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INTRODUCTION

During the summer of 1975 the surficial geology of northwestern Maine was mapped on a reconnaissance basis (Fig. 1). The mapping was funded by the Land Use Regulation Commission, Maine Department of Conservation, and organized by the Bureau of Geology, Robert G. Doyle, State Geologist. The results of this mapping are designed to be a part of the basis for zoning the land use in the unorganized townships in the area of study. The area of study extends from the Boundary Mountains on the west to the Moosehead Lake region on the east. The West Branch of the Penobscot bounds the north, and the Dead River and Piscataquis River bound the south of the study area. The following U.S. Geological Survey topographic maps, 15-minute series are the base for reconnaissance scale mapping: Attean, Bingham, Brassua Lake, First Roach Pond, Greenville, Long Pond, Moosehead Lake, Northeast Carry, Penobscot Lake, Pierce Pond, Sandy Bay, Sebec Lake, Seboomook, Skinner, Spencer Lake, and the Forks.

The area mapped in 1975 totals 3,200 square miles or about 2 million acres. This is equivalent to about 10 percent of the area of the state of Maine and compares with the 1 million

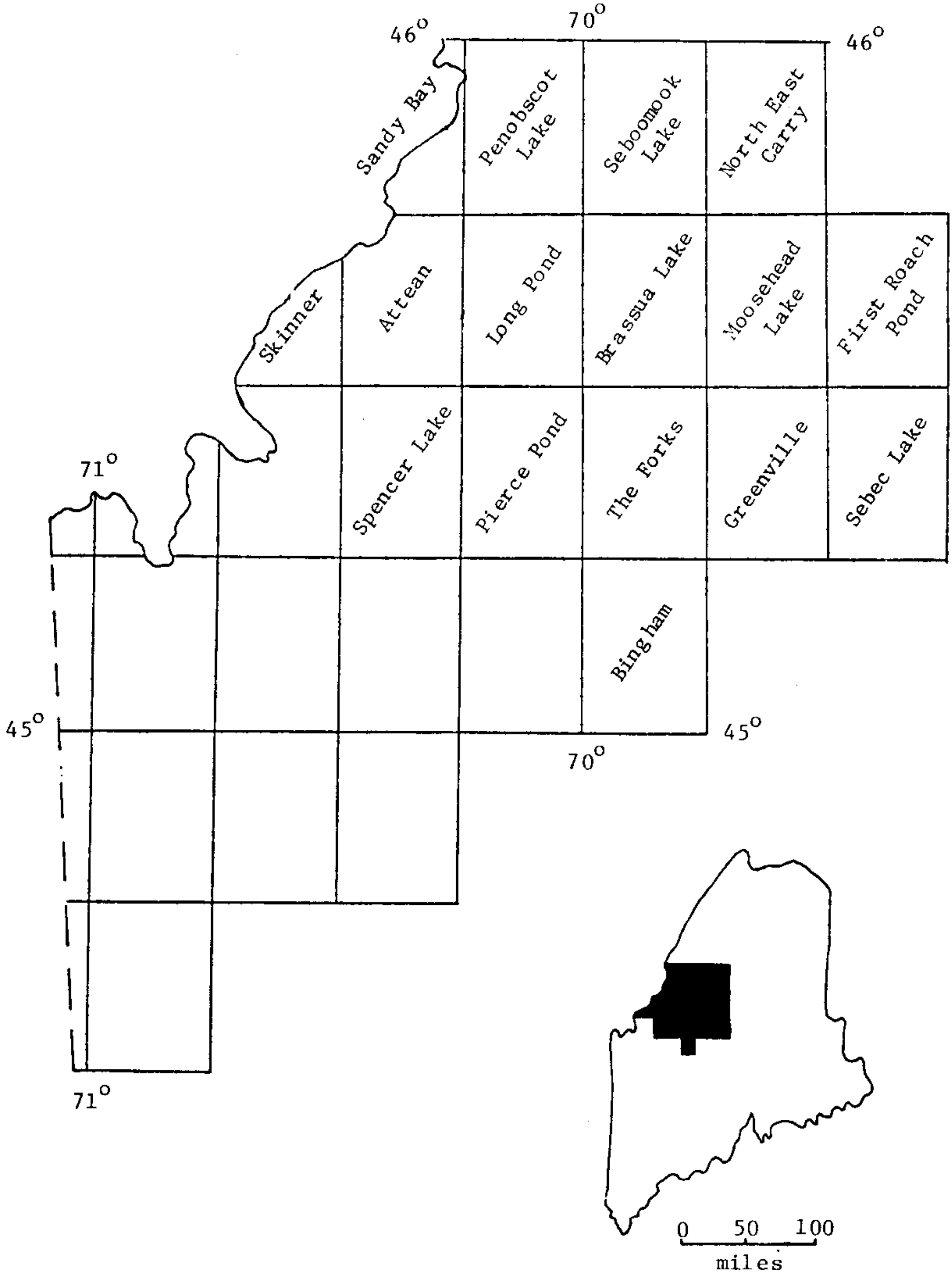

Fig. 1. Location Map of Project area. Outlined, named quadrangles are those described in this report. Outlined, unnamed quadrangles are those described by Caldwell (1975). Scale of large map is approximately 1 in = 16 miles.

acres mapped during 1974.

Previous Work in the Area

Stone (1899) studied the glacial deposits of southern and eastern Maine but visited only the Lily Bay, Roach Pond and Sebec Lake areas. Leavitt and Perkins (1934, 1935) describe major glacial deposits in the accessible parts of Maine, including many in the area of the present study. Perkins (1935) shows many other deposits, not described by them, in the map of Glacial Deposits of Maine. Many of these features appear to have been interpreted from the surface expression shown on topographic maps. Borns and Hagar (1965) discuss marine clays and late glacial outwash in the Bingham area. Albee and Boudette (1972) present a map of surficial deposits of the Attean Quadrangle. Recent works by Shilts (1970, 1976) describe the origin and chronology of glacial deposits in the Eastern Townships of Quebec, to the north and west of the Jackman area. Caldwell (1975) describes the glacial deposits in the Rangeley-Stratton area, southwest of the area of the present study.

Recent studies of the bedrock geology in the Greenville-Jackman area include those of Albee and Boudette (1972), Boucot *et al.* (1959), Boucot (1961), Espenshade (1972), and Espenshade and Boudette (1967). Canney *et al.* (1964) and Young (1968) discuss metalliferous deposits in the Attean and Long Pond Quadrangles. These and other studies are compiled by Doyle (1967) in the preliminary map of the geology of the State of Maine.

Access and Exposures

U.S. Route 201 and State Routes 9 and 15 provide access to parts of the area of study. Several fine gravel roads maintained by the Scott and Great Northern paper companies and the Boudry Lumber Company reach the most remote parts of the area. The Canadian Pacific Railroad crosses the area in an east-west direction, reaching many parts otherwise inaccessible. Fire patrol planes, under contract to the Maine Forest Service, provided an excellent overview of all parts of the area. The many lakes and ponds not only allow easy access to areas not reached by roads and foot trails, but also provide along their many miles of shoreline some of the best exposures of the glacial deposits. Other natural exposures exist in stream banks and valleys. Road cuts and gravel pits exist in all parts of the area.

Method of Study

The results of the surficial geologic mapping presented in this report are based on reconnaissance mapping. The methods used involve identification of exposed material and interpretation of the form of deposits. The limits of individual deposits are determined on the basis of their surface expression on topographic maps and infra-red transparent photographs. Little third-dimensional information, except in exposures, was available. Part of the interpretation of the deposits is based on our concept of the style of deglaciation in north central Maine. In addition to their use in the location and interpretation of surficial deposits, the U-2 infra-red photographs were invaluable for the location and destination of the numerous woods roads not shown on topographic maps. These photos also clearly show the location of gravel pits.

Acknowledgements

The project was funded by the Land Use Regulation Commission, Department of Conservation, and administered by the Bureau of Geology, Department of Conservation. Robert G. Doyle, State Geologist, and Walter Anderson, Assistant State Geologist, provided welcome assistance in logistics and supply.

The diligent and intelligent work of the following members of the field party was responsible for the success of the project: Barry Alexsavich, Thomas Brewer, Lorraine Downey, Barry Fogel, Andrew Genes, Lindley Hanson, David Hoexter, Dorothy Hunnewell, Richard Jordan, Uldis Kaktins and Donald Skiba. Judy Brewer and Kiah Caldwell provided delicious and ample food that increased both our spirits and energy.

