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LEGEND

MESOZOIC

CRETACEOUS

UPPER CRETACEOUS

12 — *Chiefly marine shale*

CRETACEOUS AND JURASSIC (?)

11 — *Upper Cretaceous, Lower Cretaceous (?) and Jurassic (?): shale, limestone and sandstone; probably some non-marine beds*

PALÆOZOIC

DEVONIAN

10 — *Limestone and dolomite*

SILURIAN

9 — *Magnesian limestone*

ORDOVICIAN

8 — *Dolomite, dolomitic limestone, limestone and sandstone*

PRECAMBRIAN

CHURCHILLIAN GROUP

POST-MISSI

7 — *Granite, granite-gneiss, granodiorite and syenite; mostly of undetermined age, but post-Missi where determined*

6 — *Gabbro and diorite*

MISSI SERIES

5 — *Conglomerate, arkose, quartzite, greywacke, and quartz-plagioclase-mica gneiss*

PRE-MISSI

4 — *Granite and diorite*

Wekusko and Hayes River groups

3 — *Sedimentary and volcanic gneisses and schists, some sedimentary members are of Missi age*

2 — *Chiefly acidic volcanics and derived schists; quartz-feldspar porphyry, sediments, and derived schists*

1 — *Chiefly basic volcanics and derived schists*

Geological boundary

Trail or portage

Rapid or fall

Notes: *East of Lake Winnipeg rocks other than granite are known to occur, but their relations and areal extent are not known everywhere.*

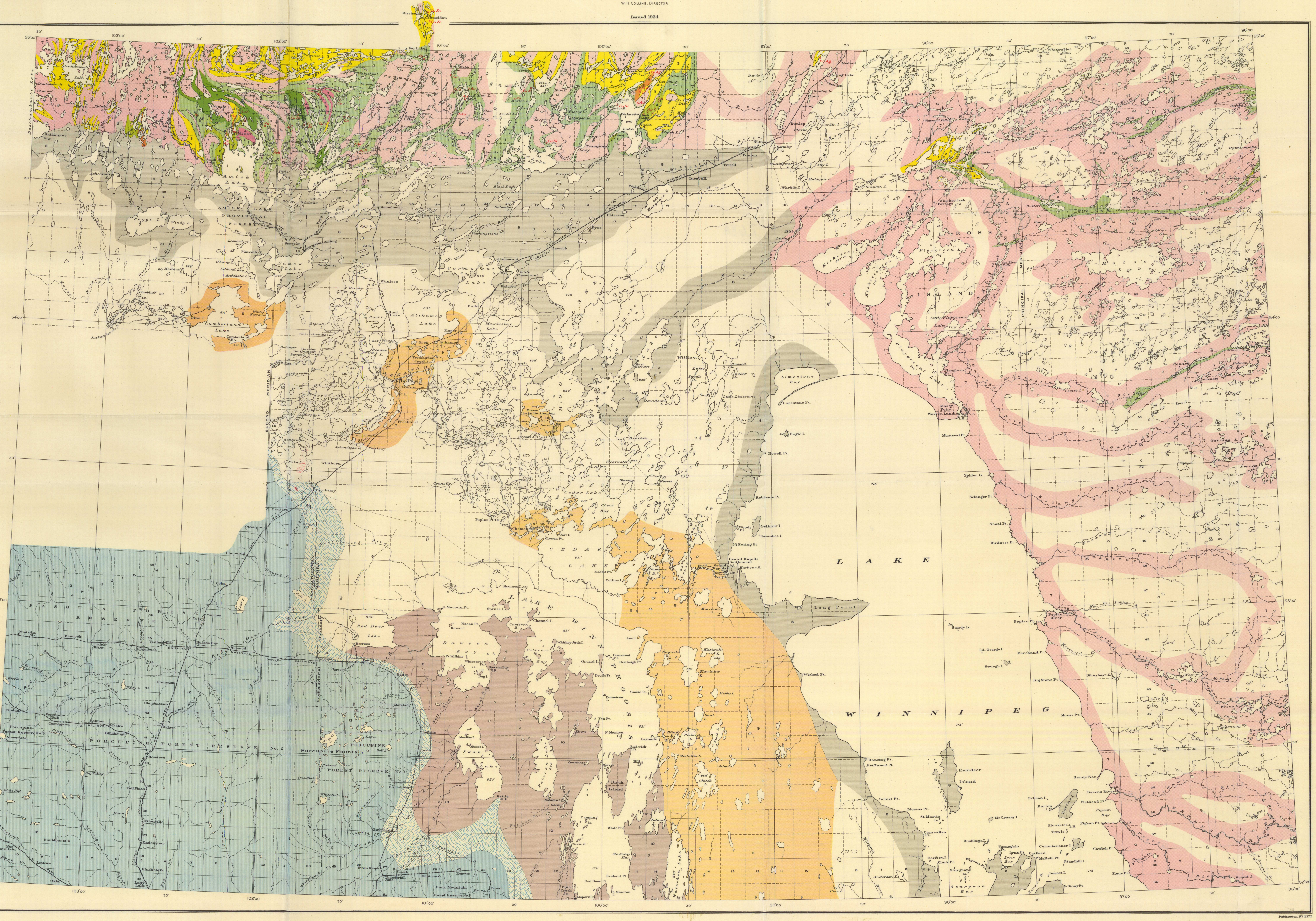
Some part of the western margin of the area represented as occupied by Devonian may be underlain by strata of later age.

