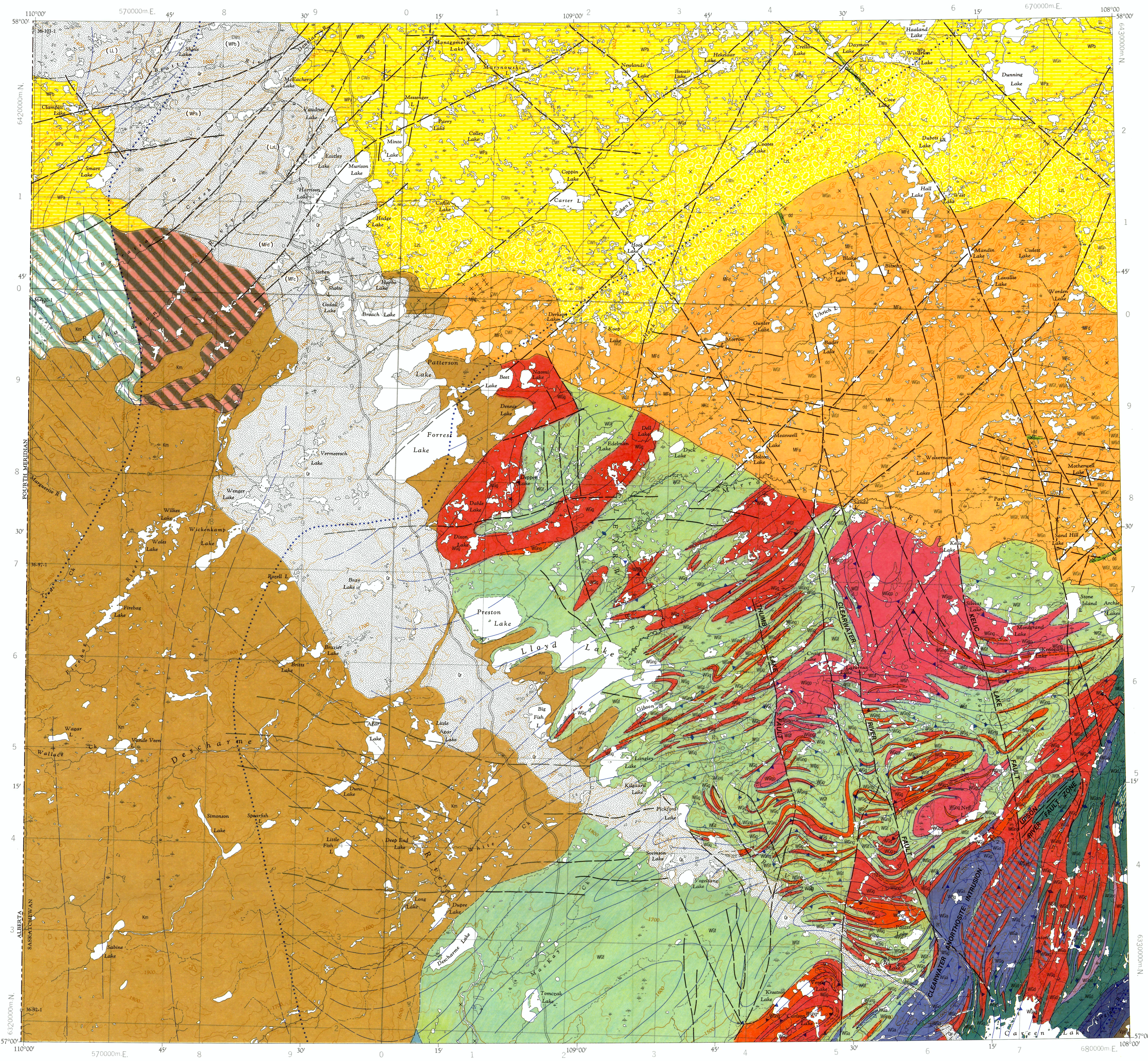
Saskatchewan Energy and Mines
Saskatchewan Geological Survey

Map 231A. COMPILATION BEDROCK GEOLOGY SERIES

LLOYD LAKE, NTS AREA 74F

SASKATCHEWAN
Scale 1:250 000

First Edition, 1986



LEGEND

QUATERNARY

Qr — **Recessional moraine:** unconsolidated sand and gravel of the Cree Lake Moraine

~~~~ UNCONFORMITY ~~~~

LOWER CRETACEOUS

Km — **Mannville Group:** grey, kaolinitic, locally argillaceous and carbonaceous quartzose sands and poorly consolidated sandstones of fluviatile, deltaic and marine origin

