lake in the Alexander Lake map area. The main outcrop area of Quartz Diorite C in the Shield of Alberta lies outside this study area, just north of Colin Lake, about 8 miles (13 km) northeast of Kettle Lake.

This rock unit has a spotted to mottled appearance in outcrop due to the presence of white to pink feldspar megacrysts within a dark gray matrix. These megacrysts range from 5 to 15 mm long and usually constitute up to about 20 percent of the rock. The medium-grained, mafic-rich matrix is made up of feldspar, quartz, biotite, and hornblende. The matrix is typically foliated, but where sheared, it becomes well foliated and the megacrysts are augen-shaped. Minor amounts of granitic materials associated with Quartz Diorite C include aplite-pegmatite and microgranite. The dominant quartz diorite composition ranges to granodiorite.

In the field, Quartz Diorite C is closely associated with other granitoids such as Fishing Creek Quartz Diorite, Wylie Lake Granodiorite phase, Granodiorite D (Godfrey and Peikert, 1963, 1964), and the high-grade metasedimentary rocks. These field associations found in various parts of the Colin Lake-Wylie Lake region strongly suggest a genetic link between these rocks.

Granodiorite D (124)

Granodiorite D is found as small, elongated outcrops in the Alexander Lake map area. The main expression of this rock type in outcrop lies in the adjacent Colin Lake district map area. Throughout all map areas, Granodiorite D is very closely associated with Granodiorite E, and a genetic relationship is strongly indicated.

This rock unit is mottled to spotted in appearance; gray, white, and pink to red feldspar megacrysts are developed within a gray to pink matrix. The subhedral to euhedral feldspar megacrysts range in size from 25 to 100 mm and are typically from 10 to 15 percent in abundance. The medium- to coarse-grained matrix is composed principally of feldspar, quartz, and biotite, and although the texture is usually massive, locally it is foliated. As in the case of most Colin Lake Granitoids, outcrops typically contain a small percentage (1 to 5) of intermixed leucocratic aplite, pegmatite, and microgranite. These minor leucocratic rocks are present in Granodiorite D as patches and irregular masses that generally are too small or too low in concentration to be represented on the map. The compositional range of Granodiorite D overlaps both the granite and quartz diorite fields.

The most distinctive feature of this map unit in outcrop is the very large feldspar megacrysts; however, smaller feldspar megacrysts in the 8 mm size range are also present in the coarse-grained matrix.

Leucocratic Granite (126)

This rock type, found in small amounts associated with the granite gneisses and Colin Lake Granitoids, has limited outcrop in the Alexander Lake map area. It is more abundant in adjoining map areas to the east, near Colin Lake (Godfrey and Peikert, 1963, 1964) and north at Charles Lake (Godfrey, 1966).

Leucocratic Granite is light-colored in outcrop, being white to pink to reddish. Though of varied textural character, the rock is typically equigranular, massive, and medium grained, but ranges from coarse to fine grained. The borders of the masses may be sharp or gradational, and simple or irregular in outline. The mineralogy is relatively simple; the principal minerals are: quartz, potassium feldspar, and plagioclase, with usually less than 1 percent mafic minerals (chloritic biotite, muscovite, hornblende, and garnet). This rock unit is compositionally in the granite field with very minor extensions into the fields of quartz-bearing syenite and quartz diorite (Fig. 4D).

Leucocratic Granite is mixed on a small scale with other granitoids in the map area, the proportions ranging from a few percent to 90 percent in outcrop. The Leucocratic Granite is typically intimately intertongued with its host, the contacts being irregular in shape. In places the Leucocratic Granite forms dykes and contains xenolithic blocks of country rock, indicating a younger intrusive relationship. Leucocratic Granite is thought to have originated as a quartzo-feldspathic metamorphic differentiate (mobilizate), the local gneissic and granitoid rocks acting as source materials. Structural relationships suggest that masses of Leucocratic Granite have been remobilized to various degrees, ranging from essentially unmoved material, to clearly fully mobilized intrusive dykes.

Wylie Lake Granitoids

This group of granitoid rocks (Wylie Lake Granodiorite phase, Granodiorite E, Fishing Creek Quartz Diorite, Wylie Lake PQ Granite phase, Granodiorite D, and Leucocratic Granite) are typical of the Wylie Lake region, and extend into the extreme southeastern corner of the Alexander Lake map area.

In the Wylie Lake map area Leucocratic Granite is commonly found intimately mixed with all other Wylie Lake Granitoids. Individual bodies are not large enough to be distinguished on the geological map, but most outcrops contain Leucocratic

TABLE 5

Modal and Chemical Analyses for Standard Samples for Wylie Lake Granitoids, in percent.*

	Fishing Creek Quartz Diorite (133)						
Standard Sample Number	265	267	280	287	288	289	296
Quartz	21.7	23.4	28.5	23.5	25.2	31.4	31.9
Potash Feldspar	7.3	3.0	-	10.2	4.2	6.0	13.6
Plagioclase	54.4	62.1	45.7	47.1	52.1	61.3	43.4
Biotite	7.5	11.5	25.6	19.1	18.4	0.5	7.1
Chlorite	-	-	-	-	-	-	-
Hornblende	8.9	-	-	-	-	-	-
Epidote	0.2	tr	0.1	0.1	-	tr	tr
Muscovite	0.1[1]	-	tr	tr	0.1	0.8	4.0
Garnet	-	-	-	-	-	-	-
Calcite	-	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-	-
Accessories	-	tr	0.1	-	-	-	-
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000	1000
SiO_2	62.86	66.85	63.65	68.53	65.38	75.43	72.92
TiO_2	0.39	0.64	0.73	0.44	0.62	0.06	0.20
Al_2O_3	18.05	15.55	16.21	15.65	14.93	12.97	13.73
Fe_2O_3	3.29	4.57	5.37	3.92	5.15	0.39	2.14
MgO	2.84	3.34	2.47	2.09	2.05	0.20	0.64
CaO	4.17	2.11	3.75	3.03	2.73	1.64	1.11
Na_2O	3.00	3.29	3.20	2.86	2.95	3.78	3.28
K_2O	3.66	2.47	2.78	2.92	3.87	4.23	4.72
MnO	0.06	0.04	0.09	0.06	0.07	0.01	0.02
P_2O_5	0.11	0.25	-	0.06	0.21	0.07	0.12
LOI	1.72	0.91	0.98	0.87	1.27	0.65	0.98
H_2O	0.29	0.11	0.15	0.17	0.22	0.16	0.06
TOTAL	100.44	100.13	99.38	100.60	99.45	99.59	99.92

[1] Sericite

*Chemical analyses by J.R. Nelson

Granite in varied proportions. Areas where Leucocratic Granite makes up over 50 percent of an outcrop are indicated on the geological maps.

Leucocratic Granite is typically light colored, usually white, but locally pink to reddish in color. Though of varied texture, it is typically equigranular, massive, and medium grained, but locally ranges to coarse- and fine-grained phases. The margins of the leucocratic masses may be sharply defined or gradational, and simple or complex in outline.

These Leucocratic Granite bodies appear to have formed by a late-stage segregation process, possibly as a product of metamorphic differentiation. Some segregated bodies were later locally remobilized and now intrude various host rocks.

Wylie Lake Granodiorite Phase (131)

This map unit forms an important component and has its principal outcrop area in the Wylie Lake Granitoid structure of the Alexander and Wylie Lakes district.

This map unit has an overall dark greenish or brownish red appearance in outcrop. Hand specimens are usually finely mottled, having red feldspars within a dark, medium-grained matrix. The texture is equigranular, except for rare 15 mm pink feldspar megacrysts in a feldspar-quartz-biotite matrix, and is typically poorly foliated to massive. The composition ranges from granodiorite to quartz diorite (Fig. 4A).

Structures of regional scale, such as the Wylie Lake Dome, can be outlined in the field by screens of metasedimentary rocks and granite gneisses within the Wylie Lake Granodiorite and other Wylie Lake Granitoids.

Wylie Lake Granodiorite has a typically granitoid texture, however, locally it can be either distinctly gneissic or megacrystic (potassium feldspar). These lithologic variations suggest, respectively, incomplete granitization of parent gneissic materials, and limited potassium metasomatism.

Granodiorite E (132)

This rock type crops out extensively in both the Wylie Lake and Colin Lake map areas. It is intimately associated with other Wylie Lake Granitoids, especially Fishing Creek Quartz Diorite, Wylie Lake Granodiorite phase, and Granodiorite D.

Granodiorite E has a greenish or brownish red overall color in outcrop, and may appear finely mottled in hand specimen. Pink to red subhedral feldspars from 6 to 8 mm long may be slightly megacrystic in an equigranular, medium-grained, massive to poorly foliated matrix of feldspar, quartz, and biotite (chloritic). Larger megacrystic feldspars, from 10 to 15 mm long, are present occasionally, and although of low abundance ($<$ 1 percent), are nonetheless characteristic of the rock type. The typical granodiorite composition of Granodiorite E ranges to subordinate amounts in the granite field (Fig. 4B).

The close field relationships and similar mineral compositions of Granodiorite E, Granodiorite D, and Wylie Lake Granodiorite phase strongly suggest a genetic link. The differences in feldspar megacryst occurrences among these three granitoids may be due, in part, to variations in potassium metasomatism.

Fishing Creek Quartz Diorite (133)

This rock is one of the abundant types in the Wylie Lake Granitoid complex. The principal outcrops lie in the Wylie Lake map area, with minor extensions in the Alexander Lake map area (north), Fletcher Lake map area (west) and Fort Chipewyan map area (southwest). The name is derived from a creek which crosses extensive outcrops of Fishing Creek Quartz Diorite north of Fidler Point.

