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DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 68-45

GEOLOGY OF SIOUX LOOKOUT MAP-AREA, ONTARIO, A PART OF THE SUPERIOR PROVINCE OF THE PRECAMBRIAN SHIELD (52 J)

(Report and P.S. Map 14-1968)

R. Skinner

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Illustrations

east as Marchington Lake. Drumlins are numerous in the northern and central parts of the area and eskers are common throughout most of the area. Some eskers are 25 miles long, with interruptions, but most are less than 5 miles long. Most have rounded crests and broad sandy aprons as a result of wave action. Glacial striae, drumlins and eskers commonly trend southwesterly, indicating a southwesterly movement at least for the last ice. Small morainic hills are present a few miles northeast of Sioux Lookout, on the east side of Lac Seul, and east of Lake St. Joseph; washboard moraines are plentiful northeast of Lac Seul and in the central and eastern parts of the area; and about a dozen kames, a square mile or more in extent, are present in the centre of the map-area. According to Zoltai (1965) the Sioux Lookout map-area as far north as Lake St. Joseph was covered by Glacial Lake Agassiz as shown by the presence of lake deposits and wave action on glacial deposits within this area and to the west.

GENERAL GEOLOGY

All rocks of the area are Precambrian in age and all but the diabase (7), which may be Keweenawan, are Archean. The oldest rocks are Keewatin-type greenstones (1) with minor acid to intermediate volcanics (1a), iron-formation and sediments. These are overlain unconformably by Temiskaming-type sedimentary rocks intercalated with acid to intermediate volcanic rocks (Savant Group and equivalents (2)). Migmatites (3a) consisting of interlayered metasedimentary rocks and granitic material, and paragneiss (3b) appear to grade into sedimentary rocks of unit 2, and are extensively intruded by granitic rocks (6), which also intrude granodioritic and granitic gneisses (4), which in turn appear to intrude greenstones (1). Syenite (5a) and serpentinite (5b) occur in small bodies cutting greenstone (1) but their ages are not known relative to one another or to rocks younger than greenstone (1).

Greenstone (1)

Unit 1 is composed of mainly mafic metavolcanic rocks (greenstones), but also contains some metagabbro, amphibolite, rhyolite and dacite flows and tuffs, metadiorite, metasedimentary rocks and iron-formation. Where these occur in significant amounts they have been shown separately on the map. Greenstones are commonly greenish grey, aphanitic to fine-grained, massive metabasalt or meta-andesite, but some are schistose, fragmental, or laminated (tuff) varieties of these rocks. Pillows are abundant in greenstone west of Sioux Lookout, at Sturgeon Lake, and on the east side of Savant Lake and southeast of Lake St. Joseph. Metagabbro sills, or coarse-grained metabasalt flows, are intercalated with greenstone and form prominent curved linears east of Highway 599 north of the tote road to Savant Lake. In places greenstone is intercalated with rhyolitic and dacitic flows and tuffs (1a) as south of Superior Junction, at Sturgeon Lake and probably at and west of Lake St. Joseph; and with slates and tuffs as southwest of Sturgeon Lake and at Richan Lake; and with quartzite and iron-formation as northeast of Neil Lake, south and southeast of Armit Lake, and along Highway 599 north of Wiggle Creek.

Unit (1b) is composed of dacite flows and tuffs and their coarse-grained (quartz-diorite?) equivalents. The dacites are commonly cream weathering, greenish grey, finely porphyritic, foliated rocks with phenocrysts of glassy quartz and white plagioclase up to 3/16 inch long. The coarser grained varieties are greenish grey, medium-grained, granitic looking rocks with smoky to glassy quartz (in places containing a red mineral or stain), white to greenish grey altered feldspar and highly altered dark green ferromagnesium grains up to 3/8 inch long. The latter contain biotite and chlorite. Unit (16) underlies an area of about 6 square miles north of Kashaweogama