~~~~ UNCONFORMITY ~~~~

MIDDLE DEVONIAN

Dn — **Undifferentiated calcareous rocks:** comprising calcareous sandstones and breccias, argillaceous dolomite and calcareous dolomite

~~~~ UNCONFORMITY ~~~~

NEOHELIKIAN

dd — **Diabase dyke:** fine to very coarse grained, subophitic texture; possibly related to the Cree Lake Dyke Swarm

PALEOHELIKIAN

ATHABASCA GROUP

LL — **Locker Lake Formation:** mainly pebbly sandstone of marine origin

WP — **Wolverine Point Formation:** marine sandstone and siltstone

WPb: mainly siltstone and clay-rich sandstone, phosphoritic, tuffaceous
WPa: mainly sandstone, minor siltstone

LzL — **Lazenby Lake Formation:** pebbly sandstone containing sparsely disseminated clasts; probably of marine origin

MF — **Manitou Falls Formation:** mainly fluviatile sandstone and conglomerate

MFd: intraclast-rich sandstone (fluviatile)
MFc: sandstone (fluviatile)
MFa: sandstone, minor pebbly sandstone, minor conglomerate, minor intraclast-rich sandstone (marine, interbedded fluviatile)

~~~~ UNCONFORMITY ~~~~

AGE UNCERTAIN; CATACLASIS PROBABLY LATE HUDSONIAN

x — **Cataclastic rocks:** grey to pink mylonitic gneisses derived from mafelsic gneisses of the Western Granulite Domain and from the 'Virgin Schist Group' of the Virgin River Domain

VIRGIN RIVER DOMAIN

PROBABLY EARLY TO MIDDLE APHEBIAN

Vpsn — **'Virgin Schist Group':** interbanded fine- to medium-grained metasediments and possible metavolcanics, consisting of meta-arkose, garnet-biotite gneiss, biotite schist, porphyroblastic feldspar-biotite gneiss and hornblende gneiss

FIREBAG DOMAIN

PROBABLY MAINLY ARCHEAN

Fn — **Undifferentiated gneisses:** mylonitized psammopelitic, psammitic and blue quartz-bearing granulite facies gneisses

CLEARWATER DOMAIN

PROBABLY MAINLY HUDSONIAN[1]

CWn — **Undifferentiated granitic and supracrustal rocks:** mainly equigranular granite, megacrystic granite and felsic gneisses intermixed with pelites, psammites and quartzites

CWf — **Felsic gneisses:** pale pink or grey, medium to coarse grained, foliated felsic gneisses, subcropping beneath Athabasca Group

[1]The term 'Hudsonian' has been used by most authors in Saskatchewan to indicate the tectonometamorphic activity or orogeny which affected Aphebian rocks or older basement during the interval approximately 1900 to 1650 Ma ago (see Douglas, 1980; Bell and Macdonald, 1982).

WESTERN GRANULITE DOMAIN

PROBABLY MAINLY ARCHEAN WITH HUDSONIAN PLUTONS AND REWORKING

WGn — **Undifferentiated gneisses:** predominantly mafelsic to felsic gneisses with intermixed supracrustal material, including biotite and amphibole gneiss, subcropping beneath Athabasca Group

WGxn — **Augen gneiss:** streaky gneisses gradational to mylonite, interbanded with granite (unit WGg) and mafelsic gneiss (unit WGd)

WGg — **Granite:** pink, generally medium grained, massive to weakly foliated with clear and blue quartz; biotite ± hornblende ± pyroxene ± garnet; local inclusions of 'Careen Lake Group' (unit WGng)

WGa / WGag — **Anorthosite:** grey to blue grey to pink grey, medium to coarse grained with local cumulate layering; includes areas of leucogabbro and gabbronorite; plagioclase ± hypersthene ± clinopyroxene ± hornblende ± zircon ± actinolite; locally migmatitic with granite (unit WGg), mafelsic gneiss (unit WGd) and felsic granulite (unit WGf)

WGag: migmatite complex with granite (unit WGg)

WGf — **Felsic granulite:** medium-grained, weakly foliated hypersthene-bearing gneisses of overall granodioritic composition with local blue quartz and garnet and minor amphibolite and orthopyroxenite; locally migmatitic with granite (unit WGg) and anorthosite (unit WGa)

