CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 55-33

GEOLOGICAL NOTES ON THE REGION SOUTH OF LAKE ATHABASCA AND BLACK LAKE SASKATCHEWAN AND ALBERTA

(74 F-P, parts of)

(Map and Report)

By

D. A. W. Blake

OTTAWA

1956

Price, 50 cents

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
Paper 55-33

GEOLOGICAL NOTES ON THE REGION SOUTH OF LAKE ATHABASCA AND BLACK LAKE SASKATCHEWAN AND ALBERTA

(Map and Report)

By
D. A. W. Blake

OTTAWA
1955

Price, 50 cents

CONTENTS

Illustration

GEOLOGICAL NOTES ON THE REGION SOUTH OF LAKE ATHABASCA AND BLACK LAKE SASKATCHEWAN AND ALBERTA

INTRODUCTION

North of Lake Athabasca in northern Saskatchewan, many important deposits of uranium have been discovered since 1944. Some of these deposits have already been brought into production. The region south of Lake Athabasca, however, remains little known and unexamined by prospectors. It is generally believed that this large area, underlain as it is by flat-lying Athabasca sandstone, is of no economic interest, in spite of the fact that in 1951 uranium was discovered near Stony Rapids, at the base of the sandstone series. This discovery did, however, arouse the interest of mining companies and geologists in the Athabasca sandstone south of Lake Athabasca and occasioned a demand for geological information. In 1952 the writer made a reconnaissance geological survey of this region to determine the nature and extent of the Athabasca sandstone and the likelihood of the existence of ore deposits. The investigation was confined to the northern part of the region. Earlier, J. C. Sproule, also D. L. Downie and S. C. Ells (8, 9, 10, 11)[1] studied the sandstone in its southern and southwestern parts. The southeast part of the sandstone region, however, remains unstudied and its boundary there undetermined.

[1] Numbers in parentheses are those of references cited below.

Circumstances render it impossible for the writer to make his own microscopic studies of rock sections or to examine hand specimens, so that petrographic descriptions are necessarily brief.

ACKNOWLEDGMENTS

The writer was assisted in the field by Paul Dallaire and Peter MacIntosh, both efficient canoemen. Pilots of Saskatchewan Government Airways and McMurray Air Service rendered courteous and prompt service and transported the writer's party to many areas difficult of access. Dee Exploration Company Limited supplied means of transportation between Stony Rapids and Black Lake and rendered many acts of kindness while the writer was camped at Middle Lake. Special thanks are due friends for their help in preparation of the preliminary draft.

REFERENCES

1. Alcock, F. J.: The Athabaska Series; Am. Jour. Sci., Fourth Series, vol. I, No. 295, pp. 25-32 (July 1920).

2. ______ Geology of Lake Athabaska Region, Saskatchewan; Geol. Surv., Canada, Mem. 196, 1936.

3. Blake, D. A. W.: Oldman River Map-area, Saskatchewan; Geol. Surv., Canada, Mem. 279, 1955.

4. Christie, A. M.: Goldfields-Martin Lake Map-area, Saskatchewan; Geol. Surv., Canada, Mem. 269, 1953.

5. Ells, S. C.: Exploration of Bituminous Sand Areas in Northern Alberta; Dept. Mines, Canada, Mines Branch, Investigations of Mineral Resources and The Mining Industry, 1931, No. 727, pp. 107-134 (1932).

6. Hale, W. E.: Black Bay Map-area, Saskatchewan; Geol. Surv., Canada, Paper 53-15, 1954.

7. McConnell, R. G.: Report on a Portion of the District of Athabasca Comprising the Country between Peace River and Athabasca River; Geol. Surv., Canada, Ann. Rept. 1890-91, vol. V, pt. I D (1893).

8. Sproule, J. C.: Cree Lake Area, Saskatchewan; Geol. Surv., Canada, Paper 38-9, 1938.

9. ______ Weitzel Lake, Northern Saskatchewan; Geol. Surv., Canada, Map 576A, 1940.

10. Sproule, J. C., and Downie, D. L.: Brustad River, Northern Saskatchewan; Geol. Surv., Canada, Map 577A, 1940.

11. Sproule, J. C., Ells, S. C., and Downie, D. L.: Upper Clearwater River, Northern Saskatchewan; Geol. Surv., Canada, Map 578A, 1940.

12. Tyrrell, J. B., and Dowling, D. B.: Report on the Country between Athabasca Lake and Churchill River; Geol. Surv., Canada, Ann. Rept. 1895, vol. VIII, pt. D (1896).

