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DEPARTMENT OF ENERGY,
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SURFICIAL GEOLOGY OF KINGSTON (NORTH HALF) MAP-AREA, ONTARIO

E.P. Henderson

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SURFICIAL GEOLOGY OF KINGSTON (31C N½) MAP-AREA, ONTARIO

(Report and Map 7-1972, Map 8-1972)

E.P. Henderson

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

A method of reconnaissance mapping of landforms and surficial materials on Shield terrain was devised and tested using multiple-mapping units. Such units were found to be best suited to depict the intricate patterns of distribution of surficial material over complex Shield topography. The last ice sheet moved generally toward 197 degrees over the western half of the area and southwesterly over the eastern half. Some diversion of ice flow towards the south was caused by calving at the edge of the retreating ice sheet into proglacial Lake Iroquois along the southern edge of the map-area and into an encroaching Champlain Sea on the east.

Well-developed De Geer moraines cover one area where cravassed ice calved into Lake Iroquois. The lake evidently had little or no land shoreline within the map-area but still lapped the ice sheet when disintegration of the ice dam to the east dropped Ontario basin waters to lower levels. Contemporarily with failure of the eastern ice dam, the Champlain Sea attained its greatest western expansion about 12,000 years B. P. and left low beach ridges marking the marine limit. At no time, however, did marine waters encroach upon the Ontario drainage basin or mingle with proglacial lakes west of the ice dam. Postglacial tilting of 5 1/2 feet per mile in a direction of north 20 degrees east is indicated by regional marine limits.

Exposures of coarse-grained granite bedrock suggest remnants of a deep regolith developed during a previous interglacial, or even earlier, unremoved by subsequent glaciation.

RÉSUMÉ

Une méthode de cartographie de reconnaissance de la topographie et des dépôts meubles du Bouclier a été imaginée et expérimentée en utilisant des unités multiples d'identification. De telles unités ont été jugées les mieux adaptées pour représenter les réseaux de distribution compliqués des dépôts meubles au-dessus de la topographie complexe du Bouclier. La dernière calotte glaciaire s'est généralement déplacée à 197 degrés sur la moitié ouest de la région et en direction sud-ouest sur la moitié est. Une certaine dérivation de l'écoulement glaciaire vers le sud à été causée par le vêlage de la calotte glaciaire en recul dans le lac pro-glaciaire Iroquois le long de l'extrémité sud de la région couverte par la carte et dans la mer Champlain qui empiétait à l'est.

Des moraines de De Geer bien développées couvrent une zone où eut lieu le vêlage dans le lac Iroquois. Le lac n'avait évidemment que peu ou pas de ligne de rivage à l'intérieur de la région couverte par la carte mais recouvrait encore en partie la calotte glaciaire lorsque la désintégration du barrage glaciaire à l'est a abaissé le niveau du bassin hydrographique de l'Ontario. En même temps que la défaillance du barrage glaciaire de l'est, la mer Champlain a atteint sa plus grande extension vers l'ouest il y a environ 12,000 ans B. P. et a laissé des crêtes de plage qui indiquent la limite atteinte pas la mer. A aucun moment, toutefois, les eaux de la mer n'ont recouvert le bassin de drainage de l'Ontario ou ne se sont mêlées aux lacs pro-glaciaires à l'ouest du barrage glaciaire. L'inclinaison post-glaciaire de 5 1/2 pieds par mille en une direction de 20 degrés nord-est est soulignée par les limites atteintes par la mer dans la région.

Des affleurements de la roche en place, un granite à grains grossiers, présentent des restes d'une couche profonde de débris qui s'est développée pendant une période interglaciaire précédente, ou même avant, et qui n'a pas été enlevée par la glaciation qui a suivi.

SURFICIAL GEOLOGY OF KINGSTON (NORTH HALF) MAP-AREA, ONTARIO

INTRODUCTION

The purpose of the field survey was to devise and test a reconnaissance method of mapping landforms and various surficial materials on Shield terrain, and to interpret the glacial and postglacial history of the map-area. Because of the complexity of the topography and the intricate pattern of distribution of the surficial materials, multiple-mapping units are required to portray the features at a reconnaissance scale. A preliminary map of the surficial geology of the entire area has not been published and, hence, most of the mapped data in this report are appearing for the first time. The extreme southeastern part of the area, however, appeared as a preliminary map on a scale of 1 inch to 1 mile (Henderson, 1967b).