Fishing Creek Quartz Diorite is light- to medium-gray overall in outcrop, and is mottled grayish white on a medium- to dark-gray background in hand specimen. The texture is medium grained, and typically is almost megacrystic, but locally it can be distinctly megacrystic or equigranular. Megacrysts of white to gray to pale green feldspars which range from 5 to 10 mm long are enclosed in a greenish gray matrix of feldspar, quartz, and biotite. The rock is commonly poorly foliated, but is locally gneissic or massive. Although the rock type is predominantly quartz diorite, the composition ranges to quartz-bearing diorite, granodiorite, and granite (Fig. 4C).

Fishing Creek Quartz Diorite is closely associated with other Wylie Lake Granitoids in the field, particularly within the Wylie Lake structural complex, indicating a similar origin or genetic connection for these rocks.

Wylie Lake PQ Granite Phase (134)

This rock unit is found as small mappable bodies up to 1 mile (1.6 km) across, mostly within the granite gneiss terrain, extending from Alexander Lake to at least as far north as the 60th parallel near Charles Lake (Godfrey, 1966). This rock unit includes two lithologies described earlier - Biotite 'p' Granite (Godfrey, 1963) and Biotite 'q' Granite (Godfrey, 1966).

Wylie Lake PQ Granite phase has a pink to red overall light color in outcrop, and shows mottled red spots in a darker background in hand specimen. The textural appearance is largely influenced by numerous pink to red feldspars

TABLE 6
Modal and Chemical Analyses for Standard Samples for Wylie Lake Granitoids, in percent.*

	Fishing Creek Quartz Diorite (133)					
Standard Sample Number	300	301	302	303	305	306
Quartz	36.8	29.5	21.5	14.9	4.4	23.4
Potash Feldspar	-	0.3	60.5	2.9	-	25.7
Plagioclase	51.7	58.2	12.7	75.5	74.5	41.7
Biotite	11.3	8.2	3.7	5.5	19.7	8.5
Chlorite	0.1	2.8	-	0.8	-	0.5
Hornblende	-	-	-	-	-	-
Epidote	-	0.2	-	-	0.1	-
Muscovite	-	0.3[1]	1.6	0.4[1]	0.4	-
Garnet	-	-	-	-	-	-
Calcite	-	-	-	-	-	0.3
Pyroxene	-	-	-	-	-	-
Accessories	0.2	-	-	-	0.2	-
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000
SiO_2	63.74	68.21	73.22	65.62	55.94	70.29
TiO_2	0.62	0.30	0.02	0.18	0.71	0.31
Al_2O_3	16.40	14.80	15.07	19.66	21.14	14.32
Fe_2O_3	4.63	3.31	0.42	1.70	5.80	2.82
MgO	2.49	1.67	0.17	4.29	1.17	1.09
CaO	4.13	2.23	0.99	0.67	3.42	0.93
Na_2O	3.53	3.16	2.69	5.82	5.05	3.23
K_2O	2.80	4.36	7.14	1.29	3.01	6.03
MnO	0.06	0.07	-	0.01	0.04	0.06
P_2O_5	0.35	0.12	0.03	0.05	0.06	0.05
LOI	0.93	1.67	0.53	0.81	2.00	0.97
H_2O	0.20	0.21	0.18	0.14	0.56	0.14
TOTAL	99.88	100.11	100.46	100.24	98.90	100.24

[1] Sericite

*Chemical Analyses by J.R. Nelson

that tend to be megacrystic. These large feldspars, up to 8 mm in size, are enclosed in a finer-grained matrix of quartz, feldspar, and biotite (chloritic). The texture is typically massive, but it can be foliated near contacts and sheared zones. The size and abundance (10 to 25 percent) of large feldspar crystals and the biotite content can differ within masses, but more variation can be expected between masses. The development of sericite in some areas of foliation indicates a post-crystalline metamorphic origin for both sericite and the foliation.

Field relations, particularly to the north and northeast of the Alexander Lake map area, point to the intrusive emplacement of the Wylie Lake PQ Granite phase. Many small bosses appear to have domal structural relationships with the enclosing granite gneisses, and gneissic xenoliths are found within the granite (Godfrey and Peikert, 1963, 1964).

Undifferentiated Granitoids (136)

It has been necessary to designate local areas within the general outcrop area of the Wylie Lake Granitoids (which predominate in the Wylie Lake map area), as "Undifferentiated Granitoids" where field data are insufficient for a finer subdivision of the rock units. Nearby traverses indicate such a complex, small-scale mixture of lithologies that it seems unwise to extrapolate lithologic boundaries and unnecessarily mix field and extrapolated information on the accompanying geological maps.

The principal components of the Undifferentiated Granitoids are: Fishing Creek Quartz Diorite and Wylie Lake Granodiorite phase. Lesser amounts of Granodiorite E and Granodiorite D are also present. Leucocratic Granite, which is a minor component of all these granitoids, would also be a subordinate constituent of the Undifferentiated Granitoids.

Granodiorite D (137)

Granodiorite D (137) is found principally in the Wylie Lake north region. Like Colin Lake Granodiorite D (124), this rock type has close field associations with both Fishing Creek Quartz Diorite and Wylie Lake Granodiorite.

Granodiorite D associated with Wylie Lake Granodiorite is light in overall color, mottled to spotted, with white, pink to red feldspar megacrysts in a medium- to coarse-grained matrix; on the other hand, Granodiorite D associated with Fishing Creek Quartz Diorite tends to be medium gray in overall color and mottled to spotted, having white to pink feldspar megacrysts in a gray medium-grained matrix. The euhedral to subhedral feldspar megacrysts range from 25 to 100 mm in size and make up 10 to 15 percent of the rock. The matrix is composed principally of feldspar, quartz, and biotite. The texture is usually poorly foliated but locally can be massive or well-foliated.

Outcrops of Granodiorite D contain small amounts (1 to 5 percent) of leucocratic aplite, microgranite, and pegmatite. The composition of Granodiorite D overlaps the fields of granite and quartz diorite (Fig. 4E).

The dominant textural feature in outcrop is the abundant large feldspar megacrysts. The close field association of Granodiorite D with either Fishing Creek Quarz Diorite or Wylie Lake Granodiorite suggests the derivation of Granodiorite D by potassium metasomatism and recrystallization of either of these rock types. Granodiorite E may be an intermediate phase between Wylie Lake Granodiorite and Granodiorite D.

Chipewyan Red Granite (150)

The Chipewyan Red Granite is a major granitoid lithology in the Fort Chipewyan map area to the southwest (Godfrey, in press) and is of very minor significance in the Wylie Lake map area. The rock type is so named because it is found principally in the Fort Chipewyan district.

Chipewyan Red Granite has a uniform pink to red color both in outcrop and in hand specimen. The rock is made up of equigranular, medium-grained (less commonly fine-grained) quartz, potassium feldspar, and plagioclase. This rock has no feldspar megacrystic phases, unlike every other granitoid unit in the map area. It is leucocratic insofar as mafic minerals generally constitute less than 1 percent of the rock. Chloritic biotite and, much less commonly, garnet make up the mafic minerals. The texture is typically massive, though ranging to poorly foliated or lineated, the latter due primarily to rodded quartz.

Chipewyan Red Granite bodies are interpreted as being relatively young intrusions from field relationships.

REGIONAL CATACLASTIC ZONES

A major mylonitic belt cuts through granite gneisses which are situated in the Alexander Lake map area and along the western margin of the Wylie Lake map area. This northerly trending mylonitic belt is referred to as the Allan Fault system (Godfrey, 1958). Three recrystallized rock units are distinguished in the mylonitic belt, based on the interpreted, different parent lithologies. These distinctions depend primarily on the recognition of parent lithologies in less-crushed sections of the mylonitic belt. Gradations in cataclastic textures and color correlations with more intensely mylonitic sections are also useful for mapping purposes. Other lithologies make up minor portions of this cataclastic belt on a scale too fine to be distinguished on the present scale of mapping. Furthermore, the definitive classification of some smaller bodies within the cataclastic belt can be difficult in the field.

TABLE 7

Modal and Chemical Analyses of Standard Samples for Wylie Lake Granitoids and Amphibolites, in percent.*

	Leucocratic Granite (135)					Amphibolite (20)
Standard Sample Number	274	293	297	304	307	282
Quartz	29.5	20.7	24.7	32.4	26.1	5.0
Potash Feldspar	42.2	60.4	39.5	-	27.3	-
Plagioclase	27.4	28.3	32.0	67.2	42.9	45.6
Biotite	0.1	0.1	-	-	1.7	4.7
Chlorite	0.2	0.4	0.3	0.4	1.7	-
Hornblende	-	-	-	-	-	44.5
Epidote	0.1	-	-	-	0.1	0.2
Muscovite	0.4[1]	0.2	2.2	-	-	tr[1]
Garnet	-	0.2	-	-	-	-
Calcite	-	-	1.3	-	-	tr
Pyroxene	-	-	-	-	-	-
Accessories	0.1	-	-	-	-	tr
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000
SiO_2	74.62	73.36	73.77	76.37	73.77	54.63
TiO_2	0.05	0.04	0.62	0.11	0.62	0.62
Al_2O_3	13.27	8.81	13.02	13.90	13.05	18.43
Fe_2O_3	0.37	4.77	0.75	0.21	0.79	5.26
MgO	0.22	0.28	0.16	0.30	0.34	6.66
CaO	0.37	0.21	0.59	0.36	0.81	7.24
Na_2O	3.41	2.86	3.50	8.00	2.91	2.82
K_2O	6.95	6.59	6.77	0.22	6.66	2.36
MnO	0.02	0.01	0.04	0.01	-	0.07
P_2O_5	0.04	0.17	0.15	0.02	0.06	0.23
LOI	0.49	0.93	0.54	0.16	0.98	1.67
H_2O	0.12	0.06	0.12	0.10	0.13	0.20
TOTAL	99.93	98.09	100.03	99.76	100.12	100.19

[1] Sericite

*Chemical Analyses by J.R. Nelson

Recrystallized Cataclastic Rock (221)

The presence of less-crushed zones and cataclastic gradations establishes granite gneiss as the main parent material of this rock type. It is found in both the Alexander Lake and Wylie Lake map areas.