WGng — **'Careen Lake Group':** medium grained, grey to pink migmatite of interbanded garnetiferous meta-arkose and metapelitic rocks with garnetiferous granite (unit WGg); ± cordierite ± sillimanite ± garnet ± biotite ± pyrite ± graphite ± gahnite ± magnetite; minor diopside gneiss, actinolite gneiss, quartzite and rare magnetite-quartz-rich iron formation

WGgp — **Megacrystic granite:** hypersthene-bearing with local clinopyroxene; includes megacrystic granodiorite and augen granite gneiss

WGbd — **Diorite, quartz diorite and norite:** medium grained, grey green, poorly foliated with clear or blue quartz; ± hornblende ± plagioclase ± pyroxene ± biotite ± magnetite ± serpentine

WGd — **Mafelsic gneiss:** medium-grained, light grey to pink, well-foliated blue quartz gneisses; ± hornblende ± biotite ± feldspar ± garnet ± magnetite ± chlorite ± serpentine; includes garnetiferous granodiorite and local migmatite with granite (unit WGg)

SYMBOLS

Bedrock exposure; approximate area of abundant bedrock exposure

Geological contact: defined to approximate, inferred

Sub-Athabasca Group geological contact: inferred

Structural lineament, possible to probable fault, as interpreted from geological, geophysical and/or airphoto evidence

Structural trend lines interpreted from airphotos and structural orientation data: dip shallow (0-29°), moderate (30-59°), steep (60-84°), subvertical (85-90°)

Projected sub-Phanerozoic structure trend lines interpreted from aeromagnetic data

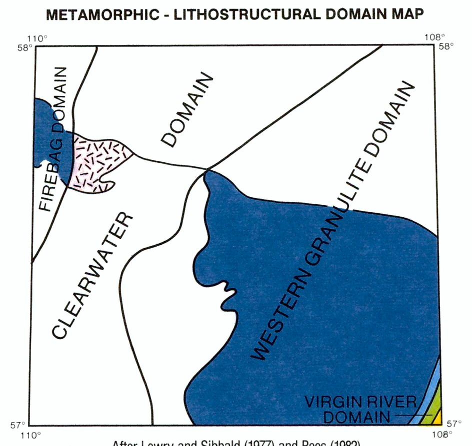
Approximate to inferred northeasterly subcrop limit of Devonian strata

Approximate to inferred lithostructural domain junction

Mineral prospect, deposit:
1. Virgin, Cu-Zn-(Ni-Au) (Beck, 1959; Scott, 1985)
2. Camel Lake Prospect, Ni-Ag-(Cu-Au) (Scott, 1985)

Sample location (geochronology):
1. 2056 ± 50 Ma, U-Pb zircon isochron (Lewry, pers. comm.)

METAMORPHIC - LITHOSTRUCTURAL DOMAIN MAP



After Lewry and Sibbald (1977) and Rees (1982)

HUDSONIAN METAMORPHISM

Metamorphic Facies	Isograds
Lower amphibolite	
	staurolite-cordierite-diopside
Lower amphibolite and upper greenschist (undivided)	

ARCHEAN (KENORAN?) METAMORPHISM

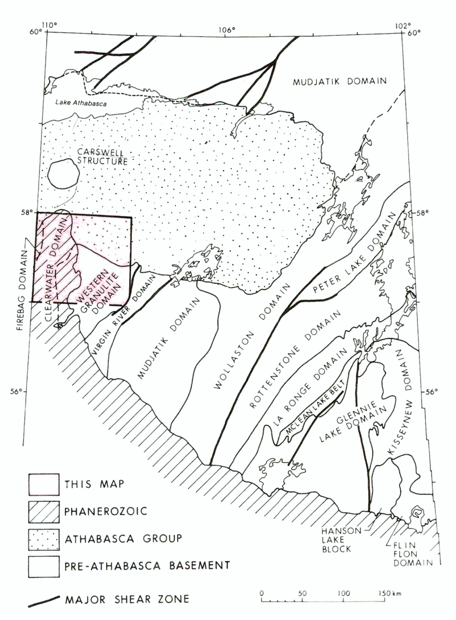
Granulite facies (weakly retrogressed by Hudsonian greenschist to lower amphibolite metamorphism)

Granulite facies (strongly retrogressed by Hudsonian greenschist to lower amphibolite metamorphism)