The Department of Transportation loaned the invaluable U-2 photographs. Earl Williams, District Supervisor of the Northern Maine District, placed the local Forest Service rangers at out disposal. These included Bruce Small, Moose River; Galen Cook, Seboomook; Everett Parsons, Caratunk; Warren Bennett, Holeb; and Vaughn Thornton, Greenville. These rangers loaned their boats, gave permission for camping, and provided current information on road conditions.

The Scott Paper company provided detailed maps of

their active wood operations. Barry Hussey of the Canadian Pacific Railroad carried members of the party on the track maintenance vehicle along the complete length of the railroad in the study area. stopping at our request and allowing examination of otherwise inaccessible exposures.

GEOLOGY OF THE GREENVILLE-JACKMAN AREA

Bedrock Geology

The bedrock of the area (Doyle, 1967) is dominated by lower and middle paleozoic sedimentary and metasedimentary rocks that have strong northeast trends. Volcanic rocks and metaquartzites are prominent ridge-formers, as at Mt. Kineo, Misery Ridge, Spencer Mountain and Enchanted Mountain. Large granite and related plutonic rocks form high hills and mountains in the Roach Pond, Sebec Lake and Moxie Lake areas, while in the Attean region a large, low basin is formed over quartz monzonite. Gabbro and diorite form high elevations in the Squaw Mountain, Moxie Mountain and Pierce Pond areas.

The general shape and relief of the landscape of the Greenville-Jackman area is the product of the relative resistance to erosion, the areal extent, and structure of the bedrock. From the time of formation of the bedrock, which ended about 300 million years ago, to a million or so years ago the area was subjected to a long period of weathering and erosion which etched the pre-glacial landscape on rocks of differing resistance to erosion. Prior to glaciation, the landscape was molded in essentially its present form, with major mountains and valleys in their present locations. The effects of glacial erosion and deposition, described in the following sections, put the final touches on the familiar scenery of today.

Glacial Geology of Northwestern Maine

Effects of erosion:

The erosion of rock by glacial ice is the result of the large force existing at the base of a glacier. Glacially transported rocks on the summit of Mt. Katahdin (elevation 5267 feet) indicate glacial ice was at least thick enough to completely cover the highest mountain in Maine (Caldwell, 1972). There is no way to judge how much thicker the ice in Maine was, although it may have covered some lowland areas by more than a mile of ice, equivalent to a base pressure of over 2000 lbs/in^2 (160 kg/cm^2). Under such a force, rocks can be crushed, cracked and deeply gouged by other rock fragments imbedded in the base of glaciers.

On the smallest scale, bedrock surfaces are smoothed and polished by the abrasive force of fine-grained rock fragments imbedded in glacial ice. Sand and gravel fragments scratch and gouge the polished bedrock surface beneath glaciers. Under a glacier covering a large area, this action results in large quantities of fine-grained rock fragments being eroded from rock surfaces and incorporated in the moving glacier. Two main directions are recorded by striations and grooves, from N10°W to N35°W and N50°W to N80°W. The significance of this difference is discussed in a following section.

On a larger scale, large blocks of bedrock may be plucked from fractured outcrops, especially on south-facing slopes, and carried away from the outcrop by moving ice. The plucking action results in steep south-facing slopes, often with a nearly vertical bedrock face. On the north sides of hills the slopes are often gentle, with abraded, polished and striated surfaces. This asymmetry of bedrock hills, called stoss-and-lee form, is used by Jahns (1943) to show that plucking accounts for a greater amount of glacial erosion than does abrasion.

In valleys, especially those oriented more or less parallel with the direction of ice motion, plucking removed large quantities of debris and produces deep basins. Most of the large lakes in the region occupy depressions produced by glacial erosion, some over 100 feet below their natural outlets.

Deposits of active ice:

The most widespread glacial deposit in the area of study is till, or hard-pan. In most exposures the till is compact, fissile and clay-rich. Such till is interpreted as lodgement, or basal, till which has been plastered on the land surface by active ice. The particles which make up the till are produced by both abrasion and plucking, and the relative amounts of fine and coarse particles reflect the relative importance of abrasion and plucking, respectively. In the Attean area, where underlain by quartz monzonite, the till is loose and sandy and contains numerous large boulders.

Overlying the basal till in some exposures is a loose, sandy till interpreted as material let down directly from melting ice. Such material is termed ablation till.

The maps of the surficial geology presented with this report indicate areas underlain by till as "ground moraine (gm)." This term refers to any deposit of till without pronounced linear elements. (Flint, 1971).

The thickest till deposits occur in valleys, where they may reach thicknesses as great as 100 feet, as in the valley of Austin Stream near Bingham. On most high hills and mountains, deposits of till are thin and commonly have numerous small outcrops of bedrock. We have mapped such thin till deposits as "thin drift cover (tdc)" and have only indicated the large outcrops separately.

The type, lodgement or ablation, and the thickness of till in a particular area will determine, to some extent, the kind of land use possible in that area. This matter is discussed in a later section of this paper dealing with the land-use potential of different kinds of glacial deposits.

<u>Landforms composed of till</u>:

In most of the region mapped, the till has no particular topographic form but rather reflects the subsurface bedrock topography. Locally, however, topographic forms composed of till, such as drumlins and end moraines occur. Drumlins are streamlined till hills which have their long axes oriented parallel to the direction of motion of the ice which formed them. End moraines are irregular ridges of till or gravel consisting of material carried to the terminus of a glacier.

Drumlins and end moraines occur in the Attean, Spencer Lake, Pierce Pond, Long Pond, Penobscot Lake and Greenville Quadrangles. Their significance is discussed in the section of this report dealing with the history of glaciation of the Greenville-Jackman area and in the section in which the glacial deposits of individual quadrangles are described.

Deposits of washed drift:

Washed drift deposits are formed as the result of the melting of glacial ice. This melting process produces water which issues from the front, margins, and both top and bottom surfaces of of ice. This meltwater transports, segregates into different ranges of particle sizes, and deposits rock fragments contributed to the meltwater by the ice. Two principal kinds of washed drift deposits are recognized: 1) ice-contact deposits, and 2) pro-glacial deposits.

Ice-contact deposits are formed, at least partly, against or on masses of stagnant ice. Upon the melting of the supporting ice mass, the deposit partially collapses, resulting in disrupted bedding within the deposit and slumping of at least part of the surface of the deposit, producing an irregular, hummocky surface. Ice-contact deposits are composed primarily of poorly sorted sand and gravel, with only minor silt and clay. Although we have mapped all types of these deposits as "ice-contact," there are several different kinds, which are primarily distinguished on the basis of their topography. Eskers are long, sinuous ridges of ice-contact origin. Kame terraces border valley walls; they may have a generally level upper surface and irregular ice-contact slopes descending into a valley. Kames are round, cone-shaped masses of sand and gravel.

Pro-glacial washed drift deposits are transported by meltwater streams away from the melting ice. An outwash deposit is composed of sand and fine gravel, with the possibility of considerable silt and clay interbeds. Outwash deposits slope away from the parent mass of ice, and often have a flat surface indented with depressions called kettles. Outwash deposits may grade into deltas which are deposited in standing water. Silt and clay-sized particles carried by meltwater streams into bodies of standing water, either fresh or marine, form glacial lake and glacial marine clay and silt deposits. Criteria for distinguishing glacial lake from glacial marine clay and silt are discussed by Caldwell (1959).

Both ice-contact and outwash deposits occur in all the quadrangles discussed in this report. Glacial lake sediments occur in the Attean, Brassua Lake, Northeast Carry, First Roach Pond and Sebec Lake quadrangles. Glacial marine sediments occur in the Bingham Quadrangle, in the valley of the Kennebec River.

All types of washed drift deposits are discussed further in the section of this paper in which the surficial geology of individual quadrangles is considered. The use of washed drift deposits in interpreting the history and style of deglaciation in the Greenville-Jackman area is discussed in the next section of this paper. In a subsequent section, deposits of washed drift are considered in terms of their land-use potential.

Style of deglaciation:

The wasting of glaciers is visualized as occuring in two ways: 1) active-ice wastage, in which a glacier actively moves ice to its terminal position, but at the same time melting consumes more ice than is brought to the front; and 2) stagnation, in which large masses of ice cease to move, with melting consuming the ice in place.