The rock has an overall light appearance, mostly pink to red in color. White to pink feldspar porphyroclasts, from 5 to 20 mm long and typically making up to 5 percent of the rock, are enclosed in a foliated, finely banded, mylonitic matrix. Minor amounts of cataclastically deformed, associated parent lithologies, metasediments and amphibolite may be included in this rock unit.

Recrystallized Cataclastic Rock (222)

The presence of less-crushed zones and cataclastic gradations within the mylonitic belt establishes metasedimentary rocks as the main parent material of this rock unit. Recrystallized Cataclastic Rock (222) crops out in both the Alexander and Wylie Lake map areas.

Outcrops and hand specimens have a dominantly dark greenish or medium- to dark-gray color. The rock is granulose (siliceous) to schistose, with abundant platy minerals - biotite, chlorite and sericite. Porphyroclasts of white to pink feldspar, and minor quartz, ranging in size from 5 to 20 mm are enclosed within a foliated to finely banded, mylonitic matrix. Minor amounts of associated parent lithologies, particularly amphibolite and granite gneiss, may be present locally in this cataclastic rock unit.

Recrystallized Cataclastic Rock (223)

Examination of less-crushed zones and cataclastic textural gradations establishes Granodiorite D as the parent rock for this rock unit. Within the present study area this rock unit crops out only in the mylonitic belt of the Alexander Lake map area.

The overall rock color tends to be medium- to dark-gray. White to gray feldspar porphyroclasts and euhedral porphyroblasts, from 10 to 50 mm long, typically make up as much as 10 percent of the rock. The matrix is mylonitic, foliated, and locally gneissose. Relatively undeformed minor amounts of aplite and pegmatite are present as small bodies, and, though irregular in outline, their direction of elongation tends to parallel the northerly trend of the regional metamorphic foliation.

Contact relationships between the Allan Fault mylonitic belt and other rock units, and cataclastic textural gradations to parent materials, are described in more detail by Godfrey (1966) from well-exposed outcrops to the north of this study area.

ATHABASCA FORMATION (240)

The Athabasca Formation is found in situ at only one place within the map area, just west of Fidler Point. Here, the formation occupies a topographic low in the basement surface and has been protected from glacial erosion by basement rocks of the Fidler Point headland just to the east. Concentrations of angular Athabasca sandstone rubble along the Lake Athabasca shoreline near Greywillow Point and towards Fallingsand Point indicate another area that is underlain by the Athabasca Formation (map 18).

The Athabasca Basin, of which almost 90 percent lies in Saskatchewan, has been the subject of a study by Fahrig (1961). More recently, Ramaekers (1978a) has published a reconnaissance sedimentalogical study of the basin, plus more detail for two local areas (1977, 1978b).

West of Fidler Point the Athabasca Formation consists of a flaggy to rubbly bedded, medium-grained quartz sandstone, typically with a hematite red to mauve to buff color. Minor gritty bands and well-rounded quartzite pebbles from 2 to 6 cm in diameter are present. The sandstone has an opaque, gray-white siliceous cement.

The main Athabasca Formation outcrop occupies an area of about 0.9 by 0.1 miles (1.5 by 0.15 km) on the west side of Fidler Point. Structural information from the central section of this long outcrop is presented in figure 2. The basement escarpment on the east side of the Athabasca Formation is shown as a fault trace, and limited structural data strongly suggests the presence of a northward plunging syncline within the Athabasca rocks. Figure 3 gives an interpretation of a transverse cross section. These structural data point to post-Athabasca tectonic deformation; and, although it may be of only local significance, faulting has proven to be of considerable importance in the localization of uranium deposits in such geologic settings.

The Athabasca Formation in Saskatchewan is known to be underlain by highly altered, regolithic basement material (Beck, 1976). Such material is exposed in a shoreline section about 4 feet (1.1 m) thick just north of Greywillow Point. Highly altered, intensely hematite-stained basement rocks that show no sign of having been water-transported are cut by numerous fractures and quartz veinlets.

Extensive sand and Athabasca sandstone rubble along the shore from Fallingsand Point to the Saskatchewan boundary strongly suggests that the immediate hinterland of muskeg and glacially covered lowland could be underlain by the Athabasca Formation. The regolith outcrop just north of Greywillow Point suggests that a thin erosional wedge of Athabasca Formation strata onlaps the basement regolith and adjacent basement rocks. This onlap forms a fairly flat-lying platform for a distance inland of up to 1.5 miles (2 km) from the shoreline and for a length of 5 miles (7 km)

TABLE 8

Modal and Chemical Analyses of Standard Samples for Wylie Lake Granitoids and Cataclastics, in percent.*

	Granodiorite D (137)					Cataclastic Rocks (220)	
Standard Sample Number	266	276	279	281	299	278[3]	291[2]
Quartz	20.0	31.4	36.2	22.5	18.0	53.5	30.2
Potash Feldspar	25.8	6.0	-	15.3	29.0	5.1	40.0
Plagioclase	38.6	61.3	48.3	52.4	30.4	6.6	24.2
Biotite	14.5	0.5	14.6	-	16.4	6.7	2.5
Chlorite	0.2	-	0.1	4.7	1.6	-	1.2
Hornblende	-	-	-	-	-	-	-
Epidote	0.3	0.6	0.2	3.8	-	0.1	0.2
Muscovite	0.6[1]	0.8	0.3[1]	1.1[1]	3.0	28.0	0.7[1]
Garnet	-	-	-	-	-	-	-
Calcite	0.2	-	-	-	-	-	-
Pyroxene	-	-	-	-	-	-	-
Accessories	-	-	tr	tr	-	-	1.0
NUMBER OF POINTS	1000	1000	1000	1000	1000	1000	1000
SiO_2	62.03	65.18	65.21	65.87	62.78	69.59	69.73
TiO_2	0.65	0.63	0.62	0.26	0.44	0.59	0.59
Al_2O_3	16.09	14.98	15.79	16.09	16.92	13.57	14.63
Fe_2O_3	5.10	5.17	4.32	2.64	4.21	4.96	1.91
MgO	3.06	2.25	2.17	1.17	2.03	1.97	0.64
CaO	1.33	3.57	3.07	1.16	1.98	0.69	2.48
Na_2O	2.57	3.14	3.18	3.03	2.79	1.68	2.86
K_2O	6.19	3.24	4.10	6.65	6.90	4.61	5.76
MnO	0.09	0.06	0.05	0.04	0.09	0.04	0.04
P_2O_5	0.11	0.19	0.12	0.09	0.21	0.10	0.09
LOI	2.07	0.97	1.18	1.90	0.98	2.11	1.19
H_2O	0.26	0.28	0.11	0.36	0.34	0.26	0.19
TOTAL	99.55	99.66	99.92	99.26	99.67	100.17	100.11

[1]Sericite

[2]Granite Gneiss parent (221)

[3]Basic metasedimentary rock (222)

*Chemical Analyses by J.R. Nelson

along the shoreline to northeast of Fallingsand Point into Saskatchewan. Alcock's map (1936) shows Athabasca Formation rocks along the shoreline of Lake Athabasca in the adjoining area of Saskatchewan.

Relief of the basement surface undoubtedly results in an irregular erosional edge of Athabasca Formation onlapping the basement. Such relief may result in windows (inliers) and indentations along the contact of the two lithologies. The rugged basement relief at Fidler-Lapworth Points demonstrates this and in such situations local facies variations within the Athabasca Formation can be expected – for example, the development of fanglomerates and their gradation and intertonguing with sandstones.

The presence of regolithic basement along the Lake Athabasca shoreline reflects the geologic circumstances which have combined to preserve this outcrop despite erosion by both continental glaciation and storm wave action. Presumably glacial erosion stripped some Athabasca sandstone cover and the upper parts of the basement regolith at this exposure. A number of narrow quartz veins cross-cut the regolith, which suggests proximity to a fault zone. Solutions circulating along a fault zone could have entered and cemented the permeable regolithic horizon in the wallrock, thereby increasing its resistance to erosion.

The importance of post-Athabasca faulting in the localization of uranium ore bodies at Key Lake and Maurice Point, Saskatchewan, and elsewhere in the region of the Athabasca basin is well known (Beck, 1976). Evidence of such faulting in the Athabasca Formation, basement regolith, and basement rocks of the Wylie Lake map area is detailed below. The presence of fractured, offset, and recemented quartzite pebbles in the Athabasca basal conglomerate just west of Fidler Point indicates post-Athabascan faulting and a probable fault contact along the east side of this outcrop.

Cross-cutting quartz veinlets in the basement regolith north of Greywillow Point suggests its proximity to a fault zone. The extension of shears mapped in nearby basement rocks (map 18) would intersect overlying Athabasca Formation rocks to the south and east, beneath the waters of the present Lake Athabasca. These observations provide reason for serious speculation and a possible incentive in the exploration for uranium deposits within and close to the Athabasca Formation in this part of Alberta.

