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Charles D. and Mary Vaux Walcott
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GEOLOGICAL BACKGROUND OF THE IYATAYET ARCHEOLOGICAL SITE, CAPE DENBIGH, ALASKA

(With Four Plates)

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INTRODUCTION

Iyatayet, a stratified archeological site at Cape Denbigh, Alaska (fig. 1), offers an exceptional opportunity to examine a sequence of human occupations against a background of fluctuating climate. Iyatayet is the discovery site and the type locality of the Denbigh flint complex, the oldest large assemblage of cultural remains thus far found in Alaska. The site was excavated by Giddings during 1948, 1949, and 1950. Hopkins visited the site for three days in August 1950.

The discovery and excavation of the Iyatayet site were important steps forward during the past 15 years in the study of early human history in Alaska. Detailed geologic investigations during the same period have clarified many aspects of the late Quaternary geomorphic and climatic history of the region. Until recently, however, little progress has been made in relating archeological sequences to a geologic and climatic chronology. The younger archeological sites have been occupied too recently to record notable geologic changes, and most of the older sites have lacked distinctive features upon which to base a chronology.

Many problems in the archeology and Quaternary geology of Alaska await the accumulation of additional evidence. A better understanding of the time relationship between archeological and geological events will assist in their solution. The precise dating of these events, the nature of the Alaskan environment during early periods of human history, and the nature and availability of routes for the spread of population at various times are among the problems whose solutions depend upon evidence to be gathered from both geological and archeological investigations.

Three culture layers at Iyatayet separated by sterile zones or sharp physical discontinuities record three distinct periods of occupation separated by long periods during which the site was abandoned (table 1). The deeper layers indicate by their character that they have been subject to soil movements and to soil-forming processes that are no longer active at Iyatayet. These layers record a sequence of climatic changes similar to known sequences in other regions in Alaska. Converging lines of evidence indicate that the earliest dwellers at Iyatayet lived during a warm period in Alaska more than 8,000 years ago and perhaps more than 12,000 years ago. The later dwellers lived during two periods in the past 2,000 years, and their deposits reflect minor climatic fluctuations in the Bering Sea region.

GEOGRAPHIC SETTING

Iyatayet is located on the west face of the Reindeer Hills, a few miles north of Cape Denbigh, Alaska (fig. 2). The Reindeer Hills are isolated bedrock hills, ranging in altitude from 700 to 1,000 feet, which form the western extremity of a peninsula jutting from the east coast of Norton Bay near the village of Shaktolik. On the landward side the hills slope gently eastward and merge into a poorly drained coastal plain which composes most of the peninsula. On the seaward side the hills terminate abruptly in rugged sea cliffs, 100 to 300 feet high, extending with only minor embayments from Cape Denbigh to Point Dexter.

The hills are drained by several straight, shallow valleys that enter Norton Bay between Cape Denbigh and Point Dexter. Most of these valleys have been truncated by the retreat of the sea cliffs, and the streams descend to the sea in cascades at the valley mouths. The largest stream, Iyatayet Creek, has excavated its valley apace with the retreat of the cliffs, and its valley floor is graded to present sea level (pl. 1). The Iyatayet site is at the mouth of Iyatayet Valley.

Bedrock of the Reindeer Hills consists of coarsely crystalline, banded, reddish-brown and light-gray marble.[1] The marble is tightly

[1] The Reindeer Hills are shown erroneously as basalt on Smith and Eakin's geologic map (1911, pl. 6) of southeastern Seward Peninsula. Small bodies of basalt possibly may be present, but none were seen by the writers.

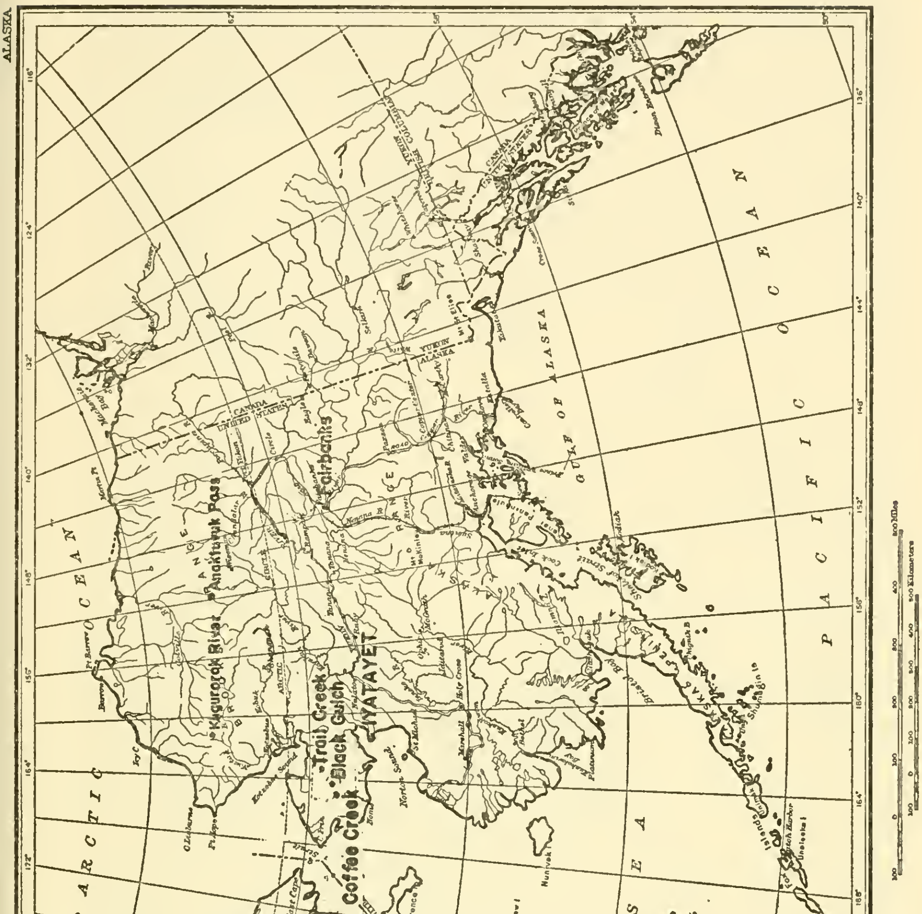

FIG. 1.—Index map of Alaska.

folded and is cut locally by large dikes of dense, dark, igneous rock largely altered to serpentine. Silt and peat 10 to 20 feet thick underlie the coastal plain to the east of the Reindeer Hills. At least 100 feet of sand and gravel is believed present beneath the silt and peat.