The style of deglaciation in New England is still a subject of controversy. Most workers have recognized that active-ice retreat occured in the midwestern United States, where numerous end moraines, representing an equilibrium between forward motion and melting, mark the active ice margins. In New England, on the other hand, it has generally been concluded that, following a period of end moraine formation in the coastal regions of southern New England, the last ice sheet completely stagnated. With the melting of this stagnant ice, local deposits of ice-contact and outwash materials were formed in central and northern New England. Jahns (1941) presents another interpretation of the relation between outwash and ice-contact deposits and the style of deglaciation in central New England. Koteff (1974) elaborates on Jahns' work; he identifies examples of ice-contact deposits which merge with outwash deposits, the point of merger marking the down-ice end of a stagnant zone near the glacier front. At the up-ice end of the stagnant zone (the end of ice-contact features), active ice brought material from the base of a glacier to the upper surface along a shear zone. This material was then reworked by meltwater and deposited as ice-contact features in the stagnant zone, and as outwash at the down-ice end of the stagnant zone. Thus interpreted, some ice-contact-outwash sequences of washed drift mark active-ice margins and, therefore, have the same significance as end moraines. Koteff (personal communication) has recently observed retreating glaciers in Alaska at the termini of which ice-contact outwash deposits mark successive ice margin positions.

Although it is not accepted by all glacial geologists (e.g., Flint and Gebert, 1976; Goldthwaite, 1938; Borns, 1970), the morphological sequence concept does appear to be a more rational and coherent picture of deglaciation than that painted by adherents of wholesale stagnation. It should be pointed out, however, that, regardless of one's view of the style of deglaciation, identification of ice-contact and outwash features _per se_ is the same. The difference is merely the mapper's conception of the origin and significance of the features.

In the Greenville-Jackman area we have been able to identify numerous examples of morphological sequences. These are discussed in a following section in which the surficial geology of each of the quadrangles is described.

Sequence of Pleistocene events correlated with events in other areas:

The oldest known Pleistocene deposits in Maine occur on the Sandy River in New Sharon, about 70 miles south of the study area. Here Caldwell (1959) describes two tills separated by an organic sediment dated by carbon-14 as more than 52,000 years B.P. The lower till is thus older than the class Wisconsin stage, but is likely post Sangamon. The upper till at New Sharon, up to 100 feet thick, probably represents deposition during the whole of the last (Wisconsin) stage of glaciation.

Near Bingham, on Austin Stream, is an exposure of till about 100 feet thick. At the base of this till is a deposit of highly deformed varved clay, below which is older till. Although no organic material was found between the two tills, I believe the two tills may eventually prove correlative with the upper and lower tills at New Sharon.

An excellent summary by Schafer and Hartshorn (1965) outlines the deposits which document the advance and initial retreat of the Wisconsin glacier in coastal regions of New England.

1. Materials older than the Wisconsin ice advance:

   a) At Harvard, Mass., horn of extinct bison, 21,200 ± 1000 B.P. (W. 544).

   b) Marine shells in pro-glacial stratified drift on outer Cape Cod, 20,700 ± 2000 B.P. (Ziegler et al., 1964, p. 710).

2. Material marking readvance of ice to outmost Wisconsin moraine on Martha's Vineyard. Tundra plant material in clay, Zack's Cliff, west end of island, 15,300 ± 800 B.P. (W. 1187, Kaye, 1964, p. 138).

3. Materials younger than Wisconsin till in southern Connecticut: oldest peat developed on last till, Lyme, Rogers Lake, 14,240 ± 240 B.P. (y 950/951).

A slight readvance of ice to Middletown, Connecticut, about 13,000 B.P. (Flint, 1956) is correlated by C-14 dates with the Lexington moraine in Massachusetts and the Pineo Ridge moraine near Cherryfield in east coastal Maine (Borns, 1974). This readvance is correlated with the Port Huron readvance of the Midwest (Schafer and Hartshorn, 1965; Borns, 1974).

Fossiliferous glacial marine clays, both overlying and in places overlain by outwash sediments, are dated by carbon-14 between 12,900 to 12,100 years B.P. (Stuiver and Borns, 1968; Bloom, 1963). The marine clays are generally older nearer the present coast of Maine and become progressively younger inland. Less than one mile south of Caratunk, unfossiliferous marine clay underlies an outwash delta and in part is interbedded with the deltaic foreset beds (Fig. 2). The topset beds of the delta (present elevation between 540 and 560 feet) mark the inner edge of the post-glacial marine transgression in the valley of the Kennebec River.

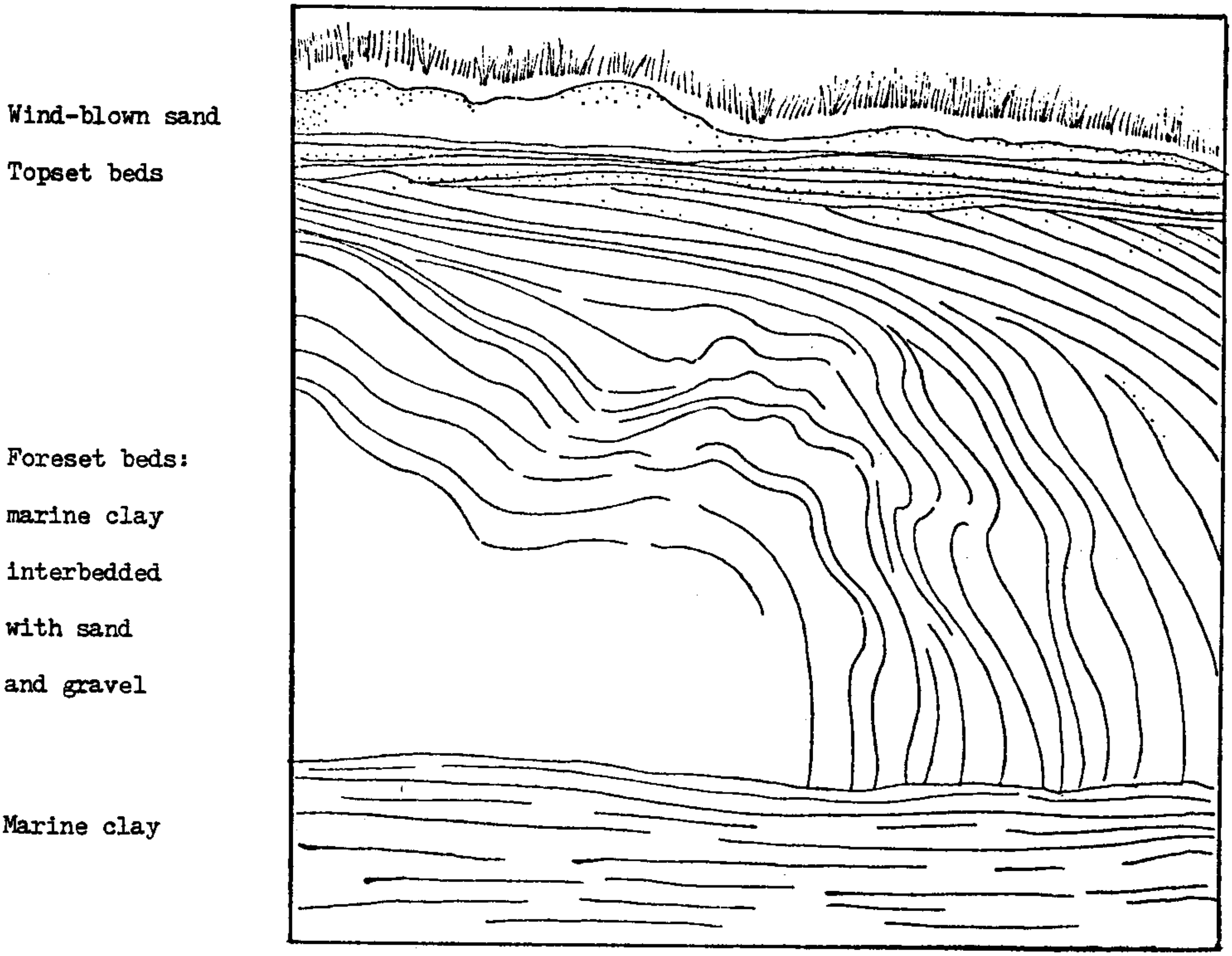

Fig. 2. Cross section of Delta located in Caratunk, Maine.