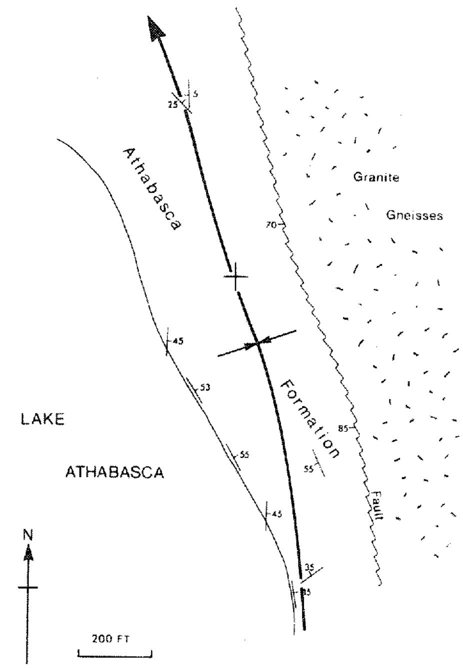


FIGURE 2. Sketchmap of Athabasca Formation just west of Fidler Point

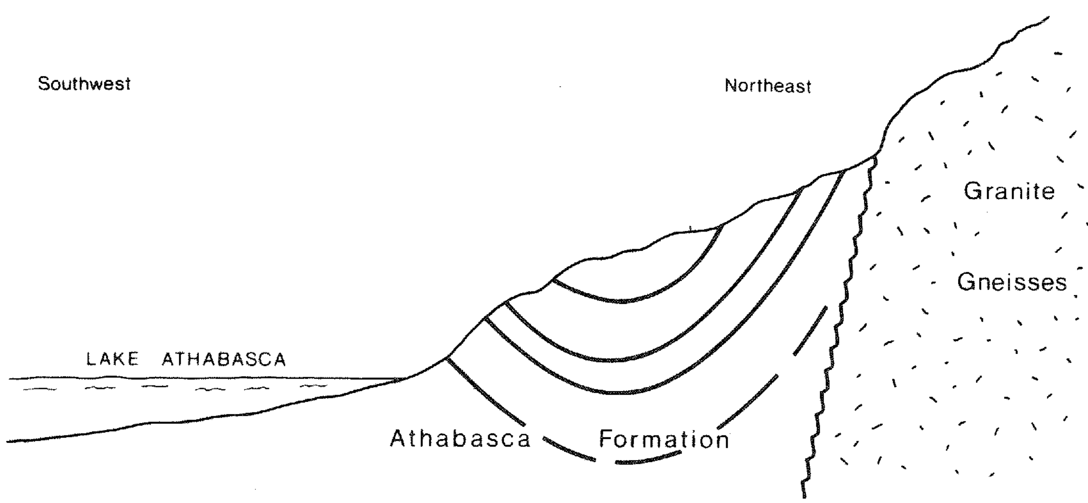


FIGURE 3. Schematic cross section through Athabasca Formation, Fidler Point

TABLE 9

Modal and Chemical Analyses of Standard Samples for the Metasedimentary Rock Bands, in percent.*

	Metasedimentary Band Number						
	33	34	35	43	44	45	46
Quartz	44.7	30.0	38.2	45.5	31.2	41.7	36.9
Potash Feldspar	2.1	8.4	3.4	1.8	6.5	11.3	1.6
Plagioclase	25.5	33.0	37.7	15.6	33.8	21.4	30.6
Biotite	14.0	15.8	15.8	11.3	17.9	14.9	18.8
Chlorite	1.2	0.4	1.0	5.9	0.5	2.1	1.7
Hornblende	4.1	6.5	2.1	-	1.6	0.2	1.0
Epidote	0.7	1.2	1.4	0.7	1.6	0.3	0.7
Muscovite	5.4	0.7	0.4	13.8	4.7	6.7	6.1
Spinel	-	-	-	-	-	-	-
Garnet	1.2	-	-	2.6	0.3	-	0.5
Pyroxene	-	3.3	-	-	-	-	-
Cordierite	-	-	-	-	-	-	-
Andelusite	-	-	-	-	-	-	-
Sillimanite	-	-	-	0.6	-	-	-
Calcite	-	-	-	-	-	-	-
Accessories	1.1	0.7	0.3	1.7	1.9	1.4	2.1
NUMBER OF POINTS	375	375	375	375	375	375	375
SiO_2	67.66	60.68	63.32	71.89	63.19	67.25	68.62
TiO_2	0.59	0.90	0.74	0.59	0.79	0.63	0.29
Al_2O_3	13.76	14.71	16.76	12.18	18.06	17.88	15.67
Fe_2O_3	5.83	7.62	4.20	5.96	3.62	2.01	3.52
MgO	2.32	3.74	3.92	1.52	2.73	1.85	2.42
CaO	2.40	4.09	3.19	0.57	2.45	1.29	1.41
Na_2O	2.76	3.16	2.68	1.92	2.19	2.82	2.24
K_2O	2.77	3.34	3.02	3.27	4.14	4.68	4.74
MnO	0.15	0.14	0.08	0.05	0.07	0.03	0.05
P_2O_5	0.19	0.21	0.20	0.15	0.20	0.08	0.15
LOI	1.26	0.82	1.25	2.23	1.58	1.60	1.44
H_2O	0.21	0.20	0.21	0.14	0.23	0.14	0.28
TOTAL	99.90	99.61	99.57	100.47	99.25	100.26	100.83

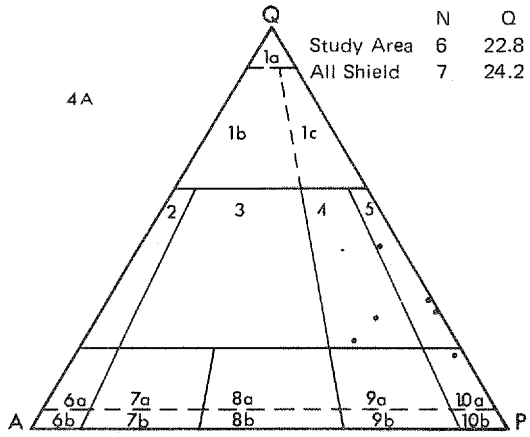
*Chemical Analyses by J.R. Nelson

LEGEND

FIGURE 4

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

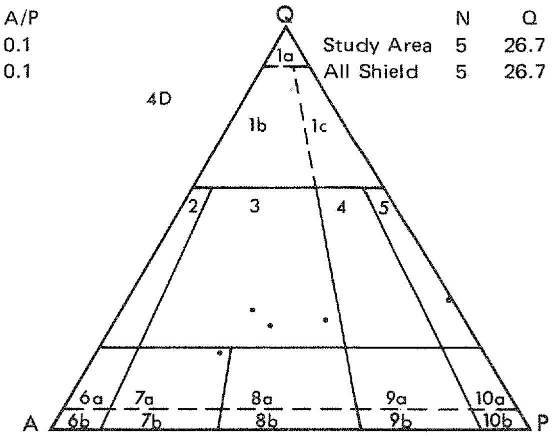
4A



	N	Q	A	P	A/P
Study Area	6	22.8	5.9	50.7	0.1
All Shield	7	24.2	6.3	47.9	0.1

Wylie Lake Granodiorite (131)

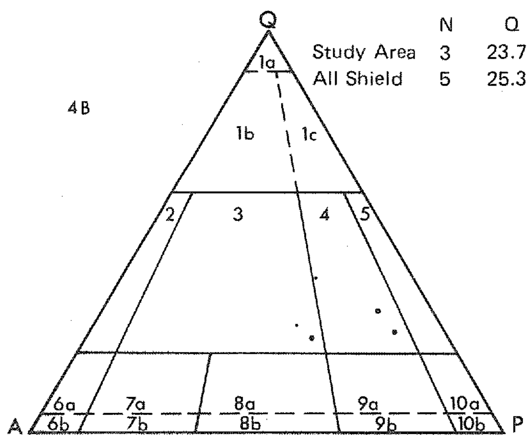
4D



	N	Q	A	P	A/P
Study Area	5	26.7	33.9	39.6	0.9
All Shield	5	26.7	33.9	39.6	0.9

Leucocratic Granite

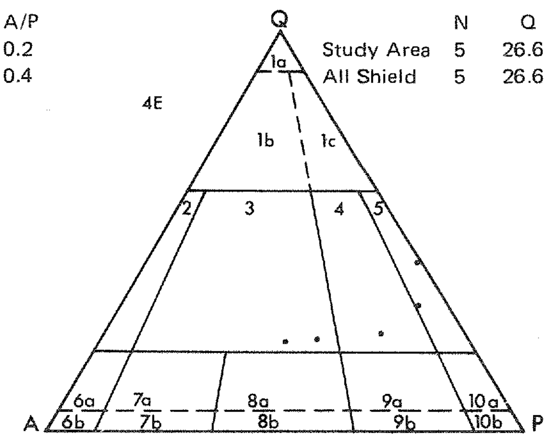
4B



	N	Q	A	P	A/P
Study Area	3	23.7	9.3	51.9	0.2
All Shield	5	25.3	17.4	44.0	0.4

Granodiorite E (132)

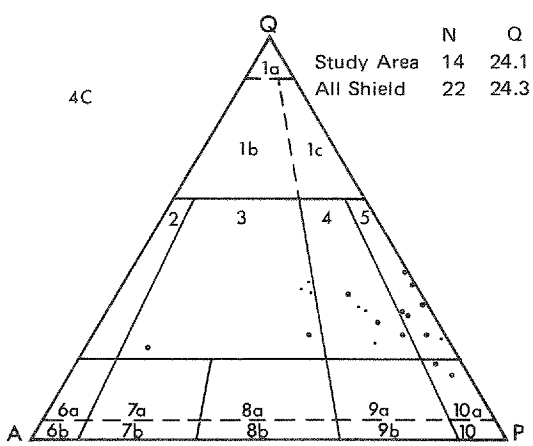
4E



	N	Q	A	P	A/P
Study Area	5	26.6	15.2	46.2	0.3
All Shield	5	26.6	15.2	46.2	0.3

Granodiorite D (137)

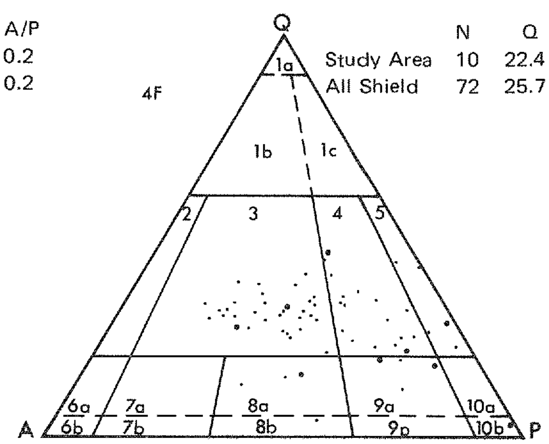
4C



	N	Q	A	P	A/P
Study Area	14	24.1	11.3	51.6	0.2
All Shield	22	24.3	11.6	48.1	0.2

Fishing Creek Quartz Diorite (133)

4F



	N	Q	A	P	A/P
Study Area	10	22.4	16.5	49.1	0.3
All Shield	72	25.7	22.2	38.7	0.6

Granite Gneisses (11, 12)

N Number of samples
• Samples from Study Area
· Samples from remainder of shield in Alberta

FIGURE 4. Ternary Quartz-Alkali Feldspar-Plagioclase Feldspar (Q-A-P) plots for granitoids and gneisses in study area, and for remainder of Shield in Alberta. Ternary field boundaries based on Streckeisen (1967).