Mainly synorogenic plutonic rocks, regional metamorphic grade undefined

Unmetamorphosed rocks

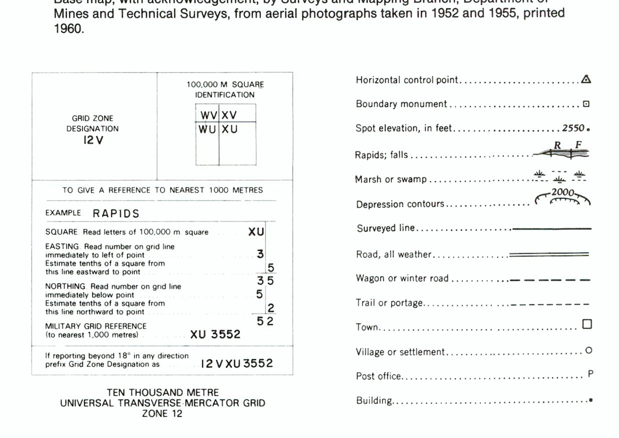
LITHOSTRUCTURAL DOMAINS OF THE PRECAMBRIAN SHIELD IN SASKATCHEWAN



Modified from Lewry and Sibbald (1977) and Macdonald and Broughton (1980)

BASE MAP LEGEND

Base map, with acknowledgement, by Surveys and Mapping Branch, Department of Mines and Technical Surveys, from aerial photographs taken in 1952 and 1955, printed 1960.



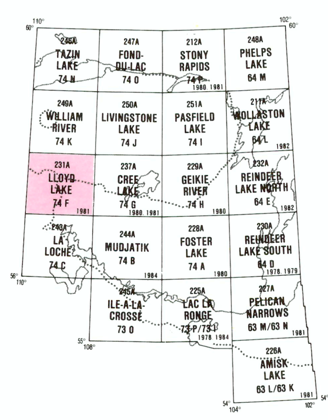
Transverse Mercator Projection
North American Datum 1927
Contour Interval 100 feet
Elevations in feet above mean sea level
Magnetic declination 18°23'E at centre of map, 1963
Annual change (decreasing) 2.3'

Geology compiled by B.P. Scott, 1981, with revisions and geological notes by W.L. Slimmon, 1985-86.

Cartography by P.A. Weir, 1986. Colour reproduction by electronic scanning of hand-coloured original. Legend and text phototypeset via in-house text-processing equipment and custom typesetting by Brigdens, Regina.

Published 1986

Series Coordinator: R. Macdonald
Production Editor: R.F. Davie



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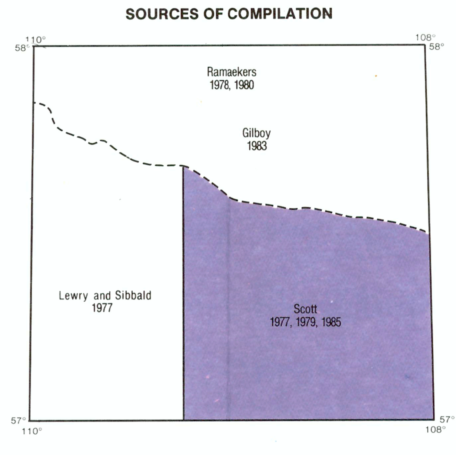
SOURCES OF COMPILATION



Saskatchewan Geological Survey 1:100 000 scale reconnaissance mapping

Saskatchewan Geological Survey Athabasca Group and sub-Athabasca Group mapping

GEOLOGICAL NOTES

The Lloyd Lake area is underlain by Phanerozoic sedimentary rocks in the southwest, Paleohelikian Athabasca Group sedimentary rocks in the north and earlier Precambrian crystalline basement rocks in the southeast. Bedrock exposure is extremely limited beneath a cover of Pleistocene glacial drift in all areas but the southeast. The Cree Lake Moraine, an end moraine peaking as much as 75 m above the surrounding terrain (Schreiner, 1984), trends southeasterly across the area.

The crystalline basement rocks have been divided into several domains - the Firebag in the west, the Clearwater more centrally, the Western Granulite in the east and the Virgin River in the extreme southeast. As bedrock is not exposed, the approximate boundaries of the Firebag and Clearwater Domains were interpreted from aeromagnetic and borehole data (Lewry and Sibbald, 1977; Gilboy, 1983). Lewry and Sibbald (1977) interpreted the Firebag and Western Granulite Domains to be deep level, mildly reworked granulite facies Archean crust separated by the Hudsonian Clearwater Domain.