Of the approximately 3,400 square miles of the map-area, 94 per cent is underlain by mixed Precambrian granite, granite gneiss, crystalline limestone and other highly metamorphosed rocks, and 6 per cent by Paleozoic rocks, principally limestone, dolomite and sandstone. Rock outcrops are almost everwhere and, in Precambrian terrain, bare rock may comprise up to 70 per cent of the surface area. The Precambrian terrain is typical Shield country with rugged, rolling hills, numerous lakes and disrupted drainage systems. Local relief is about 100 feet in most places, 100 to 250 feet in more rugged areas, and attains a maximum of 350 feet at the fire tower five miles northeast of Limerick Lake. Maximum relief in the map-area as a whole is 1,250 feet from a low of 275 feet south of Black Rapids on the Gananoque River to 1,525 at the fire tower. The bulk of the Paleozoic rocks (about 170 square miles) underlie a large, continuous tract along the eastern side of the map-area, and comprise the western end of the Central St. Lawrence Lowland. The remainder of the Paleozoic rocks (about 40 square miles) underlie small areas, up to 4 or 5 miles in extent, that form inliers and northward extending tongues of the extensive Paleozoic cover that lies between the Shield and Lake Ontario. Relief on the Paleozoic rocks is more subdued than in Precambrian terrain and, for more than three quarters of their extent, they comprise the Smith's Falls limestone plain as defined by Chapman and Putman (1951).

The northern part of the western half of the map-area and the northeastern part of the map-area drain generally northeastward to the Ottawa River; the remainder drains to the south into Lake Ontario and the St. Lawrence River.

Striae, fluting and other associated ice-flow features record a general movement of the last ice sheet only about a degree south of southwest over most of the eastern half of the map-area, although it was somewhat more southerly in the southeastern quarter. In the western half of the map-area the general flow was toward 197 degrees. During deglaciation, topographic control of ice flow became increasingly effective, and a late ice lobe moved more westerly across the area between Upper Rideau and Newboro Lakes, parallel to the long axes of their deep basins. Morainal elements partially outline the western limits of this lobe. Along the eastern edge of the region the ice calved into the Champlain Sea, encroaching from the east; this shifted

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the last flow of ice in the map-area toward the south, and a few miles east of the map-area striae record movements east of south. A readvance at this time, probably concurrent with forward movement of the Upper Rideau-Newboro Lakes lobe, may be correlated with the last ice movements as recorded by Terasmae (1960) and McClintock and Stewart (1965) to the east and southeast. Similar calving of the ice into glacial Lake Iroquois in the Ontario basin, south of the western part of the map-area, realigned the ice margin from north of west to more nearly east-west. This probably accounts for the more southerly-striking younger striae found in crossed striae sets south of Sharbot Lake and east of Parham. These youngest striae, then, represent ice movement parallel to the flow that deposited the Dummer moraine at the southern boundary of the map-area (Chapman and Putnam, 1951).

SURFICIAL GEOLOGY

Glacial Sediments

Glacial deposits are the most widespread unconsolidated materials in the area and characteristically are thin and discontinuous. Locally, however, the till is more than 10 feet thick, particularly on the flanks of hills and in morainic areas. Stony knobs and ridges of the Dummer Moraine, which lies largely to the south of the western half of the mapped area, are present as patches and north-reaching tongues of moraine of up to 6 square miles in area; these occur as far as 12 miles north of the southern border of the map-area. In areas of well-developed morainic topography, local relief may exceed 40 feet with till accumulations that must exceed 50 feet in thickness, and the moraine appears confined to areas underlain by flat-lying Paleozoic rocks. The large area of moraine east of Clareview seems to represent the eastern extremity of this major moraine system. North of Clareview and the Clare River numerous De Geer moraines have formed over an area of 4 or 5 square miles, evidently as the result of crevassed ice calving into Lake Iroquois. The ridges are up to 400 feet long and generally are 4 to 6 feet high, although the largest attain a height of 10 feet. The ridges are spaced at 400- to 600-foot intervals. They commonly form straight ridges with only faint, wavy irregularities and are confined, as is the Dummer Moraine, to areas underlain by limestone. Drumlins are uncommon and, except for a group of drumlinoid ridges in the northeast quarter of the map-area and some drumlins near Otter Lake and just east of Forfar Station, they occur as a few, atypical, isolated ridges in areas where till is scant, generally forming the most prominent local feature overlooking surrounding rocky Shield ridges. The largest, called The Ridge, 150 feet high and 2 miles long, lies 5 miles south of Coe Hill.