An ice-contact-outwash morphological sequence between Caratunk and The Forks locates the active ice margin at the time of the marine clay deposition. This sequence continues to the delta and to the marine clay. From correlation of the Caratunk marine clay with other nearby dated marine clay deposits, we infer that the marine clay at Caratunk was deposited by 12,100 years B.P. We may further suggest that at this date the area to the north was still ice-covered and that, therefore, nearly all the moraines, ice-contact deposits, and outwash in the Greenville-Jackman area are younger than the Caratunk marine clay.

Borns and Hagar (1963, 1965) find that emerged marine clays in the upper Kennebec River are intrenched and refilled with gravel. This gravel is interpreted as a younger glaciofluvial outwash, derived from active ice in the headwaters of the Kennebec. Borns and Hagar suggest this ice may be of Valders age.

In the Jackman area, between Attean Pond and Spencer Lake, are numerous end moraines and associated outwash deposits. These moraines mark either a re-establishment of moraine-forming conditions in the general retreat of late Wisconsin ice or a readvance of the ice following a retreat of unknown magnitude. To the north and west of the moraines, striation directions indicate the ice associated with these moraines flowed from a N50°W to N80°W direction. Outside of the moraines to the south and east, striations are consistently N20°W to N35°W. It is interesting to note that Shilts (1976), working in the Chadiere

River in Quebec, about 10 miles northwest of Jackman, finds two tills, the Upper and Lower Lennoxville tills. These tills are separated by deformed lake sediments. The lower Lennoxville was deposited by ice flowing from N20°W to N30°W, while the upper Lennoxville till has a fabric and provenance indicators that suggest it was deposited by ice flowing from N50°W to N80°W. The similarity of striation directions in the two areas may be coincidental.

Shilts (1976) has reappraised his and other earlier work in eastern Quebec and concludes that about 12,500 B.P. ice was stranded in the Boundary Mountain region in both Quebec and Maine. Schafer (1968) came to a similar conclusion.

Finally, post-Lennoxville oldest peat ages in the Boundary Mountains and the upper Chaudiere River basin average about 11,200 B.P. (Shilts, 1970), suggesting that the Jackman area was ice-free by this time. Presumably the area east and south of Jackman had become ice-free earlier than 11,200 B.P. but after the deposition of marine clay at Caratunk, 12,900 to 12,100 B.P.

LAND USE IN THE GREENVILLE-JACKMAN AREA

Insofar as land-use favorability and limitations are determined by the type and extent of soil conditions, the nature of glacial deposits in the area of study will determine the types of land use. Water supply, liquid and solid waste disposal, ease of excavation and slope stability are, in part, determined by subsurface soil conditions, which are, in turn, related to the type and extent of glacial deposits present.

Nature and Suitability of Surface Materials

The unconsolidated surface materials in northwestern Maine consist of gravel, sand, clay, silt, till and organic soils and muck. Most glacial deposits in upland areas are till, both ablation and lodgement. At high elevations only till or bedrock outcrops occur, and the till tends to be thin. At, and close to, valley floors till, outwash, ice-contact deposits, marine and lake clays and silts occur. Alluvium occurs in floodplains. There are swamp deposits at all but the highest elevations.

The water table tends to be seasonally higher in valley areas than at higher elevations, regardless of the type of surficial deposit present. Flooding is, of course, related more to closeness to streams and lakes, and is not wholly dependent on surficial material.

On lake shores in the study area, the most common surficial material is till, especially where the lake level is controlled by dams. Because outwash and ice-contact deposits are deposited at lower elevations, lakes, natural or artificial, tend to submerge the sand and gravel deposits and rise up to the higher till deposits. Such, for example, is the case in Greenville, where the level of Moosehead Lake is raised 25 feet or so by the two dams. Not only has much sand and gravel been submerged but the higher lake level has raised the local water table near the shore. The poor septic system drainage conditions in Greenville are partly the result of the clay-rich till deposits in the town and partly the result of the higher water table related to the higher lake level.

Another effect of an artificially raised lake level, especially if recent, is to produce accelerated shoreline erosion. Outwash and ice-contact deposits and, to a lesser extent, till deposits are being eroded rapidly. Apparently, after a long enough time, the shore will develop a stable slope and erosion will be reduced.

Table 1 relates several aspects of land use with the various types of surficial deposits in the Greenville-Jackman area.

From the point of view of development, the most usable land is that underlain by sand and gravel, especially when compared with the properties of the more widespread deposits of till. In areas of sand and gravel deposits, the likelihood of obtaining the large quantities of water needed for large-scale developments or municipal supplies is good. Because of their excellent infiltration capacity, large volumes of liquid wastes can be successfully disposed of in sand and gravel. Excavation in such granular material is less costly than in till. Graded slopes in sand and gravel are stable because of their good drainage; they are less susceptible to frost action. Valuable supplies of aggregate occur in outwash and ice-contact

Table 1. Land-use potential related to surficial deposits in the Greenville-Jackman area, Maine.

	LAND-USE CHARACTERISTICS							
SURFICIAL DEPOSIT	Water Supply	Liquid Waste Disposal*	Solid Waste Disposal	Water Table Condition	Frost Suscep-tibility	Ease of Excava-tion	Aggregate Potential	Slope Stability
Alluvium	fair to poor	fair	good	generally high	high	good	poor	good, except on stream banks
Swamp	poor quality	poor	poor	high	high	good	poor	poor
Marine and lake silt and clay	poor; possible artesian water below clay and silt	poor	good	variable[1]	high	good	good for bricks, etc.	poor
Outwash	good	good	good, if silty	variable[1]	low	good	good-fair	good, except on shores
Ice-contact	good	good	fair	generally low	low	good	good	good, except on shores
Moraine:								
Stratified	good to fair	good	fair	generally low	low	good	good	good
Till	fair	fair	good	generally low	high	poor	fair	good to fair
Ground Moraine:								
Lodgement till	fair to poor	fair-poor	good	seasonally high	high	poor	poor	poor on steep slopes
Ablation till	good to fair	good[2]	good[2]	generally low[2]	low	good	good-fair	variable

*Rating based on infiltration capacity; depth to water table is important to prevent ground-water pollution.

1 - Depends on topographic position: in low areas, water table close to ground surface; in high areas, water table deeper and more variable seasonally.

2 - Limited: fair where deposits are thin and underlain by lodgement till or bedrock.

deposits.

Certain aspects of development are incompatible with other aspects. Some common examples are sewage disposal and a source of municipal drinking water, aggregate extraction (if complete) and a potential water supply, or housing and sewage are unusable because of residential development on the deposits; fine water-bearing gravels have been removed for aggregate, while other aquifers have been polluted by waste disposal. Obviously, where sand and gravel deposits are eminently suitable for a variety of potential uses and yet small in size, the pressure for various types of land use, often incompatible with one another, is great. Allocation of such land will have to be made with great care.

In the Greenville-Jackman area, the most scenic land is on the lake shores and on the slopes of high hills and mountains overlooking the lakes. These lands are, for the most part, underlain by till. Thus, there is the ironic situation that the most valuable land from the point of view of real estate development is, in general, the least buildable from a land-use point of view.

Fine-grained materials such as till and clay are exceptionally well-suited for the disposal of solid waste, for there is much less possibility of ground-water contamination by the leachate than in more porous soils.

Limitation of Surficial Maps

The scale of the maps accompanying this report (1 inch equals approximately 1 mile) and the reconnaissance nature of the mapping of the surficial deposits limit the maps in their use and land-use planning tools. The maps are not meant to be, nor should they be, used for site selection. For instance, a square 5.5 acre plot is represented on our maps as a square about 0.2 inch on a side. The base maps themselves, especially the older ones, cannot be used to accurately locate such a small area. The various deposits we have shown do exist within the general area where located on the maps. The actual location may be somewhat different and the deposits may be somewhat larger or smaller than we have shown them.

The surficial maps are best used as a resource for planning decisions covering large areas and for locating areas in which certain types of land use will likely be more favorable than in other areas.

DESCRIPTION OF QUADRANGLE MAPS

Introduction

The order in which the quadrangle maps are described is by their location from west to east. (See Fig. 1)

In the following descriptions, certain deposits, features or areas of note are located with reference to the nine sections into which each quadrangle is divided by 5 minute latitude and longitude lines. (These lines actually are shown on older maps and are inferred by tick marks on the newer map's margins.) The accompanying sketch shows the location and designation of each of the nine sections.