PHYSICAL ASPECTS

The region between Cree Lake and Lake Athabasca is a vast monotonous plain, or, according to some men, a plateau that slopes generally northward from an elevation of approximately 1,600 feet to an elevation of 699 feet, the level of Lake Athabasca. The flat-lying sandstone underlying this region is almost entirely covered with a thick layer of glacial deposits. This glacial debris consists mainly of well-stratified and sorted sand that, in part, must have been laid down in lakes imponded by the retreating ice-sheet. These sand deposits are rapidly being dissected by streams. At several places along the south shore of Lake Athabasca the glacial sands have been blown into active sand dunes. The largest of these areas occurs at the mouths of William and McFarlane Rivers. They resemble giant snow-drifts with slightly convex, eastwardly advancing fronts. They present a beautiful but desolate picture of endless sand hills broken only by tufts of grass and groves of pine trees. Morainal deposits composed of unsorted sand and boulders are present throughout the entire region in the form of irregular hummocks and ridges that, where present, give the land a moderate relief. Eskers are nearly everywhere abundant and occur as narrow ridges that commonly exceed 10 miles in length. South and east of Black Lake there are swarms of drumlins with east-west axes and remarkably symmetrical outlines. Topographic trends, eskers, and glacial stria show that the last direction of movement of the most recent ice-sheet was from northeast to southwest everywhere in the region except southeast of Black Lake. Closely spaced parallel ridges, clearly visible on air photographs of the area where the Alberta-Saskatchewan boundary crosses the south shore of Lake Athabasca, are thought by the writer to be annual or washboard moraines, similar to those found in the Chibougamau region of Quebec.

Nearly all rivers in the area flow northward at an extremely fast rate, and where they cross glacial moraines a rapid is invariably present. In the descent of William River the writer found seventy-five rapids, most of which were formed by these glacial moraines. Thus, canoe travel in the region is difficult, and in most places only possible downstream. Travel along the south shore of Lake Athabasca is made hazardous for small craft by the shallow nature of the offshore waters and the lack of shelter.

GENERAL GEOLOGY

GNEISSES AND RELATED ROCKS EAST OF ATHABASCA RIVER

The large area of Athabasca sandstone south of Athabasca and Black Lakes is shown on the geological map of Canada (820A) to extend westward to the Palaeozoic rocks in Alberta. However, the discovery of granitic gneisses and related rocks in the vicinity of Cree Lake, Alberta, and Richardson River, requires a major revision of the western boundary of the area of Athabasca sandstone. The writer shows the revised boundary as extending from Patterson Lake in Saskatchewan northwestward to the delta of Athabasca River, thus reducing the area mapped as Athabasca sandstone by nearly 2,000 square miles.

In 1951, S. M. Roscoe observed from the air an area of abundant outcrop between Waterways, Alberta, and Goldfields on Lake Athabasca and brought this to the writer's attention. An examination of air photographs along the air route taken by Roscoe revealed that an area several square miles in extent immediately north of Cree Lake in Alberta is partly free from overburden, exposing rounded hills of rock.

A cursory examination of the rocks in the eastern part of this outcrop area disclosed that two closely associated rock types are present. One is medium- to coarse-grained garnetiferous gneiss. The red garnet crystals vary greatly in size and abundance and give the rock a spotted appearance. The rock is homogeneous over large areas and locally contains large porphyroblasts of feldspar. In a few places small lens-shaped bodies, varying from a few inches to a few feet in length, of medium-grained, dark weathering, mafic rock occur in the gneiss. The second rock type, which is intimately associated with the garnetiferous gneiss but probably of later origin, occurs as migmatitic layers and as large and small conformable sheets. It is a medium- to coarse-grained, quartz-rich, granitic rock, but it is rarely pegmatitic and locally is slightly garnetiferous. The relative proportion of the two rock types varies, but it appears that the homogeneous garnetiferous gneiss predominates in the southern part of the outcrop area, whereas the quartz-rich granitic rock predominates in the northern part. The rock assemblage is strikingly similar to that studied by the writer in Oldman River map-area (3) north of Lake Athabasca. There, garnetiferous gneisses are high-grade metamorphic equivalents of greywacke type sedimentary rocks, and associated quartz-rich granitic rocks are thought to have been emplaced both metasomatically and by intrusion. Lenticular mafic bodies that occur in the gneisses in Oldman River map-area are similar to those north of Cree Lake and are thought to be the products of metamorphic differentiation.