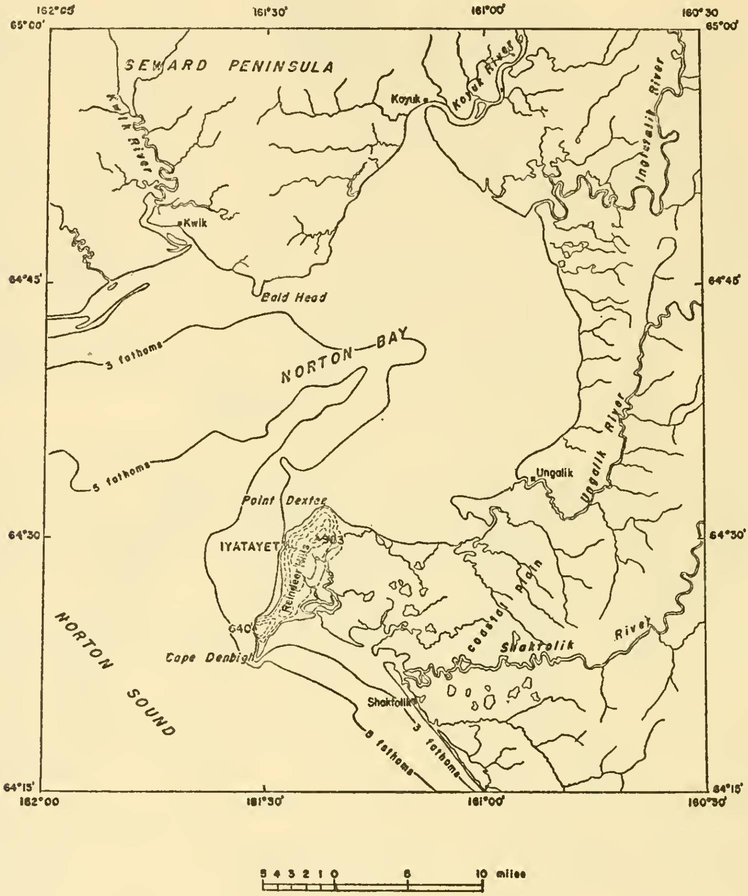

FIG. 2.—Map of Norton Bay area showing location of Iyatayet. After Norton Bay quadrangle, Alaska Reconnaissance 1 : 250,000 series, U. S. Geological Survey, 1951.

There is no evidence of glaciation in or near the Reindeer Hills during any part of the Quaternary.

Perennially frozen ground is present throughout the coastal plain east of the Reindeer Hills, except beneath lakes and streams. In the Reindeer Hills, perennially frozen ground probably is present beneath areas that slope less than 5° and that are mantled by more than 2 feet of turf, peat, or silty soil. It is lacking, however, beneath slopes as steep as the walls of Iyatayet Creek and beneath areas of exposed bedrock or rubble.

No weather records are available for the Reindeer Hills or for Shaktolik. Interpolation from weather records at Nome, St. Michael, and Nulato (U. S. Weather Bureau, 1943) indicates that the Reindeer Hills have a mean annual temperature of about 25° F. The mean precipitation is about 14 inches, of which about half falls during a well-defined rainy period from July through September. More than a third of the annual precipitation falls as snow.

GENERAL FEATURES OF IYATAYET VALLEY

Iyatayet Creek is a small, perennial stream about a mile long. The creek flows on bedrock in a sharply cut valley, the walls of which slope 10° to 15°. A narrow terrace 40 feet above the valley floor can be traced 1,000 feet upstream from the mouth of the valley (fig. 3). Farther upstream on the northeast valley wall is an area of irregular topography at approximately the same altitude as the terrace surface. The irregularities consist of semicircular benches 10 to 30 feet wide, separated from one another by steep fronts about 10 feet high. These features, termed lobate soil terraces or soil lobes (Sigafoos and Hopkins, 1952), formed at a time when the climate was colder. At present they are not active.

A dense stand of alders, 6 to 10 feet tall, covers most of the lower walls of Iyatayet Valley (pl. 1). The alder thickets are interrupted locally by small parklike areas in which there are dense stands of tall bunchgrass or open stands of dwarf birch, Alaska tea, blueberry, cranberry, and spirea. Sedges, *Equisetum,* and scattered small alders, arranged in stripes parallel to the slope, grow on poorly drained, gently sloping areas on the higher parts of the valley walls (upper left, pl. 1). Scattered spruce may grow elsewhere in the Reindeer Hills, but there are none in Iyatayet Valley.

The steep slopes of Iyatayet Valley are stable and free of solifluction or other types of mass movement today and have been for many centuries, as indicated by the lack of active soil lobes or other active frost features, by the wide distribution of an undisturbed soil profile at the surface, and by the continuous cover of large, healthy, undeformed alders. Solifluction probably is active, however, on higher, gentler slopes where drainage is poorer.