Lake and occurs as ioslated outcrops in Fairchild Lake and along the north side of Schist Lake. North of Kashaweogama Lake it is intimately associated with greenstone (1) and clasts of it are prominent in conglomerate (2a) along the north shore of Kashaweogama and Fairchild Lakes. According to Clifford (1964) dioritic rocks (metadiorites) occur as lenses and pods in biotitic schists (corresponding to the writer's unit 2c) southeast of Lake St. Joseph and as a large body intercalated with greenstone (1) on the east shore and islands of the lake, mainly north of Sioux Lookout map-area. The dioritic body has been eroded to form a conglomerate intercalated with biotite schist, which suggests that the conglomerate is equivalent to parts of unit 2a in the Savant Lake area and that the dioritic rocks are equivalent to the coarse-grained (quartz diorite?) phases of the dacite (16) north of Kashaweogama Lake; for this reason the dioritic rocks in the Lake St. Joseph area have been placed tentatively in unit (1b). Johnston (1968) has mapped dioritic rocks at Sioux Lookout that the writer also has placed tentatively in unit 1b.

Dark green, fine-grained, banded amphibolite (1c) occurs as isolated bands in granite north of Sioux Lookout, as thin bands associated with iron-formation within greenstone bodies on the west side of Neverfreeze Lake and at the south end of Wertheim Lake, and as linear extensions of greenstone bodies at and northeast of Neverfreeze Lake and along the east side of the north arm of Savant Lake.

Savant Group and Equivalents (2)

The name Savant Group was used first by Moore (1929) for all rocks older than the granite in the Lake Savant map-area. The Savant Group included "Keewatin: greenstones including pillow lavas, schists, and local bands of iron formation, conglomerate and other sediments"; "Timiskaming (?): complex series of interbedded acid, intermediate, and basic lava flows, agglomerate, tuffs, arkoses, greywackes, banded iron formation, and conglomerate, and gneisses derived from these rocks" as well as "diorite". Rittenhouse (1936) remapped part of the Lake Savant area and divided Moore's Savant Group into four main units. He called Moore's Keewatin greenstones "Jutten volcanics", the sedimentary rocks unconformably overlying the Keewatin greenstones the "Savant Series" and the acid, intermediate, and basic lava flows, agglomerate and tuffs, which overly the Savant Series, the "Handy Lake volcanics", and he called Moore's diorite "Basic Intrusives". The writer proposes to use the name "Savant Group" to include only Moore's Temiskaming (?), which is equivalent to Rittenhouse's "Savant Series" plus his "Handy Lake volcanics". The Savant Group (2a-d) lies mainly along the west side of Savant Lake and the chain of lakes south of it, and south of Neverfreeze, Kashaweogama, Fairchild and Schist Lakes and may extend south and eastward to Richan and Heathcote Lakes.

The Savant Group consists of two mainly sedimentary subdivisions, dominantly clastic, and two volcanic subdivisions, chiefly pyroclastic. Conglomerate (2a) at Savant and Kashaweogama Lakes is a felsic conglomerate commonly containing abundant rounded granitic, rhyolite and quartz porphyry clasts, and lesser amounts of angular quartzite, chert, slate, greenstone and iron-formation fragments in a greywacke-like matrix of the materials of the clasts. The granitic clasts are commonly 1 foot, and rarely up to 4 feet long, mostly quartz diorite in composition and identical to the coarse-grained phases of unit 1b present north of Kashaweogama and Fairchild Lakes. Some of the granitic clasts are pink aplites and are not similar to intrusive granites (6) found in the map-area. The granitic and rhyolitic clasts are commonly well rounded but in places they are tectonically flattened as along Fairchild and Schist Lakes and some along Kashaweogama Lake where there is a major fault. In these places the matrix is generally schistose and highly chloritic. In places the conglomerate is a greenstone conglomerate made up of a high proportion, or entirely, of greenstone clasts in a chloritic matrix as on some of the islands in the north part of Savant Lake.

In the central part of the map-area felsic conglomerate forms the base of the Savant Group, it is up to 500 feet thick and has been traced for about 30 miles, from west of Schist Lake to the east end of Kashaweogama Lake, where it passes laterally into a thick pyroclastic sequence (2b). Felsic conglomerate reappears along the west shore of Savant Lake and in the southern part of Elwood Lake, but contains some agglomeratic sections. A band of felsic conglomerate, about 1,000 feet thick, lies along the east shore of the south arm of Savant Lake where it is overlain by a few hundred feet of agglomerate or agglomeratic conglomerate.