A study of thin sections of the two main rock types, the homogeneous garnetiferous gneiss and the quartz-rich granitic rock, reveals similar characteristics. The chief component minerals quartz and feldspar are intimately intergrown, with the quartz exhibiting undulatory extinction and sutured margins. Microcline is intergrown with plagioclase to form various perthitic structures. The plagioclase, of undetermined composition, is largely sericitized. The garnetiferous gneiss contains large amounts of biotite, chlorite, garnet, and magnetite, whereas the granitic rock is poor in mafic minerals and rich in quartz and microcline. Both rocks exhibit a crystaloblastic texture and are composed of mineral assemblages that have adjusted to conditions of high temperature and pressure.

Rocks similar to those described above were discovered in 1924 by S. C. Ells (5, p. 115) in the vicinity of the junction of the north and south branches of Marguerite River. J. C. Sproule revisited the area in 1931 and reported the outcrops to lie within 1/2 mile of well-bedded dolomites of Palaeozoic age. He describes them as flesh-coloured to dark grey graphic granites and granite-gneisses that are intruded by dykes of pegmatite and aplite. He also mentions that outcrops of Precambrian rocks occur along the north branch of Marguerite River and intermittently for a distance of 75 miles from the Alberta-Saskatchewan boundary northwestward along Richardson River.

TROUT LAKE LIMESTONE

High ridges of rock were observed from the air extending westward from Trout Lake, 40 miles south of William Point. An examination of the ridges from the ground disclosed that they were not formed of the expected flat-lying Athabasca sandstone, but of an exceedingly fine-grained limestone that is so highly folded that the formation is repeated several times over the exposed width. Its relationship with the neighbouring Athabasca sandstone remains in doubt but will be discussed later. However, it is a rock unknown in the regions north and immediately south of Lake Athabasca.

Description

The limestone is exposed in six ridges that extend westward from Trout Lake. A traverse across these ridges revealed that the rock is similar throughout, although local variations are common. Its colour may be cream, buff, pink, or reddish, and beds vary from very fine to very coarse. The limestone is everywhere fine grained or aphanitic but secondary calcite crystals up to 1/8 inch across may be found. In addition to having been severely folded into major anticlines and synclines, where strata dip up to 80 degrees, the rock has locally been deformed on a small scale. Zones of intense brecciation, intricate contortion, and rupture occur in many places, although most of this deformation may be attributed to the compressional forces that produced the major folds. It is probable that some of the deformation may also be due to forces at work during the lithification of limestone. Small concentric fragments seen in some places were thought possibly to be of organic origin, but Dr. W. A. Bell (personal communication) determined them to be concretions.

Most thin sections of the limestone show very delicately laminated beds that are, in general, moderately brecciated. The carbonate mineral is calcite, of which a minor part is crystallized. Rounded grains of quartz less than a millimetre in diameter were noted in two of the six thin sections. Hematite occurs in one thin section as fine grains and as stain. No structures were noted other than styolites and microveining.

Discussion

The Athabasca sandstone all around the folded Trout Lake limestone is everywhere essentially flat lying. This suggests that the limestone was deposited and subsequently deformed at a time prior to the deposition of the Athabasca series. The limestone is definitely not a Tazin-type rock and is practically unmetamorphosed, so that a post-Tazin, pre-Athabasca age seems likely. It must be remembered, however, that there are exceedingly few outcrops in this region and the nearest known exposure of Athabasca sandstone is 16 miles away. It is possible that the Trout Lake limestone is a part of the Athabasca series and that the series was locally deformed at Trout Lake. Sandy beds in the limestone, although rare, support this hypothesis.

ATHABASCA SERIES

Introduction

In the course of exploring geologically a large area of northwestern Canada, R. G. McConnell (7), in 1891, traversed part of the south shore of Lake Athabasca and discovered there two exposures of a flat-lying clastic formation he named the "Athabasca sandstone". In 1892 and 1893, J. B. Tyrrell and D. B. Dowling (12) investigated geologically the region between Lake Athabasca and Churchill River and discovered that the sandstone found by McConnell is exposed in widely scattered outcrops along the entire south shore of Lake Athabasca, at Black Lake, and along Fond-du-Lac River. Their investigation of the shores of Cree Lake and Cree River revealed a few additional outcrops of sandstone.