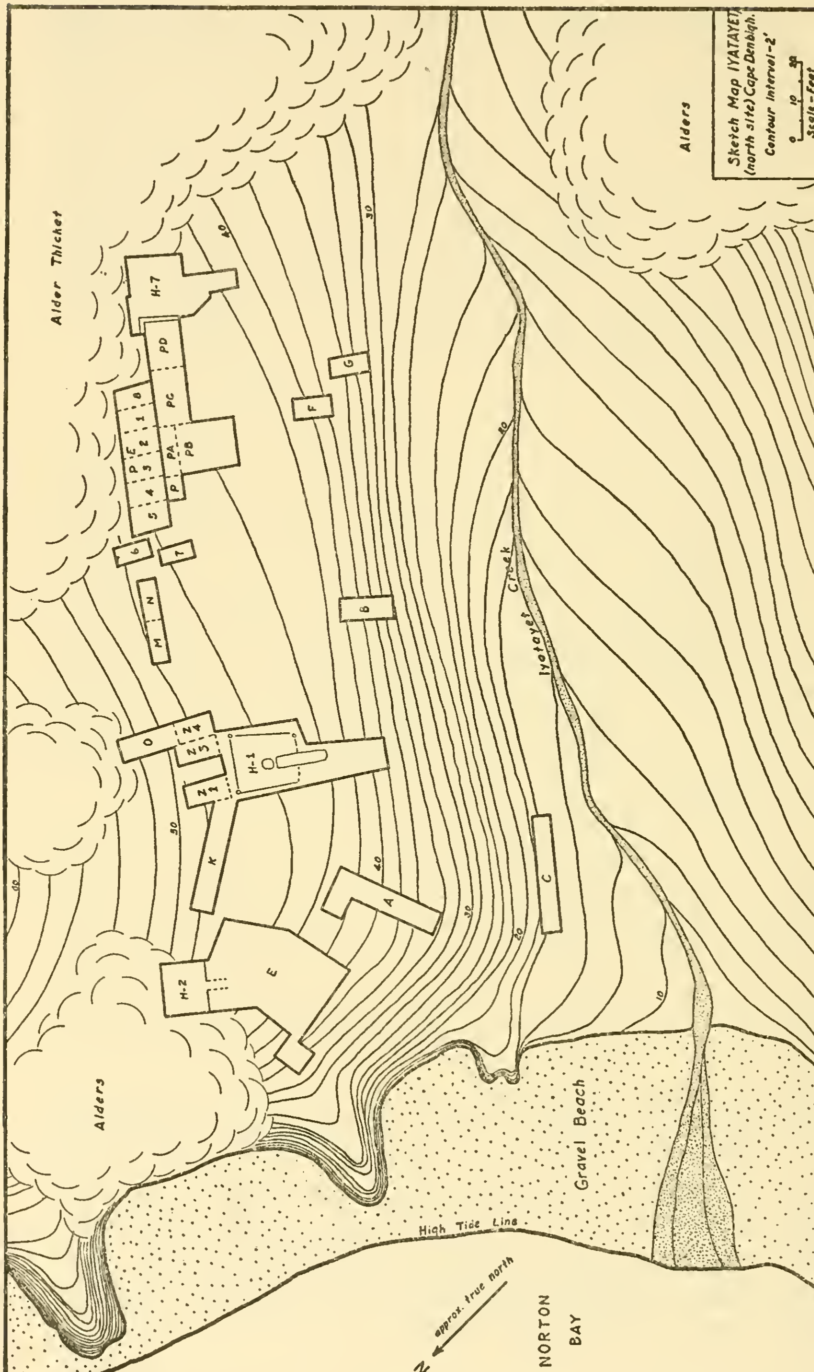

Fig. 3.—Sketch map of Iyatayet Valley. Mapped in 1950 and 1951 by J. L. Giddings. Datum is mean high tide. Numbered rectangles are excavations. H-1, H-2, and H-7 are recognizable Paleo-Eskimo houses. Widely spaced stipples are beach gravel, and closely spaced stipples are creek gravel.

GEOLOGY AND SOILS OF IYATAYET VALLEY

Bedrock of marble lies a few feet beneath the hill slopes above the terraces. It is mantled by residual weathered material consisting of angular fragments of marble in a matrix of sandy silt. The fine-grained matrix consists chiefly of the least-soluble minerals in the marble. Feldspars and unidentified alteration minerals predominate in samples examined by Hopkins; fine-grained muscovite is abundant; and quartz, apatite, tremolite, and diopside are present in small quantities. Calcite constitutes more than 95 percent of the bedrock but is scarce or lacking in the fine-grained matrix of the weathered mantle.

The 40-foot terraces on each side of the mouth of Iyatayet Creek are composed of similar weathered marble debris. The terrace fill is vaguely stratified and poorly sorted; individual fragments generally are subangular. The deposit shows little evidence of water or wave handling. It consists chiefly of material introduced into the valley bottom from the neighboring slopes by mudflow or solifluction during a past cold period, and thus may be termed congeliturbate (Bryan, 1946, p. 640). The apparent absence of turf or peat layers within the terrace fill suggests that accumulation was rapid and continuous.

The top of the congeliturbate in the terrace represents approximately the level of the bottom of Iyatayet Valley after the accumulation of the fill and before the present era of stream cutting (fig. 4). A layer of sandy silt up to 18 inches thick overlies the congeliturbate on the surface of the terrace and at many places higher on the valley slopes. An ancient soil profile is preserved at the top of the congeliturbate, beneath the sandy silt, but has been removed or masked by later soil-forming processes where the sandy silt is lacking (fig. 5).

The top of the buried soil is marked by a 1-inch layer of sticky, ashy-gray silt in which sand and rocks are lacking. The upper 2 or 3 inches of congeliturbate beneath the silt are stained yellow-brown, grading downward into pale yellow or light olive-gray. Marble fragments increase in abundance and freshness with increasing depth in the congeliturbate.

The ashy-gray silt superficially resembles volcanic ash. A sample examined by Theodore Woodward, U. S. Geological Survey Petrographic Laboratory, consists chiefly of unidentified alteration minerals. Muscovite and orthoclase feldspar are common; a few grains of quartz and hypersthene or enstatite were recognized. No volcanic glass or fragments of obvious volcanic origin were observed. All minerals present are present also in the underlying congeliturbate. The ashy-

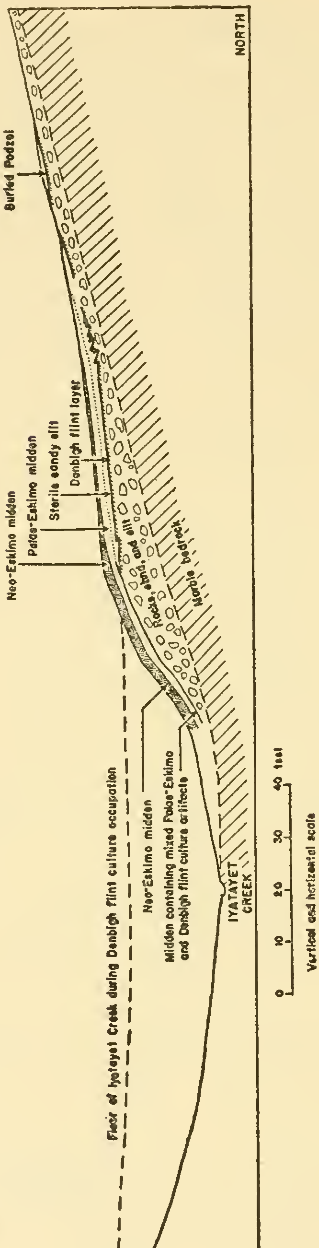

FIG. 4.—Diagrammatic cross section across Iyatayet Valley.

gray silt, therefore, is believed to be derived by weathering from the underlying congeliturbate.

The ashy-gray silt resembles the characteristic A_2 horizon of an ancient podzol. The underlying 2 or 3 inches of stained congeliturbate represent the B horizon. Kellogg and Nygard (1951, pp. 49-58) report similar but much thicker and better-developed podzol profiles at a few localities elsewhere in Alaska. A thick turf layer forms the A_1 horizon of modern podzols but has not been preserved in the buried

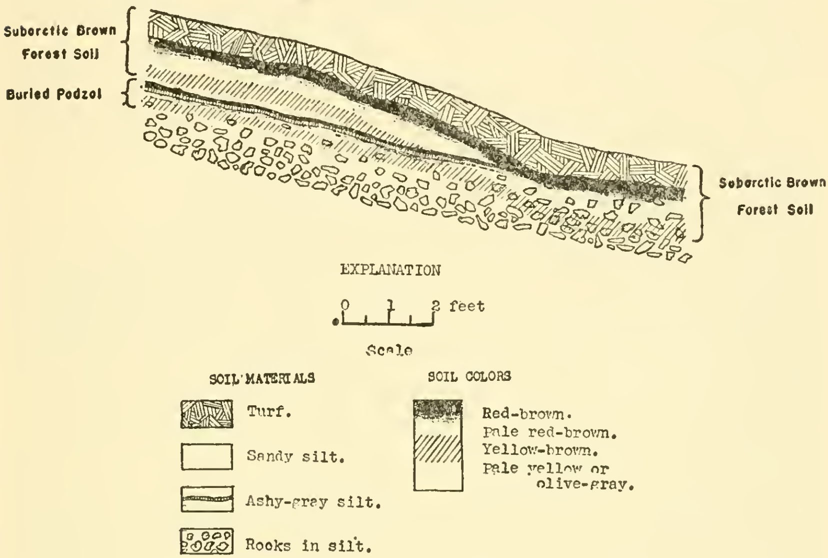

FIG. 5.—Diagrammatic sketch showing distribution and arrangement of soil layers in Iyatayet Valley. Ancient podzol is preserved in areas where it was later covered with a layer of silt (left) but has been destroyed by later soil-forming processes elsewhere (right). Left side of section is approximately 4 feet high.

soil at Iyatayet. The buried soil profile records a period of relatively warm climate and soil stability after the filling of the valley with the underlying congeliturbate and preceding the deposition of the overlying sandy silt during cold periods.