Further north, pyroclastic rocks (2b) form the base of the Savant Group for about 15 miles between the east end of Kashaweogama Lake and Neverfreeze Lake where they are probably up to 10,000 feet or more thick. They consist of rhyolite, dacite and greenstone agglomerate and tuff, minor conglomerate, greenstone and iron-formation. Rhyolite agglomerate is prominent north of Wiggle Creek, where rounded clasts range up to 4 feet long, and on the west arm of Whimbrel Lake, where it contains flattened felsic clasts a few inches long arranged parallel to the schistosity in the rock.

Sedimentary rocks (2c) consist of slate, greywacke, arkose, iron-formation, quartzite, biotite schist and biotite-quartz-feldspar schist, and form the middle unit of the Savant Group. They are tightly folded, faulted, and intruded by granite, and appear to be at least 10,000 feet thick. Iron-formation occurs as magnetite bands, fractions of an inch to a few inches thick, intercalated with greywacke, arkose or slate. It is widely dispersed along the west side of Savant Lake and the south side of Kashaweogama Lake, but apparently rarely concentrated enough to be of economic importance except on the south side of Kashaweogama Lake. Greenstone, and rhyolite and dacite tuffs occur near the base of unit 2c along the north shore of Kashaweogama Lake and greenstone occurs near the top of the unit on the west shore of the south arm of Savant Lake.

Pyroclastic rocks (2d) consist of dacite and rhyolite agglomerate and tuff, greenstone, metasiltstone, phyllite, minor greywacke and iron-formation and form the upper unit of the Savant Group. They lie mainly south of the other units of the group and, although most of their southern (upper) and eastern contacts are against intrusive granite (6), they appear to be at least 30,000 feet thick. Their northern contact with unit 2c is gradational, whereas their eastern contact with unit 2c appears to be along a fault. Their relationship with Keewatin greenstones east of the village of Savant Lake is not clear, but they appear to overly the greenstone unconformably. Dacite agglomerate forms a large part of the unit and such rocks are well exposed along Highway 599 north of the village of Savant Lake. They are grey, aphanitic to fine-grained, massive to foliated, biotitic felsic rocks that commonly have a distinctive knobby weathered surface.

Probable equivalents to the Savant Group occur in the southwest corner of the map-area at Pelican, Abram and Minitaki Lakes south of Sioux Lookout, and possible equivalents occur in the northern part of the map-area at Lake St. Joseph, Doran and Pashkokogan Lakes.

Hurst (1933) mapped the area around Sioux Lookout and called the greywacke, quartzite, conglomerate, iron-formation and micaceous schist overlying Keewatin greenstones "Temiskaming (?)" and Pettijohn (1934), after studying these sedimentary rocks in detail, called them the "Abram Series". Pettijohn called the conglomerate horizon that outcrops mainly west of Sioux Lookout on Pelican Lake the "Patra Series" and placed it in the Keewatin because it contains only volcanic and metasedimentary clasts, whereas the conglomerate in the Abram Series contains granitic as well as volcanic and metasedimentary clasts. Johnston (1967, 1968) mapped the Abram Lake area in detail and in his latest map uses Pettijohn's names "Patra" and "Abram" for his older and younger metasedimentary groups, stating that the Patra lies disconformably on the Keewatin metavolcanics (1) and is in turn overlain unconformably, or is in fault contact with the Abram metasediments. His description and maps strongly suggest that the Patra metasediments are merely a basal section of the Abram conglomerates free of granitic clasts. The writer has placed both conglomerates in the same horizon because they appear to be conformable and grade into one another along and across strike. Pettijohn (1934, 1937) correlated the Abram Series with Rittenhouse's Savant Series based on the similarity of strike, dip, lithology, sequence and structural orientation, although there is a gap between them of about 22 miles, apparently caused by faulting and batholithic intrusion. The writer is in agreement with this correlation.