NW	N	NE
W	C	E
SW	S	SE

Note: C stands for Central

Skinner Quadrangle

Less than 100 square miles of land in the Skinner Quadrangle lie in the State of Maine. The most prominent physical feature of the quadrangle is the Boundary Mountains, which in this area consist of several named and unnamed, nearly round-topped peaks. The international boundary is a drainage divide which separates the headwaters of the east-flowing Kennebec River from streams draining into the St. Lawrence River to the North. The highest elevation, Moose Hill (el. 2913 feet), lies in the extreme southwest of the quadrangle.

The Moose River, the largest river into Moosehead Lake, and its tributaries head a few hundred feet from the International Boundary. The roadbed of the Canadian Pacific Railroad closely follows the course of the Moose River through the quadrangle.

In the valleys of Gulf Stream (E) and Little Gulf Stream (SE) and their confluence with the Moose River (E) are the most extensive sand and gravel deposits in the quadrangle. Small, discontinuous ice-contact deposits lead to more extensive outwash deposits close to the Moose River. There are small ice-contact deposits near the abandoned settlements of Keough (SE) and Skinner (S) and near the outpost of Lowelltown (SW). The rest of the lowlands consists of extensive ground moraine and swamps. The higher elevations are till-covered with some large bedrock outcrops.

Sandy Bay Quadrangle

About 70 square miles of land area in the Sandy Bay Quadrangle lie within the State of Maine. The Boundary Mountains, which form a drainage divide between the St. Lawrence River and the South Branch of the Penobscot River, occur as low hills and ridges along the International Border. Near the southern border of the quadrangle, an east-trending range of mountains forms another drainage divide between Kennebec River drainage to the south and Penobscot River drainage to the north, Thus, Sandy Bay Mountain (S) forms a triple divide for three major drainage systems.

Several small ice-contact deposits with associated outwash deposits occur along the valley of the South Branch of the Penobscot River. The rest of the quadrangle consists of ground moraine and small bedrock outcrops. On the international border at the Canadian Customs is a small moraine of sandy till.

No Name Pond (SE) may occupy what remains of a small cirque, perhaps formed before the last Wisconsin glaciation and partly eroded by the last glaciation.

Attean Quadrangle

The Boundary Mountains form the northwest border of the quadrangle and are the drainage divide between St. Lawrence River drainage to the northwest and Moose River-Kennebec River drainage to the southeast. The Moose River flows across the quadrangle from west to east, leaving the quadrangle at its southeast margin and reentering at Attean Pond (SE). From Attean Pond the Moose River flows into Wood Pond (E) and leaves the quadrangle on its eastern margin at Jackman and the settlement of Moose River. Holeb Pond (S, C, W), Little Wood Pond (C) and Crocker Pond (N) are other small waterbodies in the quadrangle. Several mountains, Burnt Jacket (C), Sally (E), Attean (S), and No. 5 (S) rise from 1000 to 2000 feet above the surrounding lowlands.

A large basin occurs in the southeastern part of the quadrangle and extends eastward to the Long Pond Quadrangle, southeast to the Pierce Pond Quadrangle, and southward into the Spencer Lake Quadrangle. This basin is underlain by quartz monzonite, as are the mountains immediately to the north. There may be some difference in the quartz monzonite in the two areas that accounts for this difference in topography. Prominent jointing in the quartz monzonite of Sally Mountain (E) and Burnt Jacket Mountain (C) facilitated glacial plucking on the slopes, which has left numerous small linear bedrock outcrops in this area. These show clearly on aerial photographs. West and southwest of Holeb Pond (C, W), granofels (Albee and Boudette, 1972) has weathered and been glacially eroded into numberless, small bedrock knobs. In the northwest portion of the quadrangle folded sedimentary rocks (Albee and Boudette, 1972) produce numerous, closely spaced, northeast-trending ridges with intervening valleys 50 to 100 feet deep. These examples illustrate the remarkably different surface effects that can occur on different bedrock types.

In the low basin (SE) is excellent evidence of active ice retreat and the formation of numerous boulder-rich end moraines. The moraines are strongly lobate and suggest the shape (and size) of the tongue of ice which deposited them was greatly influenced by the bedrock basin which contains them. The moraines continue to the southeast, east and south into the adjacent quadrangles. These moraines (discussed on page 17-18, this paper) are thought to be younger than the marine clay in the Kennebec River valley at Caratunk (See description of Bingham Quadrangle). There are several drumlins in the vicinity of the end moraines.

Outwash from meltwater streams occurs in several discontinuous deposits associated with the end moraines. Outwash or lake sediments are thought to underly parts of the large swampy area named No. 5 Bog (SE). Some small ice-contact features near Spencer Rips (SE) were likely associated with stagnant ice masses left behind by the retreating ice. In the vicinity of Holeb (SW) there is a large deposit of outwash sand and gravel, and a prominent esker which more or less follows the Moose River in that area for about 5 miles. Small ice-contact and outwash sequences occur in the valleys of Turner Brook (W) and Wood Stream (C). Extensive ice-contact-outwash sequences occur along Sandy Stream (N, NE, E) which end in an outwash delta near the Moose River in the town of Jackman (E). The Sandy Stream gravel deposits are unusual in the project area in that they extend nearly to the International Border in the headwaters of the West Branch of Sandy Stream (N).

The deposition of the varved clay at Jackman and along the northeast shore of Attean Pond (E) may be related to an ice drift dam which temporarily ponded the drainage in this area. Part of the deposition of the delta at Jackman (E) and in the western part of the Long Pond Quadrangle took place during the varved clay deposition and may partly cover the clay north of the Moose River.

North of Burnt Jacket Mountain (C) the upper elevations are underlain by fissile, compact, clay-rich till. In the southeast portion of the quadrangle the till has a sandy matrix and is generally loose in texture, reflecting the influence of the friable quartz monzonite in this area.

Unusual features:

On the southwest shore of Turner Pond (W) are two ridges composed of sand, silt and organic material. The outer ridge is some 10 to 20 feet from the lake shore, and from five to six feet high; it is tree-covered. The smaller ridge, lying at the high water mark, is only one to two feet high; it is grass-covered.

These features are mapped by Albee and Boudette(1972) as ice-contact deposits. They are, however, excellent examples of ice-pushed ridges. Features of this kind were first described by Buckley (1901) as "ice ramparts." He attributed (correctly) their formation around lake shores to the lateral expansion of ice during rapid warming. The expanding ice shoves loose material around lakes into ridges. These features were termed "ice-pushed ridges" by Nichols (1953).

I believe the large, tree-covered, ice-pushed ridge was formed several decades ago, during a higher lake level formed by a now defunct logging dam. The smaller ridge is probably contemporary with the present lake level and is still being formed.

No. 5 Bog (SE) has many aspects that are reminiscent of muskeg swamps found in the arctic regions of Canada and Alaska, but that appear out of place in northwestern Maine. These include several species of plants and at least two species of birds of Arctic affinity, as well as the brightly colored, more cosmopolitan sphagnum moss.

South of Bog Pond, at the northwest end of No. 5 Bog, the swamp surface is patterned with a series of larch-covered ridges standing six inches to a foot high, spaced five to ten feet apart. The ridges are dry, with standing water in the swales between them. From the air this pattern strongly resembles features called string bogs. Henoch (1960) and Schenk (1966) attribute the formation of string bogs to the differential collapse of permafrost. Troll (1944), however, describes string bogs in areas outside the known zones of permafrost occurence. There is a possibility that the patterned surface of No. 5 Bog may be a relic feature related to permafrost. Whatever its origin, its contributes to the Arctic-like aspect of Bog No. 5.

On the north shore of Little Wood Pond (C) near Fox's Camp, there are several important Silurian fossil occurrences (Albee and Boudette, 1972). The fossils, mostly brachiopods, are flattened by metamorphic pressure. Other Silurian fossils occur south of Mud Pond (E), while on the east shore of Wood Pond (E) Devonian-age fossils occur in the Seboomook formation.

Spencer Lake Quadrangle

Spencer Stream, a tributary of the Dead River which joins the Kennebec River at The Forks, drains nearly all of the quadrangle. Tumbledown Mountain (NW), the highest elevation in the quadrangle, rises nearly 2000 feet above the nearest lowland. Several other mountains in the northern part of the quadrangle exceed 3000 feet in elevation.