The sandy silt that overlies the buried podzol is similar in size grade and mineral composition to the matrix of the congeliturbate, but it is free of large rock fragments. Locally it is laminated; the laminae are contorted and range from one-eighth to one-half inch in thickness. A 2-inch layer of peat appears within the lower part of the silt in one of the archeological excavations (pl. 2), and a Subarctic Brown Forest soil profile appears beneath the peat.

The sandy silt consists mostly of material washed from the fronts of active soil lobes higher on the slopes of the valley during a cold period. Small fans of similar material appear below soil lobes active on Seward Peninsula at the present time. Upon thawing in spring the upper soil layers within the lobes become saturated with water. Underlying, still-frozen soil prevents excess moisture from percolating deeper, and a stout turf mat retards lateral drainage. Part of the excess water eventually escapes through open, fibrous parts of the turf, carrying with it a load of silt and fine sand. Rocks are retained within the lobe by the turf. The sand and silt then are deposited on lower, gentler slopes (fig. 7).

Wind-blown sand and silt, derived from beaches and coastal dunes at a time when sea level was lower and the strand line lay at least several miles from the Reindeer Hills, may be included in the sandy silt layers, as well as in the underlying congeliturbate.

A well-developed soil profile similar to the widespread Subarctic Brown Forest soil in interior Alaska described by Kellogg and Nygard (1951, pp. 49-58) appears beneath the surface turf throughout most of Iyatayet Valley. The profile is developed in sandy silt, congeliturbate, or earthy midden, wherever these materials are near the surface. Similar soil profiles are found beneath ground levels buried by midden and beneath the peat layer enclosed in the sandy silt (pl. 2).

The soil profile generally consists of a layer of turf 4 to 8 inches thick, underlain by 5 to 8 inches of rocky mineral soil deeply stained reddish brown and containing a considerable admixture of organic material. At greater depth the mineral soil grades in color through yellow-brown into pale yellow or light olive-gray. Marble fragments are scarce and deeply weathered in the upper reddish-brown zone, where the profile is developed in congeliturbate, but rocks increase in abundance and freshness at greater depth (fig. 5, right side).

Kellogg and Nygard's schematic soil association map of Alaska (1951) indicates that tundra soils predominate on the east coast of Norton Bay. Tundra soils undoubtedly are present in less well-drained sites, but the surface soils in Iyatayet Valley resemble more closely the Subarctic Brown Forest soil.

The Subarctic Brown Forest soil profile at the surface has developed since active soil movements ceased on the slopes of Iyatayet Valley. The similar buried soil profile near the base of the sandy silt in pit Z-4 (pl. 2) may record another period of warm climate and soil stability that interrupted the accumulation of sandy silt after the buried podzol was developed.

THE IYATAYET ARCHEOLOGICAL SITE

Iyatayet Valley has been occupied by human beings during three distinct periods (table 1). Evidence of occupation is found on the surface and slopes of the terrace remnants on each side of the valley. Cultural remains of the earliest period have been termed the Denbigh flint complex (Giddings, 1951) and include a few artifacts similar to those found at several sites of seemingly great age in the interior of Alaska (Giddings, 1950; Irving, 1951; Solecki, 1951). The Denbigh culture layer is overlain by a sterile layer of sandy silt, and then by

TABLE 1.—*Summary of archeological and geological features of Iyatayet Valley*

I Archeological sequence	II Geological sequence	III Assumed climate
	Grass turf, alder roots, and Subarctic Brown Forest soil profile in underlying material	Like present
Neo-Eskimo occupation	Midden with well-preserved organic material	Like present
Paleo-Eskimo occupation	Midden with poorly preserved organic material and Subarctic Brown Forest soil profile in underlying material	Warmer than present
	Sandy silt	Cold
	Peat and Subarctic Brown Forest soil profile in underlying material	Like present
	Sandy silt and folds in Denbigh flint layer	Cold
Denbigh flint culture	Podzol soil profile. Almost no recognizable organic material	Warmer than present
	Rocky congeliturbate	Cold

a layer containing objects characteristic of the widespread Paleo-Eskimo culture (Ipiutak of Larsen and Rainey, 1948; Bristol Bay of Larsen, 1950) of the Bering and Arctic coasts of Alaska. This is overlain in turn by a layer containing Neo-Eskimo material. Grass turf 4 to 18 inches thick covers the youngest, Neo-Eskimo part of the site; the remainder is covered by large alders.

THE DENBIGH CULTURE LAYER

The Denbigh flint complex is found in place on the terrace on the northeast side of Iyatayet Creek. The culture layer lies above the ashy-gray layer of the buried podzol and is overlain by sandy silt.

Gaps in the layer caused by soil movements are found near the inner edge of the terrace. Filled excavations and house sites of the Paleo-Eskimos interrupt the continuity of the layer elsewhere on the terrace surface. The flint layer ends abruptly near the front edge of the terrace and is replaced on the steep foreslope by a diffuse zone of mixed Denbigh flint and Paleo-Eskimo material (fig. 4). The Denbigh flint material in the mixed zone probably consists of material encountered in house excavations and thrown over the terrace scarp with other refuse by Paleo-Eskimos.

Cultural material of the Denbigh flint complex consists of sparsely distributed flint flakes and artifacts (chert, obsidian, and chalcedony, in order of their abundance) pressed flush against the buried podzol. Neither these nor the small beach pebbles and angular marble fragments found in some parts of the layer are intruded into or below the underlying ashy-gray silt. Recognizable organic remains are extremely scarce and consist of tiny fragments of charcoal and decomposed bone. No house floors or tent rings have been recognized, but a series of five hearths, roughly in line, have been uncovered at the upslope edge of the terrace. Four of the hearths are shown on figure 6.