The northern areas of Archean sedimentary rocks are completely separated from the Savant-Abram sediments by a gap of at least 20 miles underlain by intrusive granite. However, they are similar lithologically, have undergone similar metamorphism, and have the same general trend. Bruce (1923a,b) mapped these rocks in the Lake St. Joseph area while studying the iron-formation contained in them. He grouped all the rocks older than the granite as "Pre Granite Complex" which he divided into two groups, one sedimentary, the other volcanic, the latter being younger than the former, based on structural relations. The sedimentary group includes biotite gneiss, and biotite-garnet gneiss along the south side of Lake St. Joseph grading northward into chloritic schist, slate, quartzite, arkose, greywacke and iron-formation. The igneous group includes interlayered quartz porphyry flows, acid pyroclastics and basic lava flows. Dyer (1934) mapped Archean sedimentary rocks east of Lake St. Joseph. He divided the rocks there into Couchiching metasediments, Keewatin lavas, and Temiskaming conglomerate. His Couchiching is a garnet-quartz-biotite gneiss which he called the Miniss Series because it is prominent around Miniss Lake. It also outcrops around Greenbush Lake and here it dips steeply under the Keewatin lavas and for this reason he regarded it as older than the Keewatin. Dyer's Keewatin formation contains greenstone with minor rhyolite flows, tuffs and agglomerates intercalated with quartz-hornblende-biotite-chlorite gneisses and schists, greywackes, arkoses, quartzites and iron-formation, and it outcrops at the south end of Lake St. Joseph, and around Doran and Pashkokogan Lakes. The only rocks he regarded as Timiskaming were the conglomerates at Doran and Thelma Lakes. Goodwin (1965) mapped the Pashkokogan Lake - East Lake St. Joseph area and divided the pre-granitic rocks lithologically into metasedimentary and metavolcanic rocks and noted that the "metavolcanics rocks generally overlie but also include some metasediments". His metasediments are confined to the area around Doran Lake and northwest of Thelma Lake. The writer classified the bedded rocks of Pashkokogan Lake as interbedded metasiltstone, phyllites and acid to basic tuffs (2d), whereas Goodwin classed them as metavolcanic rocks. Clifford (1964, 1965) mapped in detail the central and western Lake St. Joseph areas. He found that the Keewatin greenstones (unit 1 of this report) are the oldest rocks and they are overlain by silicic tuffs and agglomerates, locally intercalated with basic metavolcanics (units 1a or 2b of this report), which in turn are overlain by arkose, greywacke, phyllite, chert, iron-formation and conglomerate (unit 2c). His biotite-quartz-feldspar schists and gneisses commonly interlayered with pegmatite (unit 3a of this report) lie along the south side of Lake St. Joseph and were considered to be in part older than, and in part equivalent to the volcanic and sedimentary rocks to the north. The writer is in general agreement with Clifford with regard to the age relationship of the rock units, but is not certain whether the silicic volcanic rocks correlate with those of unit 1a, or those of unit 2b; probably both units are present.

Migmatite and Paragneiss

Migmatite (3a) commonly consists of interlayered grey, fine-grained, biotite-(garnet)-quartz-feldspar schist and white, medium-grained, pegmatitic granite or granodiorite sills. In places the schists are highly garnetiferous or are amphibolitic, and the granitic layers are grey or pink and may be porphyritic. The thickness and proportions of each rock type is highly variable. Migmatites are mainly confined to the area northwest of the Manitou-Dinorwic fault zone (Parkinson, 1962), where they are engulfed in granite and granodiorite (6). Small areas of migmatite and paragneiss are scattered throughout unit 6 in the western and northern parts of the map-area, particularly around Carling, Ragged Wood and St. Raphael Lakes, and to the east of the fault zone around De Lesseps and McCrea Lakes. The migmatites are highly garnetiferous at Lac Seul, east of Tully Lake and at Bingo, Anenimus and St. Raphael Lakes. Amphibolitic varieties are present at Otatakan Lake, Merrit and Tuktegweik Bays of Lac Seul, and at Miniss Lake. Hypersthene is present in some of the migmatites at Lac Seul, Churchill, St. Raphael and Miniss Lakes indicating that these rocks have been metamorphosed to the granulite facies.

Paragneiss (3b) is confined to the vicinity of Greenbush Lake and consists of medium-grained biotite-quartz-feldspar schists and gneisses and minor migmatite, the latter identical with migmatite of unit 3a.