Spencer Lake (NE, E), the largest lake in the quadrangle, is, with its companion, Fish Pond, about six miles long and averages less than three-quarters of a mile in width. This long, narrow shape is probably the result of both pre-glacial stream erosion and glacial erosion. Between Hedgehog and Spencer Mountains the valley of Spencer Lake is strongly U-shaped. King and Bartlett Lake (C) is the next largest lake in the quadrangle.

The large basin underlain by the Attean quartz monzonite extends to Fish Pond and the north slope of Hardscrabble Mountain. The end moraines which occur in this basin in the Attean Quadrangle extend into the northeast part of the Spencer Lake Quadrangle. A much-eroded moraine near the southern end of Spencer Lake (E) apparently is the most southerly of the moraines associated with active ice centered in the Attean Quadrangle.

Extensive outwash, related to meltwater from active ice to the north, occurs around the shores of Fish Pond (NE). These continue along Spencer Stream to the east and northeast and along Kibby Stream to the southwest.

Large areas of thin drift cover and bedrock outcrops occur on the many mountains in the northern part of the quadrangle, while in the central and southern part ground moraine is dominant. The remnants of several cirques occur on Tumbledown Mountain and Three Slide Mountain (NW, N).

Unusual features:

Several of the most beautiful beaches in the project areas occur on the shore of Spencer Lake, near Spencer Lake Camps (NE) and in the vicinity of several small sandy moraines toward the south end of the lake. The outwash, ice-contact, and moraine deposits which are the source material for these beaches are being rapidly eroded by strong waves in the lake.

Spencer Lake Camps (not operating in 1975) and King and Bartlett Camps (no longer open to the public) are fine examples of turn-of-the-century sporting camps.

Near Beck Pond (C) is an important Devonian age fossil locality (Boucot et al., 1959).

Penobscot Lake Quadrangle

West of Penobscot Lake (NW) is a short segment of the international border, marking a drainage divide between the St. Lawrence River and the Penobscot River. The North and South Branches of the Penobscot River drain nearly the whole quadrangle. Near the southern margins of the quadrangle, Boundary Bald Mountain (SW) and Ironbound Mountain (SE) approximately indicate a drainage divide between Kennebec River drainage to the south and Penobscot River drainage to the north. Boundary Bald Mountain (SW), elevation 3640 feet, is the highest mountain in the western part of the project area and one of the few in the area mapped with its summit above timberline. Canada Falls Lake (SE, E), Penobscot Lake (NW), and Long Pond (N) are the largest lakes in the quadrangle.

Along the south side of the valley of the South Branch of the Penobscot River are several segments of end moraines (W, C) which perhaps can be correlated with those in the Attean Pond-Spencer Lake area. Associated with the moraines are a number of ice-contact and outwash deposits which extend down the river to Canada Falls Lake (E). Cutting across the middle of three small brooks, Hale, Fish and Alder, are a series of ice-contact-outwash sequences which end south of Ironbound Pond (S) and a meltwater spillway. In the valley of Lane Brook (E) are several ice-contact-outwash sequences which mark positions of active ice fronts. These deposits have been greatly modified by the entrenchment and meandering of the river.

<u>Long Pond Quadrangle</u>

All of the quadrangle drains into the Kennebec River, nearly all by way of the Moose River, which flows almost directly from west to east through the quadrangle and Long Pond. The roadbed of the Canadian Pacific Railroad parallels the Moose

River through this section. The Moose River also briefly enters and leaves the quadrangle in its southwestern section. In the southeastern section, Cold Stream flows southward to the Kennebec above the Forks.

The highest elevations in the quadrangle are Bean Brook Mountain (S) and an unnamed peak east of Jackman Field (C), both over 2600 feet in elevation. Other mountains over 2000 feet high are Owls Head and an unnamed peak (W) southeast of Jackman Station, Catheart Mountain (SW), Parlin Mountain (SE), and Williams Mountain (SE).

East of Jackman Station (W) is a large outwash plain, which is a continuation of similar deposits in the Attean Quadrangle. The outwash is partly covered by swamp deposits. Two delta scarps (W) indicate the approximate lake level in which clays, partly underlying the delta and partly interbedded with deltaic foreset beds, were deposited. These lake sediments, correlated with the varved clays in the Attean Quadrangle, are mostly covered by younger outwash, which is entrenched by the Moose River.

Near Parlin Pond (S), Parlin Brook (S, SE), Bean Brook (S), and Cold Stream (SE) are several large ice-contact-outwash sequences. A segmented esker begins at Parlin Pond and continues, with some breaks, down the Kennebec River to Norridgewock, through the Belgrade Lakes to Augusta, where it is covered by marine clay. The total length of this esker is nearly 85 miles, making it one of the longest in Maine.

In the vicinity of Supply Pond (W), Bog Brook (NW, W), Heald Brook (NW, W), and Kimball Brook (NW) are several small ice-contact-outwash sequences which mark active ice fronts in those areas. Other small sequences occur in the valleys of Upper Churchill (NW, C) and Churchill Streams (N, C, E).

In the extreme southwestern part of the quadrangle is the eastern margin of the end moraines found in the low basin that extends into the Attean, Spencer Lake and Pierce Pond Quadrangles. The end moraines are late Wisconsin in age and represent the waning stages of active ice deposition in this part of Maine. By correlation with C-14 dated deposits to the south and northwest, the moraines were formed sometime between 12,100 and 11,000 BP.

In the northern part of the quadrangle, extensive ground moraine occurs. In the areas of higher relief to the south of the Moose River, there are many mountains with thin drift cover and bedrock outcrops. On the west end of Catheart Mountain (SW) is a cross-shaped bedrock outcrop which was made during the examination of that mountain for a copper and molybdenum ore deposit (Young, 1968). Bean Brook Mountain and the headwaters of Bean Brook (S) also show signs of ore mineral formation. Both the Catheart Mountain and Bean Brook mineralization are associated with the Attean quartz monzonite (Young, 1968).

<u>Pierce Pond Quadrangle</u>

Most of the quadrangle drains into the Dead River, a major tributary of the Kennebec River. Northwest of Hardscrabble

Mountain (NW) and Grace Pond (NW), drainage is into the Moose River. In the southeast part of the quadrangle Pierce Pond (SE) and other small ponds in the vicinity drain into Pierce Pond Stream, which enters the Kennebec River near Caratunk.

Pierce Pond is the largest in the quadrangle; Enchanted Pond (NW) and Grace Pond (NW) are other large ponds in the area.

Several peaks on Coburn Mountain (N) exceed 3000 feet in elevation. Shutdown (W), Grannys Cap (W), Johnson (N) and Pierce Pond (S) mountains exceed 2500 feet in height, and a number of other peaks in the quadrangle exceed 2000 feet in summit elevation.

In the northwest portion of the quadrangle is the southeastern extension of end moraines occurring in the extensive low basin found in the Long Pond, Spencer Lake and Attean Quadrangles.

In the headwaters of Bitter Brook (NW) are several small ice-contact deposits which may have formed next to a stagnant ice block, grounded when active ice retreated to the northwest. The nature of these deposits also suggests they may have been formed in water ponded between ice to the north and the high ridge of Hardscrabble Mountain to the south. Indeed, many of the moraines to the north and west may have formed under similarly ponded water.

Other small washboard (?) moraines occur in the valley of Enchanted Stream (C) and along Route 201 near the town line (NE) between West Forks and Johnson Mountain townships.

Associated with both of these moraine occurences are numerous ice-contact and ice-contact-outwash sequence deposits.

The largest deposits of sand and gravel in the quadrangle occur as outwash with minor ice-contact features at the junction of Spencer Stream and the Dead River (SW). Much of this outwash is thought to have been derived from active ice margins in the Attean Pond and northern Spencer Lake areas, and transported down Little Spencer Stream. This outwash may be related to the North Anson formations of Borns and Hagar (1965). Part of the outwash may have been derived from the draining of Glacial Lake Bigelow (Borns and Calkin, 1970).

Unusual features:

The gorge of the Dead River, from Grand Falls (SW) to the Forks (about two miles east of the quadrangle), is the largest stretch of white water in Maine and one of the longest in the United States. The river drops an average of 20 feet per mile over the 15-mile long reach, and one two-mile section near Appletree Inn (SE) has a gradient of 50 feet per mile. The banks of this spectacular stretch of river rise steeply from 100 to 200 feet above the river banks.