The distribution of cultural material in the Denbigh culture layer, pressed flush against the surface of the buried soil, is open to two interpretations. The site may have been occupied only during winter, when the ground was frozen to the surface and was too hard to allow stones or wood to penetrate under the pressure of human feet. If this were the case, however, it is difficult to understand why the stones of hearths and the ground around these obviously fire-exposed areas also should be limited by the underlying dense soil. A more appealing interpretation would be that the campers at Iyatayet left their hearths and flinty materials on top of a sod cover, the organic parts of which have long since decomposed and disappeared. Occupation would then be limited to no particular season, but probably would be limited to rather brief visits. Under continuous occupation the protecting turf layer should have been broken, permitting penetration of artifacts into the soil, as occurred during the later Paleo-Eskimo occupation.

Nearly 1,500 artifacts have been found in the Denbigh culture layer. The collection is characterized by tools and techniques that, with few exceptions, bear little resemblance to cultural materials generally recognized as Eskimo (Giddings, 1951).

Burins, or "gravers" in the European sense, and their spalls discarded in sharpening comprise about a quarter of the Denbigh flint collection (Giddings, 1951, figs. 59a, 60a). Burins apparently had not been recognized elsewhere in America before the excavation of Iyata-

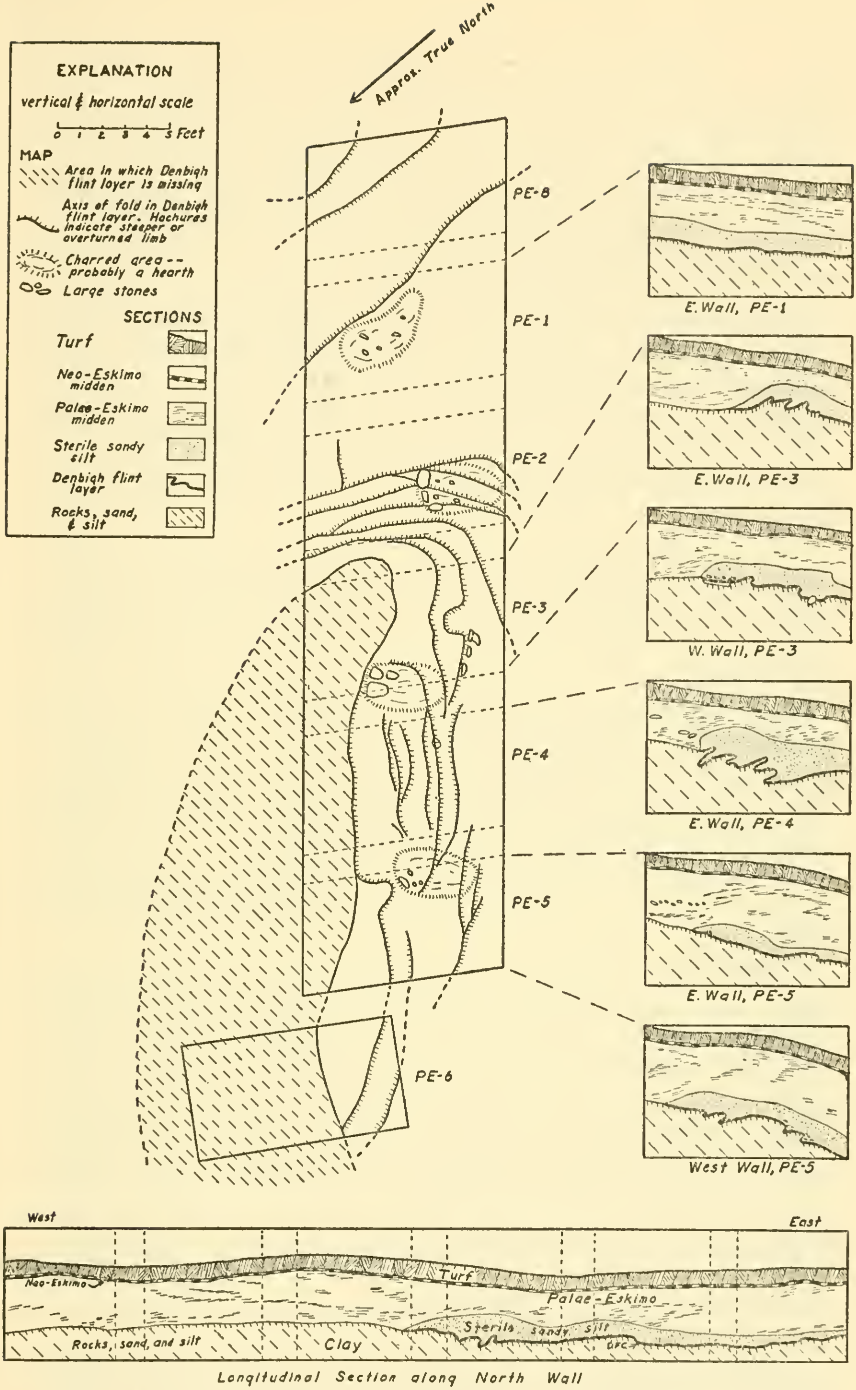

FIG. 6.—Map and cross sections showing folds in the Denbigh culture layer in pits PE-1 through PE-8. Note large gaps where Denbigh culture layer is missing upslope from folds (lower left part of map). A well-defined turf layer separates the Paleo-Eskimo and Neo-Eskimo middens in many parts of the site but is lacking in the area shown here.

yet. A variety of forms are present, several of which fall into types known from the Aurignacian and later periods of European pre-history. Referable to the same periods and places are a few other special forms found at Iyatayet, including keeled scrapers, flake knives, and gravette-like blades (op. cit., fig. 59b).

Lamelles and cores—microlithic blade developments known as early as the late Paleolithic, and with a geographic spread that includes large parts of Eurasia and Africa—comprise more than half of the collection (Giddings, 1951, fig. 61b). These have been reported previously from a few other sites in America. Many of the small blades at Iyatayet have been carefully pressure-flaked diagonally to produce the most delicate and elaborate microlithic forms known to the authors.

Several points or blades (Giddings, 1951, fig. 60), a form of "channeled" scraper (op. cit., fig. 62), and a single graver (op. cit., fig. 59b) resemble forms found in "Yuma" [2] and Folsom sites of southwestern United States so closely that there can be little doubt of technological relationship.

A few other blades and scrapers are unique at Iyatayet, and still others are of a generalized nature that renders them presently unclassifiable. Short, wide, and thin blades with concave bases (Giddings, 1951, fig. 64) closely resemble specimens found hafted as sealing harpoon blades at Ipiutak (Larsen and Rainey, 1948). A bit of birch bark that appears to have been part of a lashed or sewn vessel constitutes the only recognizable organic artifact recovered in the Denbigh flint layer.