Intrusive Rocks (4-6)

Granodioritic and granitic gneisses (4) commonly are grey and/or pink, medium-grained, biotitic (in places hornblendic), light and dark-banded rocks cut by pink pegmatite veins. Amphibolite bands and inclusions are plentiful north of Sioux Lookout. In places, the gneisses appear to be derived from sediments, because of their high biotite content, as on Wertheim Lake, or because of their fine continuous layering, as on Wapikaimaski Lake.

Syenite (5a) is confined to the area east of Sturgeon Lake. It is massive and commonly has coarse-grained, light or pinkish grey feldspar phenocrysts in a dark green matrix. The Vista Lake body is a pink hornblende syenite, the Squaw Lake body a grey mica-bearing type, and the Sturgeon Lake body is commonly a grey augitic variety. Serpentinite (5b) is known only at Armit Lake. Hudec (1965) reports traces of nickel in it, however, asbestos appears to be absent. The relative ages of units 5a and 5b are not known.

Foliated and massive granodiorite and granite (6) are widespread and appear to cut all rocks in the area with the exception of diabase (7). These rocks are commonly grey or pink, medium grained, foliated and biotite-bearing, but may be coarse or fine-grained, porphyritic, gneissic, massive, leucocratic, or hornblendic. The massive varieties are rare, are generally pink, medium-grained and biotitic or light pink, coarse-grained, leucocratic rocks. They commonly cut the foliated varieties. Much of the granite north of Whimbrel Lake is pink, massive and porphyritic. Isolated areas of dioritic varieties are present, particularly near greenstone bodies (1), as south of Schist Lake and north of Port Lake. Inclusions of metasediments are common in the granitic rocks of the northwestern part of the area and areas of paragneiss are common within them in the northeastern part. Some of these inclusions have been metamorphosed to the granulite facies. Massive porphyritic granite (6a) is pink with feldspar phenocrysts up to 2 inches long and is present only in the southeast corner of the map-area. Massive, dark grey, medium-grained feldspar (albite) porphyry (6b) forms a small stock cutting greenstone (1), at Sioux Lookout.

Basic Dykes (7)

Diabase (7) is a dark brown, medium to fine-grained, massive, andesine-pyroxene rock. It is relatively scarce, and occurs as irregular bodies and small dykes cutting granite and greenstone in the southeast quarter of the area. It is probably related to presumably Keweenawan diabase sills and dykes which underlie a large area west of Lake Nipigon, 20 miles southeast of the map-area.

STRUCTURAL GEOLOGY

The structure of the layered rocks in the map-area is difficult to interpret because they are highly deformed by folding and faulting, are engulfed in granitic rocks, and are not well exposed. One of the most useful aids in determining the structure is graded beds in greywackes. Pillows in greenstones are also useful, but these are almost entirely confined to the older lavas.

The Savant Group in the Savant Lake and Minitaki Lake areas occupies the nose of southwestward plunging synclines. In the Savant Lake area much of unit 2c is missing due to faulting along the length of Savant and Kashaneogama Lakes and in the Minitaki Lake area the south limb of the syncline has been highly deformed and partially removed by faulting along Minitaki Lake.

In the Western Lake St. Joseph area Clifford (1965) described a major syncline or group of synclines, isoclinal or subisoclinal with a gentle plunge to the east and in the central Lake St. Joseph area he found the syncline or synclines refolded into a large antiform plunging steeply eastward (Clifford, 1964). In the Pashkokogan Lake - eastern Lake St. Joseph area Goodwin (1965) states that volcanic and sedimentary rocks have been folded about east-trending and plunging axes and that a principal anticline, isoclinally overturned to the north, follows the south shore of Lake St. Joseph and that other parallel folds are indicated.

