A 5619-36 A 5619-38 A 5619-40	Granite and pegmatite intruding pre-cambrian sedimentary rocks and cut by late diabase dikes. *See* Prosperous Lake, Geol. Survey Canada Preliminary Map 45-4, northeast corner.
A 2711-94	Esker and morainic topography near Wholdaia Lake, N.W.T.
A 3783-41	Fault extending N.E. from Hornby Bay on Great Bear Lake. Late pre-cambrian sandstone on left—older granite and porphyry on right.
A 8668-71	West Bay Fault—Yellowknife Bay. *See* Yellowknife Bay, Geol. Survey Canada Map 709A.
A 4848-1L	South Nahanni River Country, N.W.T.
A 5414-75C	Outpost Island, Great Slave Lake.
A 3701-85	Giant quartz vein at Beaverlodge Lake. Contains lenses and stringers of pitchblende.
A 5611-98	Highly contorted early pre-cambrian sediments 8 miles east of Yellowknife.
A 3914-58	Belcher Island, Hudson Bay. Highly folded late pre-cambrian sediments and volcanics.

USE OF AERIAL PHOTOGRAPHS IN GLACIAL GEOLOGY

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IN MAPPING the deposits left by continental glaciers topographic form is a very important criterion. For this reason aerial photographs are of immense value to the field geologist. Only in vertical aerial photographs may all sides of a hill be examined at once. This ability makes the discrimination of drumlins, which are defined in terms of their streamlined form, possible in circumstances where ground observation is not only difficult but uncertain (Fig. 1). The topog-

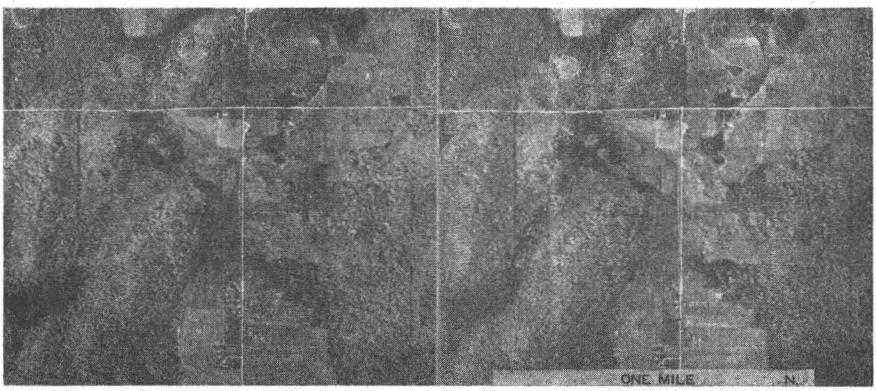

FIG. 1. Drumlins made by ice moving north of west. Deposits between drumlins are pitted outwash.

raphy resulting from a change in direction of ice movement across an area of drumlins is most confusing on the ground but is as clear from the air as it is on the best contour map. With photographs there is no excuse for confusing drumlins with knobs of a terminal moraine as has often been done in the past, particularly in heavily forested terrane. Other common errors of the past include mistaking of gullied areas and highly pitted outwash for true terminal (end) moraine. Figure 2 shows a typical rough terminal moraine with associated plain of sand and gravel outwash on the right (north). Views from above disclose that the details of the topography of many moraines are not entirely without system. Even in this apparently lawless confusion of knobs and hollows there are many

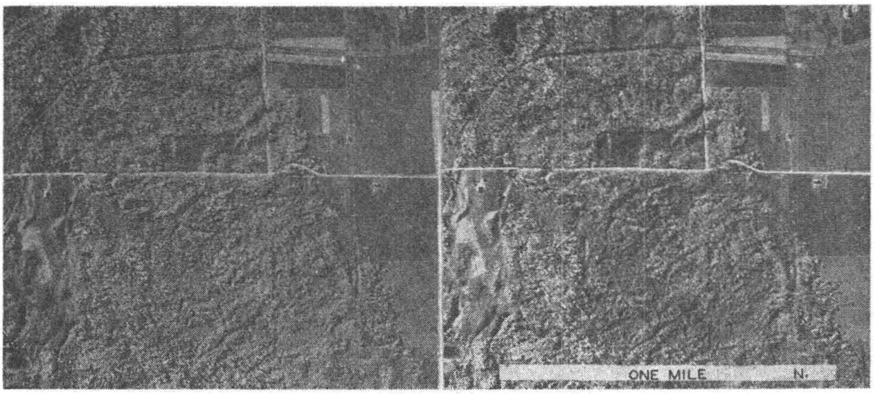

FIG. 2. Rugged terminal (end) moraine south of flat plain of outwash.