F. J. Alcock (1, 2) in 1914, 1916, and 1935, made a thorough study of several areas underlain by the Athabasca series north of Lake Athabasca. J. C. Sproule, S. C. Ells, and D. L. Downie (8, 9, 10, 11), between the years 1935 and 1938, mapped the Cree, Weitzel Lake, Brustad River, and Upper Clearwater River map-areas. The Athabasca sandstone was found to underlie the northern third of these areas. The sandstone there is flat-lying quartzite similar in most respects to that seen by McConnell and Tyrrell and Dowling.

A. M. Christie (4), who did considerable detailed and general geological mapping in the Beaverlodge Lake area, correlates the Athabasca arkose and conglomerates with feldspathic sandstones and conglomerates found on the islands south of Crackingstone Peninsula. And these, in turn, he correlates with the sandstone series south of the lake.

In 1952 W. E. Hale (6) discovered, in the Black Bay area, an angular unconformity in what are believed to be metamorphosed equivalents of the Athabasca series.

Briefly, then, the Athabasca series, of supposed late Precambrian age, underlies a large region south of Lake Athabasca and Black Lake and small areas north of Lake Athabasca. In the southern region the sandstone is thought to extend as a flat-lying sheet not over 500 feet thick eastward to Wollaston Lake, southward to Cree Lake, and southwestward to beyond Old Fort River. Lake Athabasca itself is thought to be mainly underlain by sandstone. North of Lake Athabasca the major area of Athabasca rocks surrounds, and extends north of, Beaverlodge Lake. There it is severely folded and faulted and associated with spilitic lava flows. The series outcrops in many places between Beaverlodge Lake and the Alberta-Saskatchewan boundary and on the islands south of Crackingstone Peninsula. In most of these localities it is similar to that exposed at Beaverlodge Lake, but in others it is highly deformed and metamorphosed so that the original characteristics are nearly obliterated.

Description

The Athabasca series exposed south of Lake Athabasca is composed almost entirely of sandstone, of which a massive, siliceous variety is most common. This typical sandstone is composed of rounded to subangular grains of quartz. Under the microscope it may be seen that the quartz grains have locally developed secondary facets and that sutured boundaries are common. Throughout most of the region the sandstone is fine to medium grained, although grit and pebble bands are not uncommon and where present serve to mark bedding planes that are otherwise difficult to observe. The weathered surface of the rock is mainly a remarkable white, but is locally buff coloured. The rock looks hard but when broken it is surprisingly friable and its fresh surface is buff coloured. Where bedding planes are evident they are widely spaced so that the rock breaks into large slabs. Torrential crossbedding was observed in many places throughout the area. Features of shallow water deposition, such as ripple-marks and rain-drop prints, appear to be absent in this quartz-rich sandstone.

In the northern part of the area, between Turner Point and Black Lake, lower beds of the Athabasca series are exposed, and these differ somewhat from the typical rock described above. West of Archibald River on the lake shore the sandstone is well bedded, fine grained, and cream coloured. In thin section, subangular to rounded grains of quartz are seen to be set in a matrix of chalcedony. This feature has not been noted in any other part of the region. The sandstone at Poplar Point contains a large amount of iron oxide that gives the rock a decided reddish buff cast. There, also, ripple-marks are common. The sandstone exposed on Long Island, 42 miles west of, and structurally in line with, Poplar Point, exhibits the same characteristics and is thought to be at the same horizon. A short distance east of Poplar Point three 10-inch layers of red shale are exposed at the base of a 25-foot sandstone scarp.

The sandstone is massive and coarse grained, varying in colour from buff to purple. Between Stony Rapids and Black Lake the base of the series is considerably different from the typical quartzose sandstone. There its contact with underlying rocks is exposed in several places and secondary uranium minerals are present in the sandstone. These features will be discussed later.

The boundary of the Athabasca sandstone in the underlying rocks, an angular unconformity of great hiatus, was observed at two places only; 12 miles east of Poplar Point and between Stony and Middle Lakes. East of Poplar Point, flat-lying sandstone rests on steeply dipping, ferruginous quartzite of the Tazin series. At the base of the sandstone is a few inches of conglomerate, composed chiefly of rounded fragments of quartzite. A thorough test with a Geiger counter revealed no radioactivity in the area of exposed rock. Between Stony and Middle Lakes the unconformity is exposed intermittently for a distance of about 5 miles. There, too, a thin layer of conglomerate composed of rounded quartzite fragments appears at the base of the sandstone. The sandstone in this area is very highly hematitized and crossbedded, and contains many grit and pebble bands. The Tazin-type rocks, for a distance of 2 or 3 feet below the unconformity, have been so highly weathered in Precambrian time that their original character cannot be ascertained. An ancient regolith is here preserved. Radioactive anomalies have been discovered at a number of localities above, below, and in the regolith. These interesting deposits of radioactive minerals will be described later.