Two major fault zones cut the area and more or less separate the high metamorphic grade migmatites in the west from the lower grade metavolcanic and metasedimentary rocks of the north and east parts of the map-area. The Lake St. Joseph fault zone trends easterly across the northern part of the map-area south of Lake St. Joseph and the Manitou - Dinorwic zone (Miniss River fault zone of Hudec, 1965) trends northeasterly through Minitaki, Kimmerwin, Hooker, Miniss, and Medcalf Lakes (Parkinson, 1962). Rocks along these zones have been brecciated, sheared and mylonitized over a width of half a mile in the case of the Lake St. Joseph zone (Clifford, 1965) and up to hundreds of feet on each side of each of several faults along the Manitou-Dinorwic zone (Hudec, 1965). Two other prominent faults have been mentioned previously, the one along Schist and Kashaweogama Lakes, the other through Savant Lake. Both these have sheared and schisted the rocks of units 1, 2a, 2b and 2c.

Aeromagnetic maps were used freely as an aid in drawing boundaries between rock units and in plotting major faults. They are also useful for locating and tracing iron-formation.

ECONOMIC GEOLOGY

The Keewatin type greenstones (1) contain one past producer, several gold and a few base metal showings, a lithium and an iron deposit. The Temiskaming-type rocks contain three sedimentary iron deposits and three base metal showings.

The gold showings are commonly sulphide bearing quartz veins in greenstone and occur at Sturgeon (Graham, 1931), Minitaki (Hurst, 1933; Johnston, 1967, 1968), Split (Horwood, 1938), and Savant (Moore, 1929) Lakes. Some of these deposits also contain silver, lead, zinc and/or copper. The St. Anthony gold mine on Sturgeon Lake operated at intervals from 1901 to 1929. The orebody is a northerly trending fissure vein about 1,000 feet long and up to 25 feet wide. The southern part is in greenstone pillow lavas (unit 1), and the northern part is in a granodiorite stock (unit 6). The gangue minerals are quartz, calcite and siderite and the sulphides are pyrite, chalcopyrite, galena and sphalerite (Graham, 1931).

Lithium occurs in spodumene-bearing pegmatite in greenstone (1) on Roadhouse River where Consolidated Canadian Faraday Limited have a deposit containing an estimated 2.3 million tons of ore to a depth of 500 feet averaging 1.3 per cent Li_2O (Meyers, 1967).

Northern Canada Mines Limited has an iron deposit 5 miles north of Kashaweogama Lake that contains an estimated 80 million tons of ore to a depth of 200 feet averaging 28 per cent iron (Meyers, 1967). The property was optioned in 1966 to Hanna Mining Company of Cleveland, Ohio, for 2 years. The iron is present in siliceous, magnetic, bedded iron-formation that occurs in two parallel steeply-dipping bands 50 to 400 feet thick and 500 to 800 feet apart in greenstone (1). Basic and acid tuffs occur at the contact between the iron-formation and greenstone and within the iron-formation bands, and basic dykes cut all of these rocks. Minor pyrite and pyrrhotite is common in the tuffs and is present in places in the iron-formation. The iron-formation bands have been traced for about 7 miles; they change strike from northwesterly to northeasterly towards the north, and appear to close at the north and south indicating an isoclinal fold.

The following three large iron deposits are similar in that they occur in banded iron-formation intercalated with sediments of the Savant Group. The banded iron-formation consists of fine-grained quartz and magnetite with varying amounts of slate, biotite, chlorite, epidote, amphibole, garnet, specular hematite and carbonate. The banding is due to alternating layers, each 1/4 to 10 inches thick, of black magnetite-rich layers, white quartz-rich layers, and grey, green or brown silicate rich layers. The iron-formation is intimately interlayered with slates, phyllites, quartz-biotite schist, greywacke or arkose of unit 2c of the Savant Group and equivalents and produces intense magnetic anomalies. At Doran Lake, Belcher Mining Corporation Limited and Lun-Echo Gold Mines Limited jointly hold 81 mineral claims containing an estimated 375 million tons of ore to a depth of 500 feet averaging 19.2 per cent iron (Goodwin, 1965); at Lake St. Joseph, Lake St. Joseph Iron Company Limited has an iron deposit which contains an estimated 240 million tons to a depth of 400 feet averaging 35 per cent iron (Thomson, 1963); and the south side of Kashaweogama Lake, Pershland Gold Mines Limited hold an iron deposit of considerable size, whose tonnages and grade however have not been reported. At Lake St. Joseph the iron-formation contains minor jaspilite, pyrite and pyrrhotite (Bruce, 1923a; Clifford, 1964).

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