Assemblages of artifacts in the Denbigh flint complex tradition have been found in the Kugurorok River Valley (fig. 1) in the eastern part of the Brooks Range (Solecki, 1951), in Anaktuvuk Pass in the central part of the range (Irving, 1951), and near the Anaktuvuk River at the north front of the range (Solecki and Hackman, 1951). The Kugurorok River site occupies glaciated bedrock knolls, and the Anaktuvuk River site occupies unconsolidated deposits of glacial origin. The Anaktuvuk Pass site undoubtedly also lies within a glaciated area. These sites were not necessarily covered with ice, however, during the latest glacial advance in the Brooks Range. At least four distinct Pleistocene ice advances, each less extensive than its predecessor, are

[2] This term is used here in the sense generally understood by archeologists to include several forms and techniques of early-man flint work. Although "Yuma" is in current disfavor, it has not been replaced by a similarly comprehensive term.

recognized farther east by R. F. Detterman, of the U. S. Geological Survey (personal communication).

Hopkins examined air photos of the Anaktuvuk River site. The morainal ridges upon which the site is found appear similar in degree of modification and dissection to morainal ridges deposited during the second of the three glacial advances recognized by Detterman. The other two sites at which Denbigh cultural material is found may also be in areas that remained ice-free during the latest glacial advance in the Brooks Range. Solecki (1951) states that "the fact that these early manifestations were found in glaciated areas conclusively points out that these sites were occupied within post-glacial times." On the basis of present knowledge, however, it can only be said that the sites are younger than an early glacial advance; they are not necessarily younger than the latest Pleistocene glacial advance.

Cultural material comparable with, but believed by the writers to be younger than, the Denbigh flint complex characterizes the lower levels of stratified cave deposits excavated by Helge Larsen at Trail Creek, Seward Peninsula (fig. 1). Mesolithic and early American traits, including core and microblade, diagonal flaking, and "Yuma"-like points, are common to the lower levels at Trail Creek and to the Denbigh flint complex at Iyatayet. The Paleolithic traits of the Denbigh flint complex, including burins and spalls, are completely lacking, however, at Trail Creek. These relationships suggest that no part of the Trail Creek sequence known at present is as old as the Denbigh flint complex at Iyatayet.

A carbon-14 analysis of willow stems collected in one of these lower levels at Trail Creek, but not definitely associated with cultural material, gives an age of $5{,}993 \pm 280$ years (Johnson, 1951, p. 16).[3] Because of the abundant sources of sample error in carbon-14 analyses, data obtained from single samples must be treated with extreme caution (see discussion of sample error in Flint and Deevey, 1951, pp. 259-260; and Bartlett, 1951). If, however, future analyses confirm the age of the lower part of the Trail Creek sequence, one may assume that the Denbigh flint complex at Iyatayet is older than 6,000 years.

The so-called "Siberian Neolithic," a widespread cultural horizon known from the Ural Mountains to the Lena River, contains flint

[3] A sample of charcoal from the Denbigh flint layer was submitted for age analysis at the end of the 1951 field season. When this sample was found too small for reliable use, a special trip to Iyatayet was scheduled for the 1952 field season. Aided by Alex Ricciardelli, Giddings obtained charcoal enough for more than one analysis from the Denbigh flint layer, from which carbon-14 dates are anticipated in the near future.

traditions strongly suggestive of connectives both with the Denbigh flint complex and with later Paleo-Eskimo flint developments in Alaska. Briefly, the Siberian Neolithic includes microblade and core industry, diagonal flaking, pottery in abundance and variety, and well-preserved bone and other organic material. Microburins are reported at the Kullata site near Yakutsk (Okladnikov, 1950) but are lacking at other sites. According to Grigoriev (1950, p. 177), Okladnikov believes that the Kullata site was occupied during a warm, dry period 4,000 to 6,000 years ago; other Siberian Neolithic sites are assigned dates by Okladnikov and others of 6,000 to 3,000 years ago.

Full discussion of the relationships between the Siberian Neolithic and cultural horizons represented at Iyatayet is reserved for a later paper by Giddings. For the present it may be said that the Siberian material appears to the authors transitional between the Denbigh flint complex and the Paleo-Eskimo culture and that the Siberian Neolithic is believed to represent a later culture than the Denbigh flint complex.[4]

The several lines of archeological evidence described above indicate a considerable antiquity for the Denbigh flint complex. With the exception of the probable harpoon blades, none of the artifacts can be considered characteristically Eskimo, and thus a profound separation from later, Eskimo cultures is indicated. Many of the tools and techniques of the Denbigh flint complex are found typically in United States and Old World sites occupied prior to the "postglacial" thermal maximum; some of these distant sites were occupied still earlier in the last (Wisconsin or Würm) glacial stage. The traits common to the Denbigh flint complex and to ancient sites in the Old World or the United States are so distinctive and so unlikely to have been invented twice that one must assume that the Denbigh flint complex is in a direct line of heritage with these far-distant sites. The archeological evidence argues strongly for an age greater than that of the thermal maximum as recognized in the United States, believed to have begun about 6,000 years ago (Flint and Deevey, 1951, p. 258), and may permit an age greater than that of the Mankato substage of glaciation, believed to have reached its climax between 8,500 and 11,000 years ago (op. cit., pp. 261-267; Schultz, Lueninghoener, and Frankforter, 1951, pp. 34-36). Geological evidence, summarized in

[4] The authors acknowledge with full respect the views expressed in writing and in conversations by Profs. H. L. Movius, Jr., and Lauriston Ward that more resemblances to the Denbigh flint complex appear in the Siberian Neolithic horizons than in known sites of the east Asiatic upper Paleolithic, and recognize in these views a difficulty of correlation with the dating herein proposed.

a later section, indicates that the Denbigh culture layer at Iyatayet was deposited during a warm period at least 8,000 years ago and possibly more than 12,000 years ago.

FOLDS IN THE DENBIGH CULTURE LAYER

Complex folds with axes approximately parallel to the surface contours disturb the Denbigh flint layer in several parts of the site (pls. 2 and 3). The folds are best developed near the base of the steep bedrock slope at the inner edge of the terrace, but gentler folds are noted elsewhere (fig. 4). Involved in the folds are the upper part of the congeliturbate, the ashy-gray silt, the Denbigh culture layer, and at least part of the sterile sandy silt. The folds are not reflected at the surface or in any part of the Paleo-Eskimo layer.

Axes of the folds are broadly arcuate and convex downslope. Individual folds decrease in amplitude laterally and fade out a few tens of feet from the point where they are best developed. A younger set of folds in one part of the site appears superimposed upon an older fold (pit PE-2 in figure 6).

The folds are asymmetric or overturned, with the steeper or overturned limb on the downslope side. Thin beds retain their continuity unbroken within the folds, but upslope from each set of folds are found gaps several feet wide in which both the Denbigh culture layer and the ashy-gray silt are missing. Flint chips and stones pressed flush against the lower surface of the Denbigh layer faithfully reflect the attitude of the layer, being horizontal and above the ashy-gray silt on the upslope limbs, vertical at the crests of the folds, and tilted beneath the ashy-gray silt on the overturned limbs.