MODAL AND CHEMICAL ANALYSES

Tables 3, 4, 5, 6, 7, 8, and 9 present the results of modal and chemical analyses of a series of standard samples representing the various rock units in the Alexander and Wylie Lakes map areas.

Ternary Q-A-P plots of the granitoid and gneissic rock units (using standard sample data) are presented in figures 4A, B, C, D, E, and F. The Streckeisen (1967) compositional field boundaries are superimposed on the ternary diagrams to facilitate comparisons and classification. The plots show rock type data from this study area and similar data for the same rock types from the rest of the Shield in Alberta (published and unpublished data).

Table 10 gives the compositional ranges shown in the ternary diagrams in figure 4. Table 10 reveals similar compositional ranges for the first four rock types listed, and a distinct difference for Leucocratic Granite. Both from field observations and a petrogenetic point-of-view, it appears that rock units 131, 133, 137, and 132 share a common or similar origin and history. However, Leucocratic Granite (135) (commonly intimately mixed with all the other Wylie Lake Granitoids) appears to have been introduced either as a late magmatic (?) or remobilized metamorphic segregation phase.

Granite gneisses of the Alexander-Wylie Lakes map areas have a wide range in composition (Fig. 4F) that demonstrates a heterogeneous character, and whose lithologies are of probable diverse origin. The compositions of most granite gneiss standard samples in the study area are in the fields of: granite, granodiorite, and quartz diorite, with minor variations into the fields of: quartz-bearing monzonite, monzodiorite, and diorite.

METAMORPHISM

Rocks of the Alexander-Wylie Lakes map areas exhibit three distinct phases of metamorphism - granulite, amphibolite, and greenschist facies, from the oldest to youngest, respectively.

The high-grade metasedimentary rocks of the Alexander Lake map area have an early history of granulite facies metamorphism, represented by mineral assemblages that include hypersthene and sillimanite. These granulite facies minerals in the metasediments are typically enclosed by, or partially replaced by, minerals characteristic of the amphibolite facies - almandine, hornblende, and K-feldspar. The granite gneisses show minerals characteristic of only the amphibolite facies. However, because of their close field association with the metasediments, it is most likely that the granite gneisses also attained granulite facies conditions during early phases of their metamorphic history.

All granitoid rocks in the Alexander and Wylie Lakes map areas (Wylie Lake Granitoids, Colin Lake Granitoids, and Chipewyan Red Granite) were subjected to amphibolite facies conditions as their highest grade of metamorphism, represented by almandine, hornblende, and K-feldspar.

The widespread presence of chlorite and epidote shows that all gneissic and granitoid rocks have experienced a late general retrograde greenschist facies metamorphism.

The synthesis of the metamorphic history of the Precambrian Shield in Alberta given by Godfrey and Langenberg (1978a), and summarized here, is also valid for this study area. The

TABLE 10
Compositional Distribution for Wylie Lake Granitoid Rock Types

		Alk. Granite	Granite	Granodiorite	Qtz Diorite
Wylie Lake Granodiorite	(131)	-	-	M	M
Fishing Lake Quartz Diorite	(133)	-	m	M	M
Granodiorite D	(137)	-	m	M	m
Granodiorite E	(132)	-	m	M	-
Leucocratic Granite	(135)	-	M	-	(m)

Frequency of rock type composition: M - major; m - minor; ( ) questionable data oldest rocks of the map area, a complex of para- and ortho-gneisses making up the granite gneiss-metasedimentary rock terrain, were formed under granulite facies conditions. These gneisses appear to have been partly granitized and remobilized under amphibolite facies conditions, during which time the granitoid plutons were emplaced. This deep-seated thermo-tectonic activity is correlated with the Hudsonian Orogenic Event. A later regional retrograde greenschist facies metamorphism affected all gneissic and granitoid rocks in the study area (and in the entire Shield region of northeastern Alberta); this is believed to have been a late phase of the Hudsonian Orogenic Event.

The unmetamorphosed Athabasca Formation quartz sandstones and conglomerates of Fidler Point show only patchy cementation and quartz overgrowths on clastic quartz grains.

STRUCTURAL GEOLOGY

Two major structures dominate the study area: the Wylie Lake Dome and Basin Granitoid Complex and the linear mylonitic belt of the Allan Fault, which borders the Wylie Lake complex to the west.

Study of the foliation structures in the Wylie Lake granitoids reveals a dome combined with less well-defined basins. It is assumed that erosive processes have stripped away most of the original overlying mantling gneisses. However, these can be seen in place to the west and north of the Wylie Lake Granitoid Complex; the southern extension of the complex is covered by Lake Athabasca. Harper (1978) has published a report on the geology immediately to the east in Saskatchewan.

Deformational structures in granite gneisses are characterized in outcrop by plastic flow features, such as flow folds, crenulations, boudinage, and migmatites, though agmatitic structures are also typical. Migmatitic features are associated mostly with minor bands of metasedimentary rocks.

Metamorphic foliation in the granite gneisses is commonly displayed as a classical banded gneissic structure, which locally ranges to a schist; lineation may also be displayed.

Superimposed on the above features is a range of cataclastic-recrystallization textures and structures which are developed most intensely in the Allan Fault mylonitic belt. Although cataclastic effects of the Allan Fault zone are virtually confined to the granite gneisses, this fault is presumed to be a relatively late event in the geologic history of the area and probably post-dates emplacement of the granitoid rocks. Cataclasis occurred under greenschist facies conditions and seems likely to correlate with the last phase of metamorphism during the Hudsonian Orogenic Event (Godfrey and Langenberg, 1978a).

With the exception of the Allan Fault, fault zones have been readily eroded and are now principally expressed as valley linears. Almost all bedrock is obscured in the low-lying ground by lakes, muskegs, glacial, and recent deposits. Fault-related features may be observed in the valley wall outcrops adjacent to fault zones.

Four directions of faulting are identified in the study area: northwest, north, northeast, and east. Combinations of usually two of these directions form a box-work pattern in outcrop which is characteristic of most of the study area.

The northerly fault direction is represented by the major mylonitic belt of the Allan Fault, plus several scattered subsidiary faults.

The easterly oriented fault set is the second most important group of faults in view of their high frequency and considerable strike length.

The northeasterly trending faults are essentially confined to two areas: one just northeast of Fidler Point (map 19) and the second towards the east side of the area shown in map 18.

Northwesterly oriented faults are seen as high frequency, fairly regularly spaced faults in an area just east of the Allan Fault (maps 17 and 19), and a less regular occurrence in the east portion of map 8.

The Allan Fault is a major mylonitic belt of regional dimensions and of deep-seated origin. It probably forms part of an array of mylonitic belts which extend through northern Saskatchewan (Koster 1961, 1962) and converges northwards beyond latitude 60°N within the Northwest Territories. Together, these mylonitic belts represent a major zone of deformation of considerable tectonic significance. They parallel the local metamorphic grain of the Precambrian Shield in Alberta but cut across the regional northeasterly structural trend of the Churchill Province. The cataclastic textures range from ultramylonite, to mylonite, mortar structure, and flaser gneiss. Late-formed potassium feldspar megacrysts, typically augen shaped, are common throughout the mylonitic belt. Extensive recrystallization is a significant feature in the post-mylonitization history of the study area.

Reactivation along the Allan Fault, as brittle deformation, has been seen farther north, in the Charles Lake district (Godfrey, 1966). This late-stage, brittle-type deformation also accounts for development of the subsidiary northerly faults scattered through the study area. The sense of overall movement along the Allan Fault is not known; however, local slickensides indicate a late, steep displacement.

The northwesterly, northeasterly, and easterly fault sets may be essentially contemporaneous in origin and form conjugate faults. They formed subsequent to the main movement along the Allan Fault mylonite belt but may have overlapped late-stage dislocations.

The long easterly faults extend westward beyond the Allan Fault as strong, locally mylonitic, brittle deformation zones, and disappear beneath Phanerozoic cover at the Slave River.

The northeasterly faults, particularly those at Fidler Point, are situated close to, and parallel, a major regional structure presumed to underlie the western section of Lake Athabasca.

Both joints and quartz veins show preferred strike orientations in the north, northeast, and east directions. Joints also show a local northwesterly orientation in areas close to the northwesterly faults. All of these directions coincide with fault orientations so that joints and quartz veins seem to be related to the relief of tectonic stresses. Many of the joints and quartz veins also parallel the metamorphic foliation in the host rock, so that this mechanically weak direction in the rock could have been exploited in the course of decompression during unloading.

Quartz veins are barren of all other mineralization, and are regarded as late fracture fillings associated with either joints or faults.

Very minor lateral displacements of a few centimetres are evident along tight, single shear surfaces. Such small separations are obvious and measureable where the shear surface is transverse to the internal structure of gneisses and mylonites, and a visual match across the surface of separation is possible. Similar minor strain adjustments are also likely present in the granitoid rocks; however, recognition of these structures is difficult because of the uniform lithology and the lack of a suitable internal structure in the granitoids.