PRINCIPAL MINERAL OCCURRENCES

× Asb Asbestos	× Pb Lead
× Cu Copper	× Ni Nickel
× Au Gold	× Ag Silver
× Zn Zinc	

SOURCES OF INFORMATION

Geology compiled by J.F. Wright, *from surveys by the* Geological Survey



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MAP 268A

THE PAS SHEET

MANITOBA AND SASKATCHEWAN

Scale, $\frac{1}{506,880}$ or 1 Inch to 8 Miles

Miles: 8 0 8 16 24 32

Kilometres: 10 0 10 20 30 40 50

PHYSICAL FEATURES

The Pas area is divided by northwesterly trending escarpments into several comparatively level areas each rising above its eastern neighbour. The eastern and northern part lies within the Canadian Shield. It stands 645 to 1,100 feet above sea-level, with the lowest part along Nelson river. It is a rough and rocky country, though few of the hills rise more than 125 feet above the surrounding valley floors or nearby lakes. The low hills are closely spaced in some districts so that the country is much broken. In some areas the irregularities of the rock surface have been almost covered by a smoother mantle of glacial drift largely covered by swamp and muskeg. The forest is thick in the better drained areas of low ground whereas only small jackpine grow on most of the rocky ridges. Large areas of the original forest have been burnt.

West and south of the Canadian Shield lies the Manitoba Lowland. At some places it merges northward into the Canadian Shield but elsewhere the boundary between the two physical provinces is marked by a scarp, 10 to 90 feet high and facing the Canadian Shield. The greater part of the lowland varies between 750 and 1,000 feet above the sea, rising gradually to the west and north. The surface is, for the most part, level but is broken at intervals by valleys, by cliffs from 10 to 30 feet high, and by ridges of drift as much as 50 feet high. An eastward facing escarpment in places 100 feet high separates the basin of Lake Winnipeg from a higher level on which lies Lake Winnipegosis.

West of the Manitoba Lowland lies the Great Plains region, whose eastern border is approximately marked by the eastern edge of the Mesozoic strata. These beds constitute a marked escarpment rising up to 1,400 feet above the bordering lowland. In places the rise is abrupt, in other places it takes place by a series of low terraces. The escarpment is embayed by several broad valleys that gradually rise westward and break the eastern edge of the plateau of the Great Plains into broad, semi-detached uplands or hills. The surface of the plateau is rolling and rises gradually for some distance back from the edge, but beyond this declines to the general level of the prairies.