The basin of Enchanted Pond (NW) is a magnificent U-shaped valley formed by glacial erosion in Devonian-age volcanic rocks. At the bases of steep cliffs on Shutdown and Coburn Mountains are large talus accumulations of huge blocks of rocks that extend to the lake shore. On the southwest shore of the lake, beneath Shutdown Mountain, there is a deep moat between a large talus ridge on the lake shore and talus piled at the base of the cliff. It is impossible for the huge blocks on the ridge on lakeshore to have rolled from the cliff, across the moat to their present position on the ridge. There must have been some surface over which the blocks, now on the shore, could have rolled; that surface, however, is no longer present. A stagnant ice block or a permanent snowbank could have provided such a surface. Features formed in this way in cirque basins in the Rocky Mountains are named pro-talus ramparts by Bryan (1934). Caldwell (1972) describes a similar feature in the North Basin cirque on Mt. Katahdin. The steep and high northeast-facing slope of Slidedown Mountain is well situated to cast a shadow on the base of the slope, favoring the preservation of snow or ice during intensive frost action shortly after the glacier receded from the area.

Seboomook Lake Quadrangle

The northern part of the quadrangle is part of the Penobscot River drainage, which flows eastward, and the southern part of the quadrangle drains into Moosehead Lake and the Kennebec River. Seboomook Lake, formed by a dam on the West Branch Penobscot, is the largest lake in the quadrangle. A small part of Moosehead Lake lies in the southeast part of the map.

Seboomook Mountain (N) and an unnamed hill (SW) north of Center Pond (SW) are the only elevations above 2000 feet in the quadrangle.

A deposit of ice-contact origin and outwash occurs at the west end of Seboomook Lake and in the valley of the North Branch Penobscot River. A large meltwater spillway (C) carried outwash sand from the Seboomook Lake area to Socatean Stream (S, SE). Outwash and ice-contact sand and gravel in the headwaters of the North Branch of Brassua Stream (SW) continue into more extensive deposits in the Brassua Lake Quadrangle to the south.

The rest of the quadrangle consists of clay-rich till, bedrock outcrops and swamp deposits. The shore of Moosehead Lake (SE) and most of the shore of Seboomook Lake consist of these same materials. There is a good possibility that different kinds of deposits, ice-contact, outwash or even lake sediments, may occur beneath the present lake level which is raised almost 70 feet above its natural level. Indeed, the long meltwater spillway extending from the southwest shore southeastward into Socatean Stream suggests there may have been a glacial lake in the lake basin. No field evidence for such a glacial lake, other than the spillway, was found.

Brassua Lake Quadrangle

The whole of the Brassua Lake Quadrangle is part of the Kennebec River watershed. The Moose River drains from west to east into Brassua Lake and thence into Moosehead Lake. The East and West Outlest of Moosehead flow into Indian Pond, which is formed by Harris Dam on the Kennebec River, about three miles to the south in The Forks Quadrangle.

Big Squaw Mountain (SE) is 2500 feet in elevation. Other mountains exceeding 2000 feet are Chase Stream Mtn. (SE), Williams Mtn. (SE), Long Pond Mtn. (SE), and Misery Knob (S). Misery Ridge trends across the quadrangle from southwest to northeast. The ridge is composed of very resistant quartzite and related rocks. Only in two places within the quadrangle, at Misery Pond (SW) and Tarratine (C), is Misery Ridge breached. Two streams, Misery to the north and Churchill to the south, parallel Misery Ridge and are sites of important outwash and ice-contact deposits.

One of the longest, nearly continuous deposits of sand and gravel in the study area begins on the north margin of the map near North Branch Brassua Stream (NW). After passing South Branch Brassua Stream (NW), the deposits extend into Brassua Lake as a branched esker. The deposit emerges from Brassua Lake on its south shore (C), crosses Route 15 (C), and extends up the valley of Misery Stream to Misery Pond (SW). South of Misery Pond, more sand and gravel deposits in the valley of Churchill Stream join the ice-contact and outwash system in Chase Stream valley (SW) at the southern margin of the quadrangle. This deposit extends about 5 miles into the Seboomook Lake Quadrangle to the north and 4 miles south into The Forks Quadrangle, ending at the Kennebec River about 28 miles from its northern terminus.

Isolated groups of ice-contact-outwash sequences occur around Baker Pond (N) and Gold Brook (S). North of Tarratine (C) a small esker extends into Brassua Lake.

There is evidence that a glacial lake formed in the basin of Brassua Lake with the damming of its outlet by ice somewhere to the east. Lake sediments occur near Tarratine (C) and near the railroad siding at Brassua (C). The spillway for the lake occurs south of Tarratine. Other lake sediments probably are submerged by Brassua Lake.

Unusual features:

Near the mouth of Brassua Stream (N) into Brassua Lake, the shoreline is formed from several ice-contact features and smoothed bedrock knobs. This shoreline is very beautiful, with numerous narrow channels and inlets and the waterfall of Brassua Stream.

The new dam on Brassua Lake has raised the lake level, which has partially submerged the ice-contact deposits in Little Brassua Lake (W). Here, also, the shore consists of numerous channels and inlets, all with sandy beaches. The southernmost end of these esker ridges is being eroded rapidly by the large waves which can hit the shore from the east and southeast. The drowned eskers to the north toward Fletcher Ponds (NW) are protected from large waves and have stabilized, tree-covered slopes. However, motorboats traveling at high speeds through these narrow channels can produce significant erosion.

The Forks Quadrangle

A number of peaks within the quadrangle exceed 2000 feet in elevation, including Big Squaw Mtn. (NE), Cold Stream

Mtn. (NW), Mosquito Mtn. (S), Pleasant Pond Mtn. (S), South Mtn. (S), and Bald Mtn. (SE).

Moxie Pond (C, SE) is the largest in the quadrangle. Indian Pond (N), Black Brook Pond (C) and Pleasant Pond (S, SW) are other large ponds. The quadrangle is part of the Kennebec River watershed. The Kennebec River flows from northeast to the southwest in the quadrangle, and is joined by the Dead River at The Forks (W).

Ice-contact and outwash deposits occur in Chase Stream valley (NW, N). The shore of Indian Pond (N) is mostly underlain by thin till with numerous bedrock outcrops and small gravel deposits away from the shore. At the confluence of the Dead River and the Kennebec River (W), there is an extensive deposit of ice-contact sand and gravel, and below The Forks (W) esker segments and outwash occur.

Along the shores of Moxie Pond (C, SE) and, in places, crossing the pond are several boulder moraines. Other small moraines occur on the Indian Pond road near Baker Pond (C). The origin of these moraines is problematical as they do not seem to have been formed along a great length of ice front, but appear to very localized in occurence.

Unusual features:

The deep gorge of the Kennebec River from Harris Dam (N) to The Forks (W) has banks that rise more than 200 feet. The gorge is believed to have been cut by meltwater rivers.

Bingham Quadrangle

The quadrangle is part of the Kennebec River watershed. The Kennebec River and Austin Stream are the largest waterways in the quadrangle. Wyman Lake (W, SW), Austin Pond (NE), Baker Pond (N), and Pleasant Pond (N, NW) are the largest lakes in the quadrangle.

Moxie Mtn. (N, NW), Black Nubble (NW) and Bald Mtn. (NE) are over 2000 feet in elevation.

A segmented esker follows the length of the Kennebec River through the length of the quadrangle. This is part of the esker that extends from Parlin Pond southward to Augusta. Marine clay and silt deposits occur at low elevations as far north as Caratunk (NW), where clay is overlain by and interbedded with deltaic outwash (Fig. 2). The clay at Caratunk marks the inner limit of post-glacial marine submergence in the Kennebec valley. South of Caratunk the marine sediments are overlain by younger outwash sand and gravel of the Emden and North Anson formations of Borns and Hagar (1965).

Along the abandoned railbed between Austin Stream Deadwater (E) and Moxie Bog (NE) are a series of small ice-contact deposits. On the southern shore of Baker Pond (N) is a single large ice-contact feature. On Route 16 near benchmark 1282 (E) is a large deposit of ice-contact gravel.

The thick till deposit on Austin Stream near Austin Stream Deadwater (E) is the thickest till section seen in the study area. The till overlies deformed varved clays, and within the till section are other thin seams of varved clay.

North East Carry Quadrangle

The northeastern two-thirds of the quadrangle are part of the West Branch Penobscot River drainage and the southwestern one-third is part of the Kennebec River drainage. At Northeast Cove (C) and Northwest Cove (W) are historic carries from Moosehead Lake into Penobscot River drainage. Moosehead Lake (North Bay) and Lobster Lake (E) are the largest water bodies in the quadrangle.