The granitoid rock units are typically massive to poorly foliated, and hence they do not generally display a pronounced megascopic metamorphic texture. However, close to the granite gneisses, metasedimentary rocks, and major shears the granitoid foliation is generally better defined and more distinctive. Foliation data are of sufficient density to allow reconstruction of dome and basin structures in the Wylie Lake Granitoid Complex (Langenberg and Ramsden, 1978).

Exceptionally clean outcrops of Wylie Lake Granitoids exposed along lake shores (for example, Lake Athabasca) reveal: multiple cross-cutting aplopegmatitic intrusions (deformed and undeformed), patches of granite gneiss (partly cataclastic), metasedimentary rock xenoliths with reaction rims (5 to 10 cm wide), and plastic deformational structures - crenulations, pinch and swell veins, and ptygmatic veins. Together, these features indicate a complicated sequence of injections of small leucocratic bodies and the remobilization and deformation of the entire mass, which in places approaches a migmatite in appearance. Such lithological and structural relationships are probably more prevalent in the Wylie Lake Granitoids than is presently appreciated because of the sparseness of clean outcrop surfaces away from rocky ledges along lake shores.

Athabasca Formation sandstones, just west of Fidler Point, are folded into a tight syncline (Figs. 2 and 3) and are probably in fault contact with basement granite gneisses on the east side. These structural features establish post-Athabascan deformation, at least on a local scale. Such deformation is likely related to graben-horst type (vertical) crustal movements, as suggested by the presence of both deformed and undeformed Athabasca rocks in the general region.

GEOLOGIC HISTORY

The oldest group of rocks, the basement granitic gneisses (Table 2), consists principally of para- and ortho-gneisses; amphibolites, high-grade metasedimentary rock bands, and small plutons form minor components. Formation of the gneisses probably entailed multicycle sedimentation, polyphase metamorphism and deformation, and the addition of primary magmatic material (minor plutons and basic dykes), most likely during several phases of intrusion. Major portions of the granite gneisses were migmatized, mobilized, and subsequently locally mylonitized. Mineral assemblages of metasedimentary rocks within the granite gneisses contain metamorphic hypersthene and sillimanite, indicating that granulite facies conditions were attained during their formation. Hornblende and almandine typically envelope or replace granulite facies minerals, showing that the metasediments and the enclosing gneisses were subsequently subjected to amphibolite facies conditions (Godfrey and Langenberg, 1978a).

The major granitoid complex in the Wylie Lake area was probably formed from the basement gneisses and metasediments, and was intruded during remobilization.

The granitoid complex displays a combination of dome and basins in detail. The gneisses flanking the complex to the north and the screens of Granodiorite D and Granodiorite E on the west, north, and east sides indicate an overall ovoid shape in plan view for the Wylie Lake Granitoid Complex.

The basin and dome structures of the Wylie Lake Granitoid Complex are the most southerly expression of a major regional zone of mixed gneissic and granitoid rocks. This zone extends northerly through Colin Lake, St. Agnes Lake, and Andrew Lake (Godfrey, 1963, 1964, Godfrey and Peikert, 1963) to the northern limit of mapping. Just north of Wylie Lake this zone is represented by local areas of interference folds in gneissic and granitoid rocks, enclosed within an otherwise dominantly north-trending metamorphic foliation. The granitoid lithologies are locally migmatized and gneissose, whereas the gneisses include small, massive granitic bodies within the cores of interference folds.

Interference folds and small granitic bodies within the gneisses may indicate the presence of large granitoid complexes at shallow depths. Considerable remobilization and granitization in the sequence of roof gneisses probably led to the generation and mobilization of granitoid segregations. The formation of interference folds and basin and dome structures in the gneisses and granitoids may have structural analogies with a diapiric form of intrusion. Or, they may be a consequence of opposing directions of lateral compression.

The Wylie Lake Granitoids were emplaced under amphibolite facies conditions during the Hudsonian Orogenic Event. Uplift and erosion continued in the area, and eventually continental sedimentation took place within the Athabasca Sedimentary Basin (Helikian age). The Athabasca Formation sandstones are seen to rest on weathered, regolithic basement rocks.

The development of a thick regolith beneath the Athabasca Formation is known to be very extensive from exploration drilling results in northern Saskatchewan. This feature establishes a period of tectonic stability under continental conditions prior to deposition in the Athabasca Sedimentary Basin. It is concluded that a major part of the erosional stripping of cover rock in this area took place during and shortly after the Hudsonian Event. Thus, the major granitoid masses (for example, Wylie Lake Complex) were exposed and supplied detritus to the Athabasca Sedimentary Basin.

A long interval of erosion, possibly punctuated by marine incursions during the Paleozoic, Mesozoic, and Cenozoic, followed deposition of the Athabasca Sandstone.

The next youngest sediments to be encountered in the area are the products of Pleistocene Age (Laurentide) continental glaciation. These include till, glaciofluvial, and glaciolacustrine deposits, and are identified in part on aerial photographs by their characteristic landforms—eskers, fandeltas, and raised beaches. Wind erosion of these sediments subsequent to deglaciation has led to the formation of sand sheets and dunes of a dominantly longitudinal form. It seems highly probable that glacial deposits were the source of the eolian sand, which in turn were largely derived by erosion of the Athabasca Formation.

MINERAL OCCURRENCES

At present, the uranium potential of the basement gneisses and granitoids and the Athabasca Formation and sub-Athabasca regolith is the subject of intense scrutiny.

Widespread radioactivity, associated with abundant yellow stains (possibly uranophane) on the outcrop, has been noted within an area of 40 square miles (100 km^2). This area lies east of a line between Lapworth Point and Winnifred Lake, and south of the latitude through Winnifred Lake as far east as Lake Athabasca. For the most part, this radioactivity is associated with Fishing Creek Quartz Diorite; some radioactivity is also associated with granitic metasediments and Wylie Lake Granodiorite, and even less with Granodiorite E. All of these rock units contain leucocratic segregations in swirled, locally almost migmatitic, structures which are cut by relatively undeformed dykes and irregular patches of leucocratic granite/pegmatite. Radioactivity and yellow stains are found in the Fishing Creek Quartz Diorite, but are even more prominent in the intermixed subordinate leucocratic segregations.

The highest concentrations of yellow stains and scintillometer-measured (Srat SPP 2) radiation anomalies are contained within an area 1.5 by 0.5 miles (2.4 by 0.8 km), situated 2.5 miles (4 km) south of Winnifred Lake and 0.5 miles ± (0.8 km ±) inland from Lake Athabasca. Several sites within this local area were surveyed with the scintillometer on a rough grid pattern. Areas up to 600 by 400 feet (200 by 130 m) were covered by such reconnaissance surveys. Scintillometer readings in one area ranged from 250 to 500 counts per second (cps) with local maximums of 740 cps; and in another area from 600 to 1200 with local maximums of 1900 cps. Background counts per second appear to be 100 and 500 respectively for the two data sets reported here. These data were obtained with the scintillometer held at approximately knee height. The radiation counts increase by 60 to 100 percent when the scintillometer was placed in contact with the bedrock.

In recent years, exploration geologists have shown considerable interest in the uranium potential of the Athabasca Formation and the sub-Athabasca basement regolith. Accordingly, the Athabasca Formation and the underlying regolith are described fairly extensively in the section dealing with the Athabasca Formation.

Surface exploration by industry in 1970 discovered a highly radioactive Athabasca sandstone boulder about 7.5 miles (12 km) north-northwest of Fidler Point (Netolitzky, 1970). This 6-lb (3-kg) boulder of purple-mauve Athabasca sandstone showed extensive solution-cavity development, with 0.25- to 0.5-inch (8- to 12-mm) diameter cavities in the external surface, which penetrated well into the interior. Chemical assays of part of the boulder reveal 0.43 percent U_3O_8 and no ThO_2.

This Athabasca sandstone boulder location plots just outside the present study area, and air photographic interpretation shows that it was probably found in an easterly aligned drumlinoid feature over 1 mile long (1.6 km). Glacial striae measurements in the region show that the boulder was glacially transported from the east to northeast; that is, it originated from the Greywillow Point area or farther east in Saskatchewan. A consortium with Uranertz Exploration as field operator has recently outlined a uranium deposit near Maurice Bay, 3 miles (5 km) into Saskatchewan along the direction of glacial flow from the Netolitzky boulder. However, other nearby areas should also be considered as potential sources for this boulder.

Assessment reports on mineral exploration permits are on file at the Alberta Research Council in the economic minerals file.

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LEGEND

PRECAMBRIAN*

REGIONAL CATACLASTIC ZONES

Zones of regional cataclasis and recrystallization have principally affected granite gneisses and metasedimentary rocks to produce: ultramylonite, mylonite, cataclasite, blastomylonite, and flaser gneiss; megastructure is typically streaky; may contain rounded or augen rock clasts or feldspar porphyroclasts ( ).

223 — RECRYSTALLIZED CATACLASTIC ROCK: dark colored, with white to gray anhedral feldspar porphyroclasts and euhedral feldspar porphyroblasts 10 to 50 mm long; foliated, locally gneissose; aphanitic matrix, locally medium grained; minor aplite and pegmatite. Largely Granodiorite D type parent material.

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 foliated, finely banded, aphanitic matrix. Largely granite gneiss parent material.

GRANITOID ROCK GROUP

WYLIE LAKE GRANITOIDS

136 — UNDIFFERENTIATED GRANITOID: lack of field data and local cataclasis do not allow better definition and subdivision of these areas; this broadly defined map-unit includes both Fishing Creek Quartz Diorite and Wylie Lake Granodiorite Phase.

134 — WYLIE LAKE PQ GRANITE PHASE: reddish over all; mottled to light spotted, with white to pink to red abundant feldspar megacrysts 5 to 8 mm in size in a medium-grained, massive to foliated matrix of biotite, feldspar, and quartz; minor sericite.

133 — FISHING CREEK QUARTZ DIORITE: medium gray over all; 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, and schlieren of biotite or 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.