GENERAL GEOLOGY

The Precambrian strata form two main divisions, an older group of volcanics and sediments and a younger, Missi series of clastics. The basal beds of the Missi series locally rest on granite that intrudes members of the older group. This and other facts prove an important unconformity at the base of the Missi series. Strata of the Missi series are also cut by granite, hence the interval between the invasion of these two granites, and within which the Missi clastics were deposited, is important as a datum in establishing and correlating the Precambrian succession throughout a large area in northwest Manitoba and the adjoining parts of Saskatchewan. The name Churchillian is here adopted for the group of rocks that overlie the pre-Missi granite and are beneath the great unconformity above the post-Missi granite.

The strata of the Wekusko and Hayes River groups (1, 2, 3) originally were extensive, but now occupy isolated patches of various sizes. The beds are for the most part closely folded and details of the structure and succession are unknown except in small areas, so it is likely that rocks of different ages are present. The bodies of pre-Missi lavas and sediments west of the large area of granitic rocks extending north and northeast from Lake Winnipeg are known as the Wekusko group and those on the east side of this area of granites are known as the Hayes River group.

The pre-Missi rocks are both massive and schistose and in some areas they are recrystallized to various types of gneiss and granular rocks intricately injected with granitic materials. The lower part (1) of the assemblage appears to be mainly of basic lavas, largely either andesite or basalt, but with these occur layers of fine-grained slaty sediments and banded pyroclastics, flows of acidic lavas, and dykes and bosses of grey porphyry resembling dacite and rhyolite. The upper part (2, 3) appears to consist chiefly of grey to black dacite and rhyolite with some interlayered andesite (2) and much sedimentary material in single beds and thick groups of beds. The main areas of sediments (3) include beds of greywacke, chert, argillite, slate and, at a few localities, conglomerate. These sediments are largely recrystallized to quartz-mica schists bearing in varying proportions and combinations, andalusite, chiastolite, cordierite, staurolite, cyanite, sillimanite and garnet. Locally the lavas have been recrystallized to plagioclase-hornblende gneisses and these, for mapping purposes, have been grouped with the recrystallized sediments (3) and some areas of highly altered Missi have been grouped in the same way.

The pre-Missi intrusives include granite, quartz-feldspar porphyry, diorite and brecciated diorite (4). The granite is distinguishable by numerous, small "eyes" of dark quartz; locally it has been converted into a quartz and white mica schist. These intrusives carry abundant albite or other soda-lime feldspar. They occupy small areas surrounded by rocks of the Wekusko group and are believed to represent the tops of batholiths exposed at the time the Missi strata were deposited. At Lookout island, in Amisk lake, Missi conglomerate rests on granite. The other intrusive bodies shown as of this age have a similar lithological character or structural relations that suggest strongly that they are older than the Missi series.

The Missi (5) sediments occur in troughs within the Wekusko group that were formed either by folding or by faulting or by both. The Missi series includes thick, massive beds of conglomerate, arkose and greywacke. The strata locally are altered to sericite schists and in places have been recrystallized to quartz-plagioclase-mica gneisses. The conglomerates carry pebbles of the underlying Wekusko group and also of granite. The clastics rest on granite, and on acidic lavas, sediments, and basic lavas of the Wekusko group. In places the basal conglomerate is lacking and members of the Wekusko group and Missi have an appearance of conformity. Apparently the Missi strata were deposited on a fairly rough surface developed by erosion after a period of granitic invasion. The Missi series may belong to the same system as the Seine series of western Ontario, and, if so, is older than the Algoman granite of that region.

The granitic rocks (6, 7) are probably of several ages. All are younger than a large part of the Wekusko and Hayes River groups; probably most of them are younger than the Missi series. The granites and granite-gneisses (7) are remarkably uniform over large areas. They are medium to coarse-grained, evenly granular, and grey to pinkish grey. Some bodies are more variable and include masses of quartz diorite, granodiorite, syenite and granite. Marginal parts of the granitic bodies in places carry inclusions of the rocks invaded, and granite that adjoins basalt and andesite may be rich in hornblende. Some large granitic bodies are gneissic throughout but the interiors of many are massive. The granite of some bodies a mile or more wide has a stratiform structure.