Firebag Domain

Rocks of the Firebag Domain are not exposed in Saskatchewan, but mapping by Tremblay (1961) indicates that they are exposed in Alberta, where they are part of a retrogressed granulite facies terrain similar in character to the Western Granulite Domain (Lewry and Sibbald, 1977). The retrogression may have been accompanied by deformation, as indicated by submylonitic fabrics in core from several drillholes in the area (Gilboy, 1983).

Clearwater Domain

Rocks of the Clearwater Domain are exposed only in the Clearwater River gorge, approximately 11 km south of the map area, where they consist of equigranular granite, megacrystic granite and felsic gneisses (Sibbald, 1974). The felsic gneisses resemble those of the Virgin River and Mudjatik Domains, and contrast sharply with the blue quartz gneisses of the Western Granulite Domain (Lewry and Sibbald, 1977). The northerly extension into the map area of the Clearwater Domain is based on the absence of blue quartz in basement samples from boreholes, as well as the flat aeromagnetic relief and the relatively lower aeromagnetic and gravity values compared to the adjacent domains (Wallis, 1970; Lewry and Sibbald, 1977).

Western Granulite Domain

The Western Granulite Domain is characterized by a series of layered gneisses with an overall granodioritic composition which ranges from granitic to gabbroic, plus subordinate metasediments, anorthosites and granites. Mafelsic gneisses (unit WGd), diorite (unit WGbd) and megacrystic granite (unit WGgp), the oldest rocks in this domain, possibly comprise the Archean basement on which the Careen Lake Group (unit WGng) sediments were deposited (Scott, 1985). These migmatitic metasediments contain structurally complex zones with rotated blocks and rootless folds of metasediment in a garnetiferous granitic matrix.

Felsic granulite (unit WGf) displays a weak foliation resulting from the concentration of disseminated magnetite and mafic minerals on surfaces that are frequently discordant at small angles. Within this unit, orthopyroxenite, comprising local concentrations of massive coarse-grained brown hypersthene, occurs in the west bay of Lloyd Lake, 3 km southeast of Neff Lake (Camel Lake Prospect) and 6.5 km north of Viking Lake (Scott, 1985). Several conformable sills of felsic granulite and semiconformable veins of orthopyroxenite intrude the Careen Lake Group.

Anorthosite (unit WGa) is intrusive into mafelsic gneisses and felsic granulite. The Clearwater Anorthosite Intrusion, a major anorthosite-norite plutonic complex, constitutes most of this unit, but smaller isolated bodies also occur. Recent work by Collerson and Lewry (1985) suggests that the western boundary of the intrusion may extend another 5 km west to Fournier Lake. U-Pb isotopic data from zircons in a tonalitic xenolithic raft within this extended area yield an age of 2056 ± 50 Ma, which may be the time of emplacement of the intrusion (Lewry, pers. comm.). The zoned body has an anorthositic core with Ca-rich plagioclase and Mg-rich orthopyroxene, and border rocks of leucogabbronorite and leuconorite containing Na-rich plagioclase and Fe-rich pyroxene. Primary igneous layering is visible on outcrop and regional scales, and mafic to ultramafic cumulate layering is displayed locally. Granite (unit WGg) intrudes the anorthosite and occurs throughout the map area in migmatitic zones and as irregular plutons. Contacts with the country rock are commonly sharp and irregular in the Lloyd Lake vicinity, but toward the southeast are more gradational, in places over several metres.

Mylonitic zones of augen gneiss (unit WGxn) are probably related to the Virgin River Shear Zone, which marks the boundary between the Western Granulite and Virgin River Domains. The cataclastic rocks (unit x) making up the zone resulted from probable late Hudsonian ductile and brittle shearing of rocks from both domains (Lewry and Sibbald, 1977; Gilboy, 1985).

Black massive aphanitic steeply-dipping pseudotachylite veins (not shown on map) occur in a circular area bounded by Lloyd, Laturnus and Pickford Lakes and may have been emplaced as a result of meteorite impact (Scott, 1985).

Virgin River Domain

Interbanded metasediments and possible volcanics found in this part of the Virgin River Domain are part of a continuous supracrustal belt termed the 'Virgin Schist Group' (unit Vpsn) by Johnson (1968) and Wallis (1970).