Glaciofluvial Sediments

Glaciofluvial sediments are widely distributed and are generally present as small isolated kames or esker segments but, in a few places, more extensive deposits are found as large eskers and as tabular deposits of sand and gravel associated with major spillway systems. The largest glacial spillway system begins at the south end of Mazinaw and Marble Lakes (although esker components also occur north of Mazinaw Lake) and may be traced as a series of large gravel flats south and west through North Brook to Flinton; from here major esker segments extend on through Actinolite to join the Tweed esker. The Tweed esker is a branch of a major esker system mentioned by Chapman and Putnam (1951) as the longest esker they mapped in southern Ontario; it extends from the south-central boundary of the present map-area southwestward for some 50 miles. With the present mapping, this system has been extended northeastward to the north boundary of this map-area to give it a total length of about 95 miles. That part of the esker system extending through Snow Road Station is the most prominent esker within the map-area. The length of the Tweed branch of the esker-outwash system is itself 50 to 60 miles. The esker part of the system extending from Flinton southward to Actinolite and the Tweed esker, of course, formed beneath the ice and is older than the outwash deposited subaerially between Mazinaw Lake and Flinton. Other large tabular areas of sand and gravel were deposited by meltwater escaping in the northwest corner of the map-area in the vicinity of Paudash Lake, and from northwest of Coe Hill southward into the Crowe River drainage east of Chandos Lake. The more northern gravel and sand flats deposited in the last system are separated by winding bedrock valleys that mark the escape route where meltwater crossed the rugged Shield landscape without depositing any sediment.

The largest single kames are in the eastern end of the map-area. A high ridge, one mile northwest of Forfar, is built almost entirely of gravel. The high hill at the north end of Grippen Lake is also a kame. A large kettled, deltaic, ice-content deposit, north of Plevna near the middle of the northern boundary of the map-area, was deposited in a glacial lake held up by a sill at the south end of Marble Lake. The glacial lake has since drained due to isostatic uplift as the glacier retreated, leaving the delta stranded.

Glaciolacustrine Sediments

With retreat of the ice to the north and east, much of the map-area was covered by glacial lake waters impounded in the Ontario basin by the receding Ontario lobe of the ice sheet. Sands and clays were deposited in depressional areas of the lake floor and areal distribution of the lacustrine deposits suggests they were largely laid down by cold, dense bottom currents, closely controlled by relief on the lake floor. Although Lake Iroquois was the highest of the series of glacial lakes in the Ontario basin and most glaciolacustrine sediments in the eastern half of the map-area may be attributed to it, subaerial outwash between Mazinaw Lake and Flinton northwest of Kaladar is at elevations below projected elevations for the Lake Iroquois water-plane and indicates that lake levels in the Ontario basin had fallen below that level when the damming ice stood somewhere to the south of the outwash. Perhaps the ice front was along the Dummer Moraine or only a short distance north of it. As deltaic deposits near Flinton, at the downstream edge of the subaerial outwash, are 60 to 100 feet below the Lake Iroquois water-plane, meltwater must have entered a lower level lake there which had been formed soon after the Lake Iroquois stage. This water body was probably Lake Frontenac, considered by Mirynech (1962) as the shortest-lived post-Iroquois stage in the Ontario basin. Similar evidence of subaerial erosion and the absence of lacustrine deposits north of Crowe Lake, at elevations below the projected maximum as recorded for Lake Iroquois farther south, again suggest the fall of Ontario basin water levels when the ice stood along or north of the Dummer Moraine. Small areas of lacustrine deposits that do occur north of Crowe Lake are 100 to 150 feet below the projected level of Lake Iroquois and are believed to relate to Lake Frontenac, or perhaps an even lower lake phase.