Dykes and other small bodies of pyroxenite, peridotite, gabbro, diorite (6), diabase, lamprophyre, aplite, granite, quartz porphyry and pegmatite are locally abundant in the strata of the Wekusko group and Missi series. Some bodies of peridotite, gabbro or diorite are older, and others of diabase or lamprophyre are younger than the granites. Many of the mineral deposits are near or within the dyke rocks.

The Palæozoic and Mesozoic strata are nearly horizontal but dip gently away from the edge of the Canadian Shield, so that younger and younger beds outcrop as the margin of the Canadian Shield is left behind. The earliest Palæozoic beds rest on an uneven floor of Precambrian rocks much like the present surface of the Canadian Shield. A few outliers and groups of boulders representing disrupted outliers of the Ordovician prove that the Ordovician formerly extended farther northward and faunal evidence indicates that the Ordovician and Silurian were once continuous with the areas of similar strata bordering Hudson Bay. Considerable erosion of these and any overlying Devonian strata probably occurred during late Palæozoic or early Mesozoic time. The remaining Palæozoic beds were finally stripped off the Canadian Shield by the extensive erosion of Tertiary time. The area underlain by the Palæozoic and Mesozoic is largely drift covered and for this and other reasons the succession and distribution of the strata are imperfectly known.

The lowest Ordovician (8) beds at Cormorant and Deschambault lakes are reddish and greyish sandstone whereas at Amisk, Athapapuskow, and Wekusko lakes, light-buff, dolomitic limestone appears to rest directly on the Precambrian. The Ordovician strata are at least 350 feet and may be as much as 450 feet thick. The greater part consists of dolomitic limestone and dolomite presumably equivalent to the Upper Ordovician Selkirk (Upper Mottled) limestones found towards the south end of Lake Winnipeg.

The Silurian (9) consists of the Stonewall dolomite at least 400 feet thick. The dolomites are light buff, yellowish cream and pinkish but weather almost white.

The Devonian (10) is made up of grey, white and yellowish dolomite, greenish-grey, argillaceous limestone and grey to cream-white limestone and has a probable total thickness of 400 to 500 feet. The Elm Point limestone, or lowest division of the Devonian in Manitoba, is not definitely known to outcrop within the area of the Pas Sheet, but the succeeding Winnipegosan dolomite and Manitoban limestone form prominent outcrops, particularly on the islands and shores of Dawson Bay, Lake Winnipegosis. Possibly some parts of the western margin of the area represented as occupied by the Devonian is underlain by shales and other strata of Devonian or later age such as occur farther south.

No Jurassic or beds certainly of Lower Cretaceous age are known to outcrop but strata of these ages may be present, since farther south they are believed to underlie the younger Cretaceous. The oldest Cretaceous that outcrops in the area is seen on Red Deer River, Swan River, Kettle Hill, south of Swan Lake and other places. It consists of carbonaceous and calcareous sandstones, and black and green clays and shales all probably of Upper Cretaceous age. The area underlain by these beds and the possible Lower Cretaceous and Jurassic beneath them is indicated as a unit (11) on the map; the entire group thus mapped has a variable thickness, with a probable maximum of about 200 feet. These predominantly arenaceous beds are succeeded by marine shales and limestones of Upper Cretaceous age which, in Porcupine mountain, reach a thickness of 1,000 feet or more. The marine beds (12), separately indicated on the map, include strata equivalent to the Colorado and Montana divisions of the Upper Cretaceous. They include, in ascending order: dark grey and almost black, carbonaceous, non-calcareous shales with thin interbeds of impure limestone; calcareous shales and impure limestone; dark, carbonaceous, predominantly non-calcareous shales; and light grey to greenish grey, non-calcareous shales.