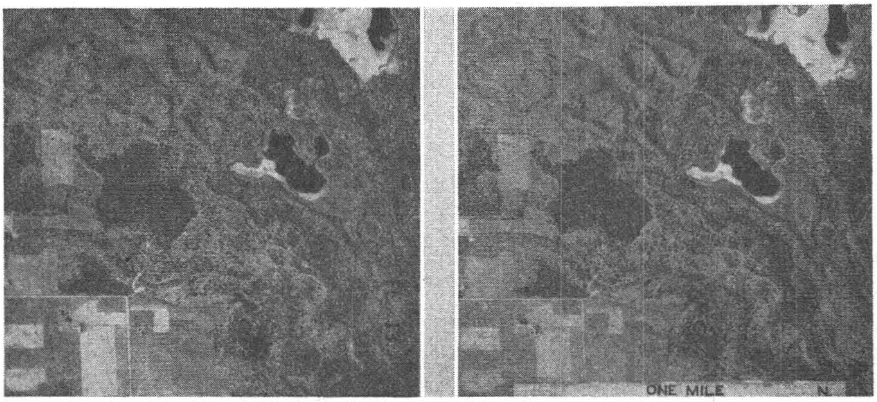

FIG. 3. Sandy outwash with both non-pitted and extremely pitted phases depending on number of ice masses present. Note sandy beds of some of the lakes and the general mottled appearance of the area. Narrow ridges of sand between kettles are crevasse fillings.

FIG. 4. Esker in plain of clay till. The ridges consist of gravel and sand. Note that they are not continuous so that gaps are a perplexing problem without the view from above.

ridges parallel to the ice front. Lakes in terminal moraine are irregular in outline with few sandy beaches and contain many bouldery islands. Outwash deposits which contained many residual ice masses (Fig. 3) have been mistaken for moraines in many ground surveys. From above, the sandy soil photographs in light tints and the many rounded kettles containing lakes and marshes give the landscape a mottled appearance. The example shown displays a cultivated area which is almost free from kettles, as well as a district where the ice masses lay so close together that the only outwash consists of narrow ridges often termed "crevasse fillings." When it is necessary to map an esker, or ridge of sand or gravel outside of an outwash deposit, the value of vertical aerial photographs is perhaps greater than in any other application to glacial geology. When an esker appears to end within a cedar swamp the photograph provides a final answer to the old conundrum of whether or not there is another section of the esker and, if so, in what direction it lies (Fig. 4). Photographs also aid in many other branches of the subject which are not illustrated here. Among these may be mentioned discrimination of thinly drift-covered rock hills, of shore lines and deposits of glacial lakes, erosion forms produced by glacial waters, in many localities before all the buried ice masses had melted to leave kettles, as well as of sand dunes on outwash plains, lake shores, and lake bottoms. Many photographs display curious soil mottling which is commonly not visible on the ground. In some cases the long-abandoned courses of glacial streams are obvious in the picture because the soil holds more moisture in these stream beds than under adjacent higher areas.

In making maps from the photographs a stereocomparator is most desirable, particularly if elevation data are needed and ground elevations have already been determined. Much information can be sketched directly from the pictures. In areas covered by a reasonably reliable public land survey the photographic data can be adjusted to fit section lines without need for radial line and ground control.

The photographs were supplied by the Wisconsin Highway Commission from Department of Agriculture surveys. All are from northeastern Wisconsin and have been previously published in the "Outline of Glacial Geology" by the present writer.

GEOLOGIC INTERPRETATION OF TRIMETROGON PHOTOGRAPHS—NORTHERN ALASKA

Sherman A. Wengerd

INTRODUCTION

The Problem

The U. S. Navy Department was authorized by Congress in 1944 to explore U. S. Naval Petroleum Reserve No. 4 in an attempt to develop quickly and efficiently the potential oil resources of northern Alaska (Foran—1946, p. 96). Initial Naval explorations in 1944 by Lieutenant Commander William T. Foran, who had in 1923 mapped parts of the Reserve as a geologist for the U. S. Geological Survey, resulted in reports of excellent seeps, reservoir rocks and adequate structure in the southeast part of N. P. R. No. 4.

The pressure of war, remoteness of the area, and difficulty of ground explo-