The main area of Athabasca sandstone, south of the lake, was hitherto thought to be everywhere flat lying. However, the writer discovered four widely separated areas in which strata had been folded. Between Turner Point and Archibald River the strata have been buckled into open folds of a total width of several hundred feet. This narrow belt of folds strikes northeastward. South of Riou Lake the sandstone has been gently arched along an east-west axis with limbs dipping not more than 10 degrees. The sandstone exposed on the southeast part of Fir Island has been severely folded. There, several open and closed anticlines and synclines are exposed and at one locality the sandstone is vertical. The deformation there was strong enough to convert the sandstone into a true quartzite. The folds strike in an east-west direction and have no noticeable plunge. Sandstone exposed in two places along Fond-du-lac River east of Black Lake was observed to dip at a moderate angle in a westerly direction to form a monocline.

In no other part of the sandstone area have dips of more than a few degrees been observed, and these shallow dips are probably the result of deposition on an inclined floor. J. C. Sproule and his associates report no folding in the Cree Lake (Saskatchewan) area.

No faults have been noted in the main area of the Athabasca series, but, because of the scarcity of outcrops, their presence is not precluded. Furthermore, diamond drilling on the Nisto property on the northwest shore of Black Lake revealed that the Athabasca sandstone has been down-faulted against Tazin-type rocks. An examination of the drill core showed that the sandstone has been brecciated, pulverized to a gouge, and considerably altered by hydrothermal solutions at the fault contact.

Discussion

The nature of clastic sedimentary rocks is chiefly determined by the topographical environment in which they were deposited. In a region of considerable relief, where sediments are rapidly transported, grains are only slightly rounded and feldspar not entirely destroyed. In semi-arid condition, where sediments are exposed to the atmosphere, iron is oxidized, giving the sediments a red colour, and the resulting rocks are often called red beds. They were deposited in tectonic basins that subsided during deposition, thus permitting, in some cases, sediments to accumulate to a great thickness. The arkoses, sedimentary breccias, and conglomerates north of Lake Athabasca are of this type, and have been correlated with the Athabasca sandstone found south of Lake Athabasca. However, the rocks north and south of the lake differ lithologically in many respects and have apparently formed under different conditions. Rocks south of the lake are composed almost entirely of well-rounded quartz grains. With few exceptions, conglomerate beds and feldspar grains are virtually absent and the red colour so prevalent north of the lake is lacking. These facts indicate that the sediments have been transported a great distance and deposited on a broad, nearly level surface, and suggest that the correlation is unwarranted. On the other hand, both Christie (4, p. 55) and the writer believe that there is a transition from the arkosic type rocks north of Lake Athabasca southward to the feldspar-free sandstone south of the lake. It has been noted above that the base of the series in the vicinity of Poplar Point and on Long Island is feldspathic and that this rock closely resembles that found on the islands south of Crackingstone Peninsula. Also, in further support of the correlation, it must be pointed out that both north and south of the lake the clastic sedimentary rocks have been deformed and intruded by diabase dykes. It is the writer's opinion that the clastic sediments north and south of Lake Athabasca were formed in the same general geological age but not necessarily simultaneously.

McConnell (7, p. 51D) placed the Athabasca sandstone in the Palaeozoic era, suggesting the Cambrian period. The lack of metamorphism, poor consolidation, and near absence of deformation support this hypothesis but nowhere in the vast area of Athabasca sandstone have fossils been found. This strongly suggests that the Athabasca series is not an early Palaeozoic marine deposit, although it could conceivably be a non-marine deposit of early Palaeozoic age. Tyrrell, Alcock, Sproule, Christie, and the writer believe that the Athabasca series is of Precambrian age for the following reasons:

the series has been deformed by folding and faulting, in some places to a great extent, whereas the neighbouring Palaeozoic rocks to the west are everywhere undeformed; diabase dykes are intrusive into the Athabasca series but have nowhere been found in the Palaeozoic rocks; age determinations made from pitchblende taken from the Athabasca sandstone in the Beaverlodge Lake area indicate that the pitchblende is definitely of Precambrain age and, therefore, the Athabasca series is somewhat older. It seems likely that the large area of sandstone in the Athabasca region may in a general way be correlated with similar areas of clastic sedimentary rocks found in several parts of the Canadian Shield and, with them, may be assigned to late Precambrian or Proterozoic time.