The folds in the Denbigh culture layer formed in the course of development of soil lobes in the overlying sandy silt (fig. 7) during a cold period long after the early occupation ended. Active soil lobes studied by Sigafoos and Hopkins (1952) creep downslope during late spring, when the thawed soil near the surface is saturated with meltwater. At deeper levels the soil remains frozen in position and cannot partake of the surface movements. Differential heaving during the fall freezing season results in similar differential movements (op. cit., fig. 1). Shear resulting from frictional drag between mobile, saturated, sandy silt above and immobile, frozen, rocky debris below produced the intricate folds in the Denbigh culture layer. The remarkable continuity of distinctive zones throughout the folds indicates that the movements were slow, perhaps totaling a few inches each year. During the folding, the total downslope length of the area occupied by

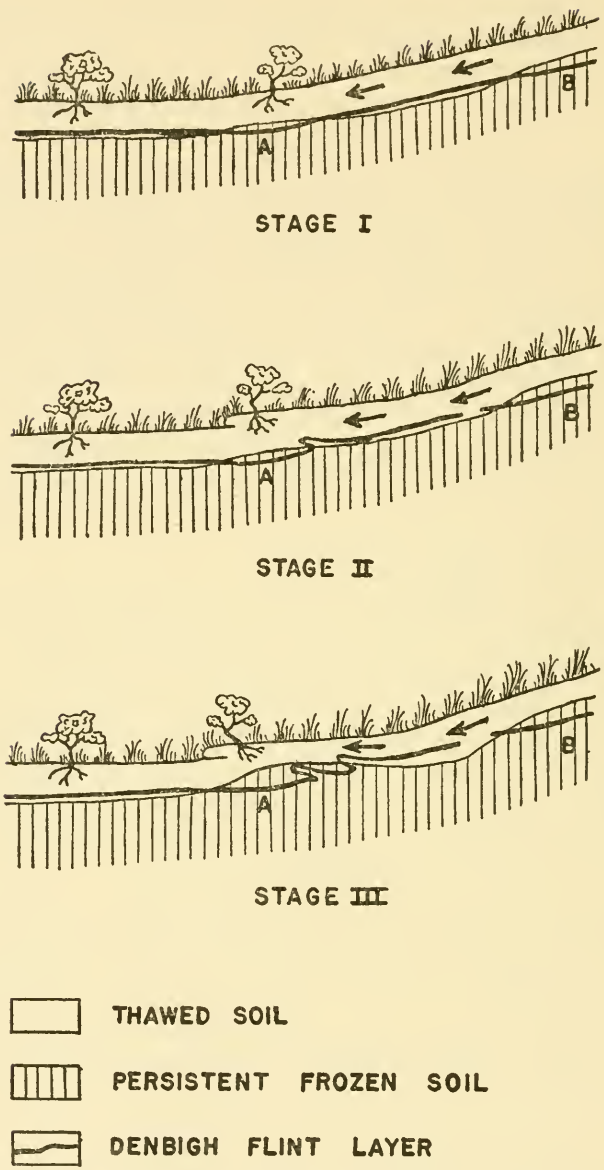

FIG. 7.—Development of folds in the Denbigh culture layer by creep and solifluction. *Stage 1:* Ground thaws during late spring but frozen ground is still present below the surface. Denbigh culture layer is thawed in most places but locally is anchored firmly in frozen ground (A). *Stage 2:* Saturated surface layer creeps downslope, forming soil lobe. Thawed part of Denbigh culture layer overrides part of layer still anchored in frozen ground (A). Gap forms upslope from fold, downslope from another area where Denbigh culture layer is frozen (B). *Stage 3:* Front of soil lobe advances, overriding surface turf, during spring in a later year. Additional folds are formed in Denbigh culture layer and gap widens where layer is missing. Note tilted shrub with roots trailing upslope.

the Denbigh flint layer was shortened. This shortening was compensated by the formation of gaps in the layer upslope from the folds. The peat layer found within the sandy silt in one pit probably is a remnant of the strong turf cover that retained the soil lobes.

THE PALEO-ESKIMO LAYER

Remains of the Paleo-Eskimo culture are found in a layer 18 to 36 inches thick on the top and steep foreslope of the terrace on the northeast side of Iyatayet Creek. The Paleo-Eskimo layer fades imperceptibly at its lower boundary into the sterile sandy silt that covers the Denbigh flint layer. A layer of grass sod locally separates the Paleo-Eskimo zone from the overlying Neo-Eskimo layer, but in some places the two layers are in direct contact. They are distinguished easily, however, by a sharp break in the degree of preservation of organic matter.

The Paleo-Eskimo layer generally consists of a rich, red-brown or light yellow-brown mixture of humic material and silty soil, but in some places it consists of soft, friable, black, peaty material. In many parts of the site, one or more former ground levels can be distinguished. Paleo-Eskimo artifacts are found in the sandy silt beneath the buried ground levels in attitudes suggesting that they have been thrust or tramped into the ground. Cross-bedded middens are found above the buried ground levels. One house and several charred areas have been recognized. Many filled excavations are present (pl. 2); some of these extend below the Denbigh culture layer.

The Paleo-Eskimo cultural material consists of stone tools, pottery, beach pebbles, angular marble fragments, charcoal, and abundant but poorly preserved organic material. Hard, firm bone, antler, and ivory are rare; generally these materials are preserved as small, friable fragments of about the same consistency as the enclosing sandy silt. Shells are abundant, but only the papery, chitinous cover of the limy valves can be recovered. Wood generally is represented by a few limp fibers or by a humic stain in the enclosing silt and sand. Rarely a recoverable log is found.

In striking contrast with the Denbigh flint complex, the Paleo-Eskimo layer contains the sorts of household equipment, tools, and weapons commonly associated with Eskimo developments locally and Neolithic developments in other parts of the world. Stone lamps of a triangular, "sadiron" shape, as well as of irregular forms, have been pecked out of igneous or metamorphic rock in relatively large numbers. Smaller stone vessels of teacup and soap-dish size and shape may have been mortars and paint dishes rather than lamps. Thick pottery vessels were occasionally made in crude imitation of stone lamps, but the great bulk of potsherds collected were those of thin, well-fired cooking pots. The pots had been either round or conical-based or flat-based, and had been imprinted over all the outer surface with striations or small check-stamps. Cord markings appear on a few sherds, and two or three vessels represented in the collection were treated on the outer surface only by smoothing. All in all, the methods of treating this pottery are in keeping with upper Neolithic practices in Asia and with Woodland and other traditions of earliest pottery making in the eastern United States.