Little Spencer Mtn. (3000+ feet elevation) and Lobster Mtn. (2000+ feet elevation) are the highest mountains in the quadrangle.

The dominant feature of the surficial geology is the large flat valley of the West Branch Penobscot River. This is interpreted as a small glacial lake that existed between Smith Halfway House (NE) and Old Roll Dam (NW). The details of this glacial lake were not carefully studied, but the field relations and topography suggest the following events. The valley of the West Branch, Lobster Lake and at least some of the land south and east were ice-free. The northward-retreating glacier stood somewhere near Smith Halfway House, preventing meltwater from flowing in its normal drainage direction. The ponded meltwater rose to form a glacial lake with an early outlet (elevation 1040 feet) west of Lobster Lake into Moosehead Lake at Northeast Cove (C). A later, lower, outlet (elevation 1020+ feet) was either uncovered or was eroded in a low valley between Mud Cove (W) and the West Branch Penobscot River. Deltas, formed in the lake from outwash derived from the north, now occur near the outlets of Luther Brook (NW) and Russell Stream (N). Retreat of the ice sheet finally uncovered the Smith Halfway House outlet and the glacial lake drained. Outwash from the north and west spread over the lake sediments leaving the valley essentially in its present form.

With the exception of an ice-contact deposit on the shore of Northeast Cove (C), the shore of Moosehead Lake is composed of bedrock and till, as is most of the shore of Lobster Lake. The present, artificial level of Moosehead Lake has likely drowned some washed drift deposits.

Moosehead Lake Quadrangle

Moosehead Lake extends over the major part of the quadrangle. The Kennebec River begins at the East Outlet dam (W) with minor flow added by way of the West Outlet (W).

Big Squaw Mtn. (SW) is the highest in the quadrangle. Scammon Ridge (SE) and Burnt Jacket Mtn. (SE) are other high peaks near the southern end of Moosehead Lake. Mt. Kineo (NW), Shaw Mtn. (NW) and Little Kineo Mtn. (NW) are prominent though lower heights near Moosehead Lake. These latter three peaks are formed of resistant felsite lava. The popular designation of the rocks at Mt. Kineo as flint, based partly on records of the Indians' use of this rock for arrowheads, is not technically correct. However, the Kineo felsite does perform as well as flint as a source for chipped implements; thus, the word flint for the rocks at Kineo should be acceptable in that sense to all but those most particular about proper scientific usage.

An interesting, discontinious, ice-contact deposit begins at Deer Head Farm (NW) and continues southward, partly on land and partly in the lake. It appears at Kineo Cove (NW) on Kineo, at Sand Bar Island (W) and Sand Bar Point (W), and at Hogback Island (W). It may continue southeastward, beneath the lake, between Sugar Island (C) and Deer Island (C) to Beaver Cove (SE) and the extensive gravel deposits on shore there. On the other hand, the ice-contact deposits may extend southward from Deer and Sugar Islands, east of Moose Island (S), into the Greenville Quadrangle at Hartford's Point and the extensive deposits at Greenville Junction. Whatever the true course of the ice-contact deposits and possible outwash, it illustrates again the frequent drowning of sand and gravel deposits by artificially raised lake levels, so common in this area.

The large deposits of washed drift between Prong Pond (SE) and Scammon Ridge (SE) extend eastward into First Roach Pond and Upper Wilson Pond. Smaller gravel deposits occur at Doughnut Cove (E), Ronco Cove (N), and Cowan Cove (NW).

Greenville Quadrangle

Moosehead Lake and the land south and west of the lake are part of the Kennebec River drainage. The rest of the quadrangle is part of the Piscataquis River watershed, which is tributary to the Penobscot River. Lower Wilson Pond (NE), Lake Hebron (SE) and Bald Mountain Pond (SW) are other significant water bodies in the quadrangle.

Big Squaw Mtn. (elevation 3,196 feet) and Little Squaw Mtn. (elevation 2,200 feet) are among the highest in the quadrangle. There are few others which exceed 1500 feet in elevation.

The principal sand and gravel deposits occur in and south of Greenville Junction (N) through the long swamp to the drainage divide (N) with the East Branch Piscataquis River. This important deposit has been largely removed, and the surficial map represents the deposits as they were in 1951 (the date of the base map).

In a pass at an elevation of 2200 feet between Big Squaw Mtn. and an unnamed peak to the south (2460 feet elevation) (NW), there is a glacial deposit which is unusual, not because of its size but for its high elevation. In fact, this well-bedded, collapsed deposit is several hundred feet higher than any similar type of deposit seen in two years of mapping glacial deposits in northwestern Maine. A possible explanation of this high-level deposit is the following: 1) Late Wisconsin ice thinned over the peaks in the Squaw Mountain area, which finally protruded through the ice as nunataks; 2) stagnant ice blocks became grounded in the high pass; 3) meltwater transported sand and gravel into the pass, where they were deposited around the stagnant ice blocks; and 4) the ice melted to lower elevations, causing the deposits to collapse into much their present form. A lower, similar deposit occurs northwest of Big Squaw Pond (NW).

Ice-contact and outwash deposits occur near the junction (SW) of the West Branch Piscataquis River and Bald Mountain Stream. In the deep valley of the East Branch Piscataquis, upstream from the Blanchard-Shirley town line (S), are features interpreted as end moraines, greatly modified by later meltwater from ice as it retreated into the Moosehead area.

Unusual features:

North and south of Squaw Brook (NW, N), along Route 15, are several outcrops of deeply weathered gabbro, an iron- and magnesium-rich rock. The weathered rock is granular, porous and permeable, and greatly resembles glacial gravel. One exposure (N), lying along the T2R6/T3R5 boundary and Route 15, grades upward from fresh gabbro to coarsely spheroidal gabbro, to finely spheroidal gabbro, to a loose residual granular material more than 15 feet thick, composed of pea-sized and smaller weathered gabbro fragments. It is so similar to gravels in the area that it could pass, and probably has passed, a percolation test for a septic tank drain field. Whether such deeply weathered deposits are pre-glacial in origin and somehow withstood glacial erosion or whether they are post-Wisconsin in development, is a question often raised but rarely settled. (See Goldthwait and Kruger, 1938).

First Roach Pond Quadrangle

The central and southern parts of the quadrangle are characterized by a large area of high relief. The highest mountains are Baker Mtn. (S), White Cap Mtn. (SE), Hay Mtn. (SE), Lily Bay Mtn. (W) and West Peak (SE), respectively, all over 3000 feet in elevation. There are 10 other peaks over 2000 feet high.

The central part of the quadrangle is part of the Kennebec River watershed, and both the northern and southern parts are in the Penobscot River drainage. First (C) and Second (NE) Roach Ponds are the two largest lakes in the quadrangle.

On the southeastern end of First Roach Pond is a large deposit of outwash sand and gravel. An esker follows Bear Brook Pond (N) into Second Roach Pond. It is submerged by the lake and emerges at the southeast end where it leads to a large deposit (E) of ice-contact gravel and sand. Northwest of Upper Wilson Pond (SW) are ice-contact and outwash deposits that are part of a larger deposit to the west in the Moosehead Lake Quadrangle.

Sebec Lake Quadrangle

Two long ridges, generally over 2000 feet in elevation, trend across the northwestern and central portions of the quadrangle. These are Blue Ridge (NW) and Barren Mountain (C, N, NE). Barren Mountain, Benson Mountain (C, E) and Roaring Brook Mtn. (E) nearly surround a large, low, oblong valley in the vicinity of Indian Pond (NE). The only outlet of this hidden valley is the narrow valley of Caribou Stream (E).

All of the quadrangle is part of the Penobscot River drainage system. Sebec Lake (S, SE) and Lake Onawa (C) are the largest in the quadrangle.

The wide valley of Wilson Stream (SW, S) is underlain by varved glacial lake sediments. These are, in part, covered by later outwash. Southeast of Gulf Hagas (NE) is a large deposit of outwash.

Unusual features:

The spectacular gorge of Gulf Hagas is in the northeast part of the quadrangle. It is nearly 3 miles long and has steep and, in places, vertical walls up to 200 feet high. It is believed that this gorge was cut by glacial meltwater streams carrying gravel and sand.

In the vicinity of Monson (SW) are several quarries which produce the famous Monson slate.

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