Lacustrine beach deposits mapped on either side of the Bedford Mills road one mile south of Westport formed at the southwest end of a long, narrow glacial lake that filled the basin of Upper Rideau Lake to about 150 feet above the modern lake level. Elsewhere in the map-area similar features are absent as either the land surface was too high to be covered by proglacial lake waters or the lake impinged on rocky ridges or the ice margin.

Marine Phase

After disintegration of the ice-dam in the upper St. Lawrence River area, and the draining of the last proglacial lake in the Ontario basin, the area north and a few miles south and west of Smith's Falls was inundated for a short time during an early stage of the Champlain Sea. The sea reached just beyond Perth at its maximum western extent in this region, and strandlines are today present at altitudes of 425 to 510 feet above sea level at the southernmost and northernmost points of the area covered by marine water. Short beaches and bars are common and deposits of marine sand and gravel may exceed 10 feet in thickness. Areas of brown, sticky clays of a type not hitherto encountered were deposited in the vicinity of Smith's Falls and are considered to be of salt or brackish-water origin although, to date, marine fossils have not been found in them. Surface clay and sand below the marine limit are probably mostly of marine origin but are commonly underlain by lacustrine material deposited in proglacial-lake waters that preceded the marine phase. Shells in deposits close to the marine limit are rare or absent and most of the map-area invaded by the sea was under rather shallow water. A few shell fragments and two nearly complete shells of Macoma balthica were found at Yule Station, five miles southeast of Jasper (east of the map-area). These were in a gravel bar only 35 feet below the presumed marine limit. A radiocarbon date of 11,800 ± 210 years B.P. (GSC-1013; Lowdon and Blake, 1970) on shells collected from marine gravel near Maitland, east of Brockville on the St. Lawrence River, with a date of 11,600 ± 150 years B.P. (GSC-842; Lowdon and Blake, 1970) on shells collected near Meach Lake north of Ottawa, indicate the approximate time of the maximum marine invasion in the western part of the Champlain Sea basin. Isostatic adjustments raised the land surface and caused recession of the Champlain Sea eastward out of the map-area after a comparatively short marine interval.

Altitudes of the marine limit south of Smith's Falls, near Atkins Lake (Henderson, 1967a) a few miles east of the map-area, and in the Ottawa area (Gadd, 1963) show the highest Champlain Sea water-plane to be tilted by post-Champlain differential uplift by at least 5 1/2 feet per mile in a direction of north 20 degrees east. Long swamps draining to the northeast and aligned closely to the direction of maximum uplift appear to contain unusually deep organic deposits. Accumulation probably continued over a long time as differential uplift slowly raised the lower ends of the marshes at a slightly greater rate than the upper ends, spreading and perpetuating waterlogging conditions favourable to preservation of organic materials throughout the marsh areas.

Recent Sediments

Since deglaciation, except for the widespread formation of organic deposits in some places, only minor changes have affected the landscape, largely from erosion of unconsolidated deposits and their redeposition on modern stream floodplains or in lacustrine deltas. The best example of these redeposited sediments is at the north end of Lower Beverly Lake where a stream flowing past Phillipsville to the northwest has partially removed an old meltwater delta to build alluvial flats downstream for 1 1/2 miles to where they grade into deltaic deposits at the lake. In some areas, particularly in the western half of the map-area, swamps have covered wide tracts of country, the larger ones burying three or more square miles of Shield terrain, except for rocky islands which project above the swamp levels.

Possible Preglacial or Interglacial Weathering Profile

Rotted, coarse-grained granitic bedrock, present intermittently over several square miles 5 to 10 miles north of the village of Oak Lake, was exposed to depths as great as nine feet in roadcuts and numerous small borrow pits. The short time available for the formation of such a deep, weathering profile in these rocks suggests the rotted bedrock may represent part of a deep regolith, developed during a previous interglacial, or even earlier, time which has escaped erosion during the subsequent glaciation(s) of the area.

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