COLIN LAKE GRANITOIDS

126 — COLIN LAKE LEUCOCRATIC GRANITE PHASE: pink to red anhedral feldspar in an equigranular fine- to coarse-grained matrix; massive to locally foliated; includes minor microgranite and aplite-pegmatite; local sericite. Typically found as small masses intermixed with other Colin Lake Granitoids.

124 — GRANODIORITE D: mottled appearance with gray, white, or pink to red feldspar megacrysts in a gray or pink matrix; subhedral to euhedral feldspar megacrysts 25 to 100 mm long, typically up to 10 to 15 percent abundance, in a medium- to coarse-grained matrix of feldspar, quartz and biotite; matrix is massive to well foliated. Predominant rock-type is granodiorite, but composition ranges to granite and quartz diorite. Includes minor small bodies of aplite, microgranite, and pegmatite.

123 — QUARTZ DIORITE C: spotted appearance with gray white (locally pink) feldspar megacrysts in a dark gray matrix; feldspar megacrysts (locally augen) 5 to 15 mm long, typically up to 20 percent abundance, in a medium-grained, mafic-rich matrix of feldspar, quartz, biotite, and hornblende; matrix is typically fairly well foliated. Predominant rock-type is quartz diorite, but ranges to granodiorite. Includes minor aplite-pegmatite and microgranite.

METASEDIMENTARY ROCK GROUP

31 — METASEDIMENTARY ROCKS: the high-grade metasedimentary rock-types included in this map-unit are lithologically and texturally gradational, and in part intermixed on a small 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, common lithologic gradational variations to: (1) fine- to medium-grained, metamorphic quartzo-feldspathic (granitic) phase ranging from individual feldspar megacrysts to nebulous or distinct aggregations and masses; locally gneissic; (2) fine-grained phyllite and schist (biotite, chlorite, sericite, and uncommonly hornblende) and phyllonite. Minor amphibolite may be present.

'GRANITIC' METASEDIMENTARY ROCK: typically mottled with white feldspar megacrysts in a darker, fine-grained (metasedimentary) matrix; fairly homogeneous in character, commonly foliated to locally gneissic; may contain garnet, white feldspar megacrysts (or augen) 5 to 15 mm long, and medium-grained, quartzo-feldspathic (granitic to pegmatitic) segregations as nebulous or distinct irregularly shaped small masses; commonly includes minor small bands of metasedimentary rocks.

GRANITE GNEISS GROUP

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 includes granite, 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. Rock-types include granite, 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, or amphibolite.

AMPHIBOLITE

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

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

Geological boundary (defined, approximate)	
Foliation (defined: dip known, dip vertical; foliation assumed)	69
Foliation trend*	
Extreme contortion (structural trend)	
Tight fold (structural trend)	
Local gneissosity in generally massive to foliated rock	
Fault (defined, assumed)	
Shear	
Quartz vein	
Joint (dip known, vertical)	69
Crystalline standard sample	259○
Metasedimentary band standard sample	33◉
Garnet	G
Chlorite, abundant	C
Epidote, abundant	E
Actinolite	Act
Allanite	Al
Muscovite	Mu
Glacial stria (direction of ice movement known)	
Wind-cut groove (wind direction shown)	
Dune*	
Sand-covered area	
Raised beach (downslope indicated)*	
Kettle*	
Drainage (permanent, intermittent)	
Muskeg	
Township boundary	

*Aerial photographic interpretation

Base maps compiled from planimetric sheets published by Alberta Energy and Natural Resources, Forestry Division, Edmonton.

Air photographs covering this area obtainable from the Technical Division, Alberta Energy and Natural Resources, Edmonton and the National Air Photographic Library, Ottawa.

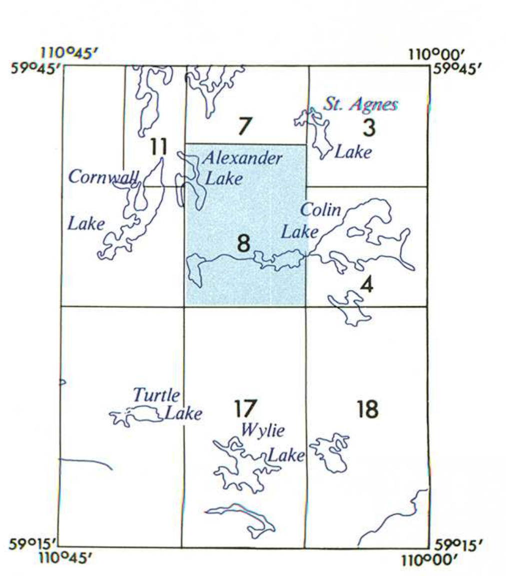
Approximate magnetic declination 24°34′ East in 1976 decreasing 6′ annually.

Geology by John D. Godfrey, Maurice B. Dusseault and Peter Klewchuk, 1971.

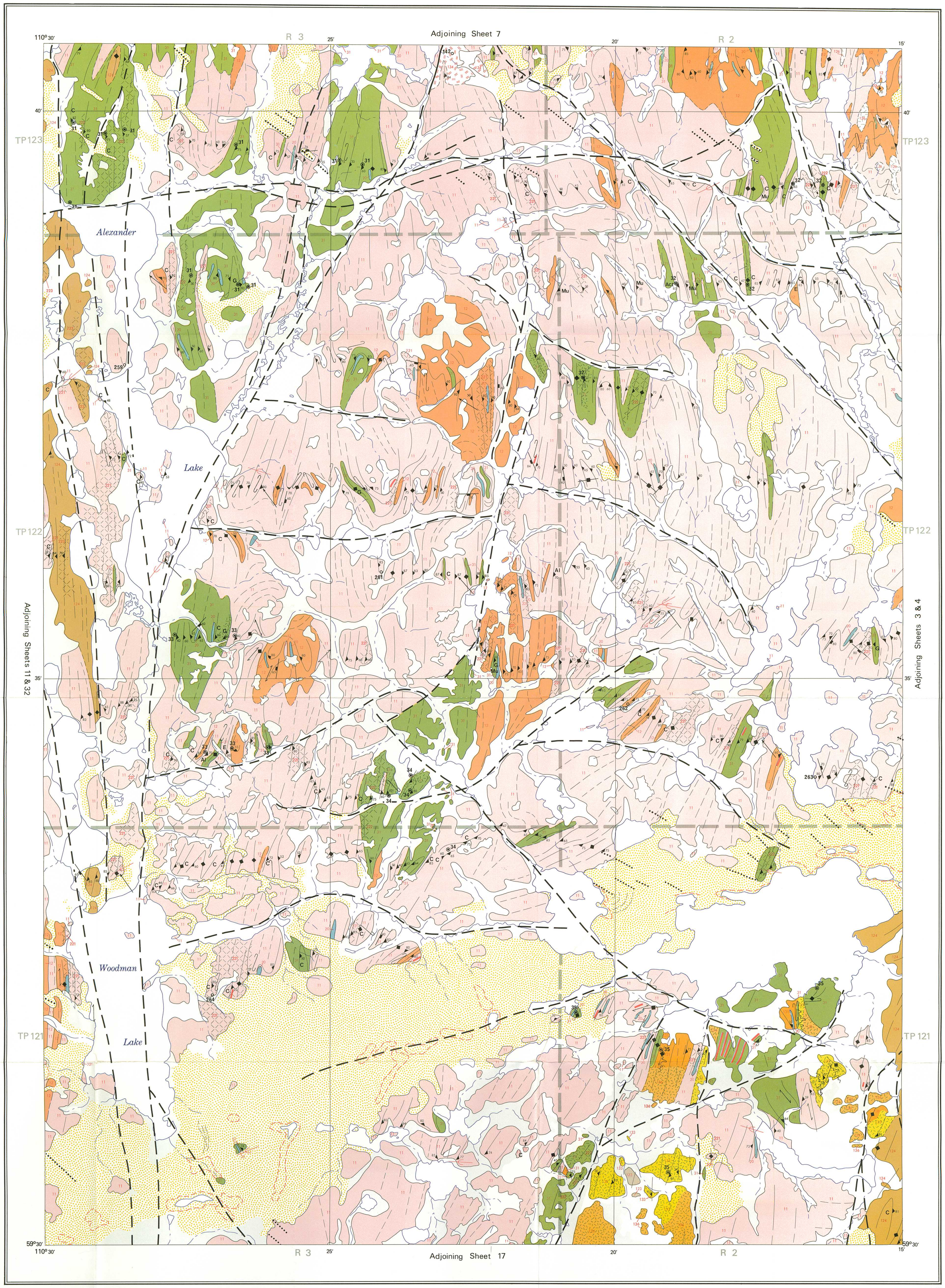
Map drawn by D. E. Jacobs
Cartographic editing by A. Campbell