The Pas area was occupied by glaciers during the Glacial period and a considerable part by Glacial Lake Agassiz. Stratified clays laid down in this lake occupy the parts of the region lying at elevations below 900 feet above sea-level. Beaches that formed along the west shore of Lake Agassiz are well preserved west of Lake Winnipegosis. One beach at an altitude of 898 to 906 feet runs from Westray northeast to within 3 miles of The Pas.

MINERAL DEPOSITS

Canadian Shield. The two main types of mineral deposits occurring in the Precambrian part of The Pas area are sulphide deposits and gold-bearing quartz bodies. They lie in chloritic and sericitic schists developed along planes of faulting and shearing chiefly within members of the Wekusko group, but a few deposits occur in the Missi series or in gabbroic and granitic intrusives. Pyrite or pyrrhotite is the abundant mineral of the sulphide deposits; some bodies carry in addition varying proportions of nickeliferous pyrrhotite and chalcopyrite, or of chalcopyrite and sphalerite, or of sphalerite, galena and stibnite. Small quantities of gold and silver also may be present. Some parts of the sulphide deposits are massive sulphides holding only small bits of country rock; other parts are of schistose country rock carrying only scattered grains, veinlets and lenses of sulphides. In some areas, parts of bodies of quartz-feldspar porphyry are sparingly impregnated with arsenopyrite, pyrite and quartz, and carry low values in gold. The gold-bearing quartz bodies are either fairly definite veins or stringers and lenses scattered through schist. These bodies in addition to quartz and gold, may carry small quantities of arsenopyrite, pyrite, sphalerite, galena and stibnite.

Of the sulphide bodies, Flin Flon is the most important. From it about 4,500 tons of copper-zinc-gold ores were mined daily during 1933 and the underground workings are down to the 1470-foot level. The ore is in andesitic lava altered to chlorite and talc schists and cut by dykes of quartz-feldspar porphyry, diorite and gabbro. The ore is of two types. One type is schist carrying only small amounts of pyrite, chalcopyrite, sphalerite and gold, and the other type is dense, very fine-grained pyrite with only small bits of schist and carrying chalcopyrite, sphalerite and gold. Some of the sulphide ore is banded and cuts the lava and schist-ore with sharp contacts. The bodies of sulphides are up to 200 feet wide. The Mandy ore-body was a small but rich lens of dense and banded pyrite, chalcopyrite, and sphalerite carrying gold. At Sherritt-Gordon three long, narrow ore-bodies have been outlined along a thrust zone in gneiss. Here coarse granular pyrrhotite is the abundant sulphide, and the ore comprises masses of pyrrhotite and of pyrrhotite and quartzite gneiss carrying chalcopyrite, sphalerite, and some gold. A number of other pyrite and pyrrhotite bodies have been explored by surface trenching and some diamond drilling but their low content of chalcopyrite and gold did not encourage further investigation of them.

Many of the gold-bearing quartz deposits occur in the Wekusko group near bodies of grey quartz-feldspar porphyry, black lamprophyre, and granite. A few deposits are in these intrusives. Some of the small quartz carry abundant free gold; in the larger veins the gold is chiefly limited to the marginal parts or to small pockets scattered through the vein. Several properties of this general type have been explored and one, the Rex, has been developed to a depth of 350 feet and has produced about $150,000 of gold. Other deposits consist of vein quartz and sulphides, including arsenopyrite, scattered through large masses of jointed and schistose rock. Some of these deposits may carry enough gold to warrant large scale mining operations.

Other mineral occurrences within the Precambrian rocks are large bodies of jointed and schistose pyroxenite and quartz gabbro carrying nickel and copper; bodies of schist carrying sphalerite and galena; pegmatitic quartz carrying molybdenite and scheelite; and pegmatites carrying spodumene and cassiterite.

Manitoba Lowland and Great Plains Region. Numerous salt springs occur about Lake Winnipegosis and suggest that beds of salt may be present in the underlying Devonian strata. Cretaceous shales exposed on Carrot river and elsewhere are oil-bearing but the oil content is not high. Several wells have been sunk in search of oil or gas but proved uncommercial.

268A