DIABASE DYKES

One basic dyke was found cutting the Athabasca sandstone on the south shore of Lake Athabasca, approximately 4 miles east of Turner Point. The dyke is 5 feet wide, black weathering, medium to fine grained, and with chilled borders. It strikes slightly west of north and, so far as could be determined, has a vertical dip. A thin section taken from the centre of the dyke reveals that the rock is relatively unaltered and its chief constituent minerals, plagioclase (An_{48}) and augite, are arranged to give a marked ophitic texture. Plagioclase and augite are present in approximately equal amounts, whereas magnetite, chlorite, talc, and apatite are accessary constituents.

North of Lake Athabasca, similar late basic dykes occur in the Goldfields region. Although the composition of these dykes varies from gabbro to syenodiorite they are believed by Christie (4, p. 60) to be related to one another and to the spilitic lava flows at Martin Lake. The dyke found by the writer closely resembles some of those described by Christie in composition and appearance, and is, therefore, correlated with them.

The only other known basic dykes that cut the Athabasca sandstone were found in the vicinity of Cree Lake, Saskatchewan. There, on a peninsula, J. B. Tyrrell (12, p. 42D) discovered a 200-foot wide dyke that strikes southwesterly. He describes it as being coarse-grained, light green, uralitic diabase that has altered the sandstone on both sides to hard pinkish quartzite.

J. C. Sproule (8, p. 11) mentions, in his description of the Athabasca sandstone in the region of Cree Lake, that diabase dykes cut the sandstone in several localities.

Beyond the western limits of the Athabasca sandstone in the area of gneissic rocks described above, the writer discovered two diabase dykes, each under 10 feet in width and striking north-westerly. A thin section of one of the dykes reveals the typical ophitic texture in which laths of andesine and uralitized pyroxene occur in approximately equal amounts.

ECONOMIC GEOLOGY

Except in areas north of the lake, the Athabasca sandstone is an unfavourable rock in which to seek vein deposits. It is nearly everywhere flat lying, poorly consolidated, and only mildly fractured. In the few places where the strata have been deformed there are no indications that mineralizing solutions have been active, other than a few quartz or carbonate veinlets. Radioactive occurrences, however, were discovered in 1951 in the vicinity of Middle Lake, and these are described below. No radioactivity has been discovered in the sandstone in any other area.

MIDDLE LAKE PROPERTY

The Middle Lake property consists of twenty-nine claims controlled by Dee Explorations Limited, 502 Standard Building, Saskatoon, Sask. Radioactivity was discovered in 1951 at the base of the sandstone series just north of Middle Lake. In 1952 the property was mapped by the company geologists and a total of 1,250 feet of diamond drilling was done. It was discovered that radioactivity is located at intervals along most of the sandstone scarps that extend northwestward from Middle Lake. The radioactivity is found in beds of sandstone and conglomerate anywhere from the unconformity to the top of the scarp. It is, however, generally concentrated in the basal layers and underlying regolith. In many places the radioactivity extends into the underlying Tazin-type rocks but not below the zone of weathering. Most of the radioactivity is due to autunite, a secondary mineral thought to be derived from uraninite and/or pitchblende from which some uranium has been leached, carried by ground waters, and concentrated in the clay material of the regolith. Thus the unconformity between the Athabasca series and underlying rocks seems to control the deposit.

S. C. Robinson[1] discovered in a sample taken from the

[1]Personal communication.

Middle Lake area a mineral that resembles autunite in ultra-violet light but whose x-ray powder pattern coincided with that of hydrated calcium-uranium-phosphate, called phosphuranylite. Prospecting northeast of Middle Lake revealed several minor deposits in sheared granitic gneisses in which the radioactive mineral appears to be pitchblende.

Nine "E" diamond drill-holes, totalling 521 feet, were drilled in the sandstone north of Middle Lake, of which only one hole gave results of possible ore grade by present standards. Assays of samples made for J. B. Mawdsley, taken from the top, middle, and bottom of the sandstone scarp, gave values of 0.0166, 0.055, and 0.022 per cent U_3O_8. Six of seven other samples taken from the property in 1953 assayed 0.05 and the other 0.10 per cent U_3O_8.

The grade of the showings is unfavourable but the possibility of finding worth-while deposits in the Athabasca series should not be ignored.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1956.