SCALE 1:31,680
1 inch to 1/2 mile

KEY MAP



LOCATION MAP



To accompany Earth Sciences Report 78-1

Published 1978

SCALE 1:31,680
Miles 1 0 1 2 Miles
Kilometres 1 0 1 2 3 Kilometres

GEOLOGY OF THE ALEXANDER LAKE DISTRICT, ALBERTA

Sheet No. 8

Alberta RESEARCH COUNCIL

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SCALE 1:31,680

Miles 1 0 1 2 Miles

Kilometres 1 0 1 2 3 Kilometres

GEOLOGY OF THE WYLIE LAKE DISTRICT, ALBERTA

Sheet No. 17

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SCALE 1:31,680

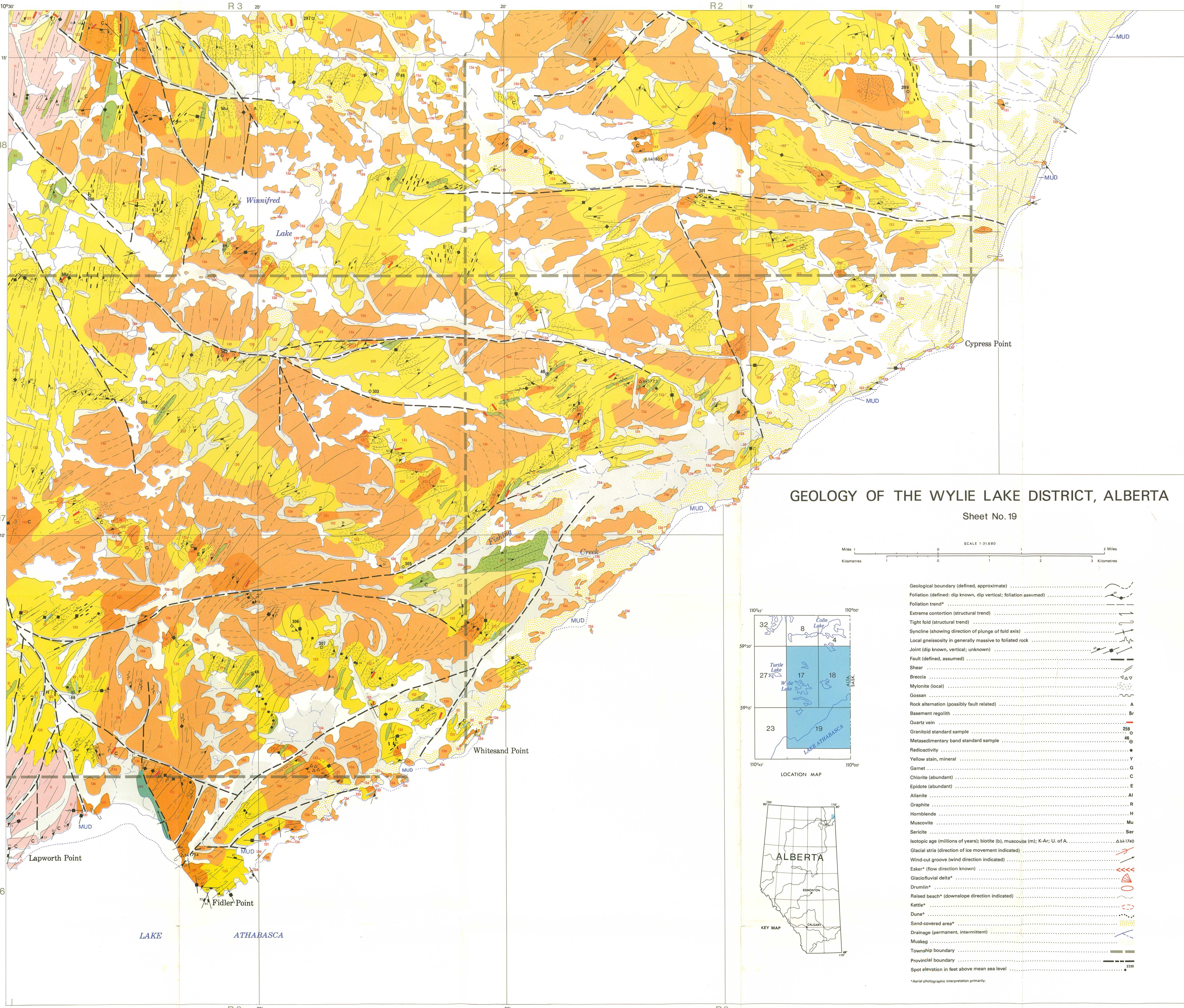
Miles 1 0 1 2 Miles

Kilometres 1 0 1 2 3 Kilometres

GEOLOGY OF THE WYLIE LAKE DISTRICT, ALBERTA

Sheet No. 18

Alberta RESEARCH COUNCIL



GEOLOGY OF THE WYLIE LAKE DISTRICT, ALBERTA

Sheet No. 19

SCALE 1:31,680

Miles 1 — 0 — 1 — 2 Miles

Kilometres 1 — 0 — 1 — 2 — 3 Kilometres

32
8
4
Colin Lake
Turtle Lake
Wylie Lake
27
17
18
23
19
LAKE ATHABASCA
ALTA.
SASK.

LOCATION MAP

ALBERTA
EDMONTON
CALGARY

KEY MAP

Geological boundary (defined, approximate)
Foliation (defined: dip known, dip vertical; foliation assumed)
Foliation trend*
Extreme contortion (structural trend)
Tight fold (structural trend)
Syncline (showing direction of plunge of fold axis)
Local gneissosity in generally massive to foliated rock
Joint (dip known, vertical; unknown)
Fault (defined, assumed)
Shear
Breccia
Mylonite (local)
Gossan
Rock alternation (possibly fault related) ... A
Basement regolith ... Br
Quartz vein
Granitoid standard sample ... 259
Metasedimentary band standard sample ... 46
Radioactivity
Yellow stain, mineral ... Y
Garnet ... G
Chlorite (abundant) ... C
Epidote (abundant) ... E
Allanite ... Al
Graphite ... R
Hornblende ... H
Muscovite ... Mu
Sericite ... Ser
Isotopic age (millions of years); biotite (b), muscovite (m); K-Ar; U. of A. ... Δbk1740
Glacial stria (direction of ice movement indicated)
Wind-cut groove (wind direction indicated)
Esker* (flow direction known)
Glaciofluvial delta*
Drumlin*
Raised beach* (downslope direction indicated)
Kettle*
Dune*
Sand-covered area*
Drainage (permanent, intermittent)
Muskeg
Township boundary
Provincial boundary
Spot elevation in feet above mean sea level ... 2250

*Aerial photographic interpretation primarily.

Alberta RESEARCH COUNCIL

WYLIE LAKE LEGEND

PRECAMBRIAN*

SEDIMENTARY ROCKS

240 / 240 Rubble — ATHABASCA FORMATION: typically hematite red, to purple to buff; flaggy to rubbly bedded, medium-grained sandstone, with gritty bands and well-rounded quartzite pebbles 2 to 6 cm in diameter.

Underlain in part by highly altered basement regolithic material (Br); shows intense hematite stains, numerous fractures, and minor quartz veinlets.

REGIONAL CATACLASTIC ZONES

Zones of regional cataclasis and recrystallization have principally affected granite gneisses and metasedimentary rocks to produce: ultramylonite, mylonite, cataclasite, blastomylonite, and flaser gneiss; megastructure is typically streaky; may contain rounded or augen rock clasts or feldspar porphyroclasts ( ).

223 — RECRYSTALLIZED CATACLASTIC ROCK: dark colored, with white to gray anhedral feldspar porphyroclasts and euhedral feldspar porphyroblasts 10 to 50 mm long; foliated, locally gneissose; aphanitic matrix, locally medium-grained; minor aplite and pegmatite. Largely Fishing Creek Quartz Diorite and Wylie Lake Granodiorite Phase parent materials.

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 foliated, finely banded, aphanitic matrix. Largely granite gneiss parent material.

GRANITOID ROCK GROUP

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

WYLIE LAKE GRANITOIDS

LEUCOCRATIC GRANITE: commonly found as small masses intimately mixed with all other Wylie Lake Granitoid rocks. Present in a wide range of proportions in outcrop, only concentrations over 50 percent are shown. White to pink to reddish leucocratic masses of varied textural character; typically equigranular, medium-grained but ranging to coarse- and fine-grained, massive; borders sharp or gradational, simple or complex in outline ( ).

136 — UNDIFFERENTIATED GRANITOIDS: lack of local field data does not allow better definition and subdivision of these areas; this broadly defined unit is composed principally of Fishing Creek Quartz Diorite and Wylie Lake Granodiorite Phase; Granodiorite D and Granodiorite E are subordinate.

137 — GRANODIORITE D: mottled appearance with gray, white (locally pink) feldspar megacrysts in a gray (locally pink) matrix; subhedral to euhedral feldspar megacrysts 20 to 50 mm long, typically up to 10 to 15 percent abundance, in a medium- to coarse-grained matrix of feldspar, quartz, and biotite; matrix is massive to well foliated. Predominant rock-type is granodiorite, but composition ranges to granite and quartz diorite.

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 locally distinctly megacrystic or equigranular; megacrystic white to gray to pale green feldspars 5 to 10 mm long in a greenish gray matrix of feldspar, quartz, and biotite; typically poorly foliated, locally massive or gneissic. Rock-type is predominantly quartz diorite but composition ranges to quartz-bearing diorite and granodiorite. Schlieren of biotite or metasedimentary rocks may be present.

132 — GRANODIORITE E: generally greenish or brownish overall; may be finely mottled; pink to red subhedral feldspars (6 to 8 mm) tend to be megacrystic with occasional megacrysts (10 to 15 mm) in an essentially equigranular, massive to poorly foliated matrix of feldspar, quartz, and biotite (chloritic). Composition ranges to granite.

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

Megacrystic Phase: white feldspar megacrysts up to 15 mm long and forming up to 15 percent of the rock; either randomly oriented or aligned with the foliation of map-units 131, 132, or 133 ( ).

METASEDIMENTARY ROCK GROUP

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; dark greenish (bluish) gray (fresh surface); 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 porphyroblasts 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 GNEISS GROUP

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; generally 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 granodiorite, quartz diorite, and quartz monzodiorite. Large areas are migmatitic, particularly where intimately associated with minor lenses, pods, and bands of metasedimentary rocks, pegmatite, or 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, p. 144-240.

Base maps compiled from planimetric sheets published by Alberta Energy and Natural Resources, Edmonton.

Aerial photographs covering this area are obtainable from the Technical Division, Alberta Energy and Natural Resources, Edmonton; or the Mapping and Surveys Branch of Energy, Mines and Resources, Ottawa.

Approximate magnetic declination 24°49′ East in 1978, decreasing approximately 4′ annually.

Geology by John D. Godfrey, Peter Klewchuk, and Maurice B. Dusseault, 1971.

Map drafted by D.E. Jacobs and C. Parent
Cartographic editing by A.R. Campbell
Scale 1:31,680 or 1 inch to ½ mile.
Published 1978

Map to accompany Report 78-1.