Structural and Metamorphic Evolution

Scott (1985) recognized three deformational events in the Western Granulite Domain. D_1 deformation followed the deposition of the Careen Lake Group and formed upright, tight to isoclinal northeast-trending folds with shallow southwest plunges. D_2 deformational folding about northwest-trending axes apparently interfered with the earlier folds, resulting in canoe-shaped folds with northwest and southeast plunges. D_1 and D_2 are associated with lower granulite facies metamorphism, as indicated by the common occurrence of hypersthene, and probably with the production of the gneissic layering.

The D_3 deformation consisted of mild reworking in the form of early ductile and later brittle shearing which produced a new fabric overprint and northeast-trending isoclinal folds with shallow north and south plunges. The new fabric, expressed as flattening and rodding of blue quartz, feldspars and mafic minerals, has a dominant linear element and subordinate planar element (Lewry and Sibbald, 1977). Deformation was strongest along the Virgin River Shear Zone and was probably coeval with the first deformational event in the Virgin River Domain. The Clearwater Anorthosite Intrusion may have been emplaced along a northeast-trending fault related to the Virgin River Shear Zone (Scott, 1985). The presence of pyroxene megacrysts with plagioclase exsolution lamellae suggests that the parent magma of the intrusion originated in the upper mantle (Gochnauer, 1978). In response to metamorphic events to the east, the southeastern corner of the map area underwent amphibolite and greenschist facies retrogressive metamorphism. Both the effect of this and the presence of the overprinted fabric decrease in intensity away from the Virgin River Shear Zone. Finally, post-Athabasca Group faulting produced major northeast- and northwest-trending subvertical faults.

Athabasca Group

In the north, Paleohelikian Athabasca Group fluviatile arenites unconformably overlie the older basement, commonly with a conglomeratic base. The underlying basement rocks are commonly saprolitic due to pre-Athabasca Group weathering. Post-Athabasca diabase dykes (unit dd) are typically located along northwest and northeast-trending faults, and may be related to those in the Cree Lake Dyke Swarm (Ramaekers, 1977, 1978).

Phanerozoic Rocks

In the southwest, Devonian and Cretaceous sedimentary rocks nonconformably overlie the Precambrian surface, which dips southwesterly in the area at a gradient of approximately 4.5 m/km. South of the map area, Paterson et al. (1978) divided the Middle Devonian rocks into 'Granite Wash' (basal sandstones and breccias) of the La Loche Formation, argillaceous dolomites of the Contact Rapids Formation and dolomites of the Winnipegosis Formation. Except for a small area south of Descharme Lake, the margin of the Lower Cretaceous Mannville Group oversteps the underlying Devonian strata and rests on either crystalline basement or the Athabasca Group.

Economic Geology

The southern edge of the Athabasca Group in the Lloyd Lake area has undergone fairly extensive exploration for uranium. In contrast to the eastern side of the basin, no significant discovery has been reported so far in this area.

Two significant mineral occurrences have been reported to date within the crystalline basement rocks. The Virgin copper-zinc showing is located on the north shore of Careen Lake near the contact between a quartz diorite or norite sill and highly altered quartzose metasediments. Mineralization occurs in small lenticular sulphide bodies within a north-trending shear zone that cuts the sill. Two grab samples of oxidized material from the shear zone assayed: 0.25 percent Cu and 0.67 percent Zn; and 0.26 percent Cu, 0.32 percent Zn and 0.02 oz./ton Au (Beck, 1959).

Southeast of Neff Lake, the Camel Lake nickel-silver prospect comprises chalcopyrite-pyrite-pyrrhotite mineralization in an orthopyroxenite dyke. Diamond-drilling returned values of up to 0.26 percent Ni, 0.5 percent Cu, trace Zn, 3.34 oz./ton Ag and 0.005 oz./ton Au (Scott, 1985).

The possibility of the Clearwater Anorthosite Intrusion being part of a major layered plutonic complex may be a favourable indication for platinum-group element exploration.

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[2]A more complete bibliography for Lloyd Lake, NTS Area 74F is available from the Saskatchewan Geological Survey, Regina.

This publication may be referenced as:

Scott, B.P. and Slimmon, W.L. (1986): Compilation Bedrock Geology, Lloyd Lake, NTS Area 74F; Saskatchewan Energy and Mines, Report 231 (1:250 000 scale map with marginal notes).

Map 231A. Compilation Bedrock Geology Series
LLOYD LAKE, NTS AREA 74F
SASKATCHEWAN
1:250 000 Scale