The grinding and polishing of slate to be seen on blade fragments are in no case as refined as are these techniques on Neo-Eskimo artifacts. Heavy scratches characterize the semilunar and other knife blades of the Paleo-Eskimos. A finer polishing distinguishes the tongue-shaped, partly chipped adz blades and the long, medial labrets of stone and jet that also are found in the Paleo-Eskimo deposits. A polished form of small, hard stone implement appears to be a cutter or groover to be used in the manner of a burin; it is fairly numerous, and is characterized by the meeting of two planes at nearly right angles at one narrow edge. Adz blades, labrets, and burinlike instruments are made of highly silicified slate or other materials that could be prepared by conchoidal flaking. Whetstones of several shapes and grain sizes as well as fragments of larger grinding stones appear in both Paleo-Eskimo and Neo-Eskimo deposits, but are lacking in the Denbigh flint complex.

The flinty materials chosen by the Paleo-Eskimo were mainly basalts and silicified slates—materials almost totally lacking in the Denbigh flint complex. They were skillfully handled, however, and furnished a base for most of the weapon points and other blades. Some use was made of chert and obsidian, but it is often difficult to determine which of the objects made of these materials belong to the middle levels and which were displaced from underlying disturbed sections of the Denbigh flint layer.

The few objects of organic materials obtained from these levels are, in almost all cases, relatable to pieces from the Near Ipiutak[5] houses and middens at Point Hope. These include harpoon heads of two types, arrowheads slotted for side blades and for end blades, bone

[5] Larsen and Rainey (1948) recognized the contents of a few isolated house and midden deposits in Point Hope as distinct from Ipiutak culture materials, though closely related. They named this aspect "Near Ipiutak" but were unable to say with certainty whether it represented an earlier or a later stage of culture.

and ivory awls or marlinespikes, ice picks, flaking hammers, and an engraving tool. Engraved decoration is lacking. A single crude, armless "doll" of ivory has a long trunk and an oval head, but lacks facial features.

All in all, the materials obtained from the Paleo-Eskimo levels at Iyatayet show close identity with those from Near Ipiutak at Point Hope, and much less similarity to those from Ipiutak proper.

No part of the Paleo-Eskimo site is perennially frozen, and the poor preservation of organic material indicates that it has not been perennially frozen during most of the time elapsed since the period of Paleo-Eskimo occupation. Small-scale plications in charcoal lenses characterize the deeper parts of the Paleo-Eskimo layer, below old ground levels. Some of these were produced by the formation and destruction of clear ice lenses during annual cycles of freezing and thawing; others were formed by local slumping as wood and other organic material in the soil rotted away. Still others probably resulted from the pressure of tramping feet when the ground was wet and soft each spring. Large-scale folds, comparable with those involving the Denbigh culture layer, are lacking. A Subarctic Brown Forest soil appears to have developed beneath Paleo-Eskimo ground levels, indicating that the soil was relatively stable and immobile. Additional quantities of sandy silt, however, were washed into some parts of the site. Some of the silt may have been introduced during brief cool periods when soil lobes formed higher on the slope, but most of the added sediment probably was derived from paths, dog holes, and other artificial bare areas. Intrusion of Paleo-Eskimo artifacts below the surface on which they lived indicates that occupation continued for long periods, through summers as well as winters. Carbon-14 analysis of a charcoal sample indicates that an older part of the Paleo-Eskimo zone at Iyatayet is 2,016±250 years old; a younger phase is 1,460±200 years old (samples 563 and 506—Johnson, 1951, pp. 15-16).

THE NEO-ESKIMO LAYER

Deposits of the Neo-Eskimo culture are found on both sides of Iyatayet Creek, on the steep slopes as well as the surfaces of the terraces. The culture layer is found immediately below the surface sod. A well-defined sod layer underlies much of the Neo-Eskimo midden and separates it from the deeper Paleo-Eskimo layer. The culture layer ranges from a few inches to 6 feet in thickness and consists of peaty, dark-brown to black midden material. Parts of the midden are perennially frozen, although underlying Paleo-Eskimo midden is thawed. The midden shows no evidence, however, of disturbance by frost action.

Organic materials, including bone, antler, ivory, and bivalve shells, are abundant and well preserved. Wood is abundant but is generally soft and friable. Some logs are fresh enough, however, to permit cutting sections for tree-ring study.

All the later deposits at Iyatayet contain sparse cultural materials displaced from older levels. This is to be expected in any village or camp site that lies above another, not only because of the Eskimo practice of digging house and cache pits, but also because of a curiosity and archeological bent of many individuals such as may be seen among Eskimos living in the area today. No doubt the Paleo-Eskimos were as keenly interested in the microlithic work of the earliest inhabitants of the site as are the Neo-Eskimos of the present day in all the curious early workmanship. The earlier artifacts are readily distinguished, however, in the deposits of the Neo-Eskimos. This is partly because of a difference in tradition of style and workmanship between the two periods. A more definitive aid in separating the later deposits at Iyatayet, however, is Giddings's excavation of a pure Neo-Eskimo site, Nukleet, on the south side of Cape Denbigh (Giddings, 1949). Several thousand artifacts from the Nukleet site delineate a sequence of stylistic changes that affords a rather complete picture of the Neo-Eskimo in the Cape Denbigh region during their period of occupation. Dendrochronological studies indicate that occupation extended from about A.D. 1100 to 1600 (op. cit., p. 86).

The Neo-Eskimos were a fishing, sealing, caribou-hunting people whose dependence on the inland, forested regions nearby is attested by their extensive use of beaver teeth as knives, their use of birch bark as containers, and their extensive use of antler. An enumeration of their other artifacts is in preparation; we may note, however, that their cultural balance seems much like that of present-day Eskimos living at points along the northeastern Bering Sea.

LATE QUATERNARY HISTORY OF IYATAYET VALLEY

CLIMATIC SIGNIFICANCE OF FEATURES OF IYATAYET VALLEY

A series of changes in climate and in the position of sea level may be inferred from the geologic and archeologic deposits in Iyatayet Valley (table 1). The recognized history begins with the carving of the bedrock valley. Because the bedrock valley is graded approximately to present sea level, one must assume that sea level stood near its present position at that time. The climate probably was not colder than at present.

A subsequent period of valley filling during an interval with cold climate is recorded by the 40-foot terrace. Lack of rounding and the unsorted character of the debris indicate, in this region, that the fill consists of congeliturbate introduced from neighboring slopes by solifluction during a period of intense frost action. The lack of wave-handled material in the terrace fill and the absence of elevated wave-cut rock terraces elsewhere along the rugged coast between Cape Denbigh and Point Riley indicate that sea level stood no higher during the deposition of the congeliturbate than it does at present. Instead, sea level is believed to have been lower. The shore line probably shifted several miles—perhaps several hundred miles—across the flat floor of Bering Sea away from the Reindeer Hills.

Iyatayet Creek was unable to transport all the load furnished by solifluction on the valley walls, and the valley was filled to a depth of 40 feet. The fill probably extended as an alluvial fan beyond the mouth of the valley across the dry floor of Iyatayet Cove.

Valleys draining the hills between the Koyuk and Kwik Rivers, 40 miles north of Cape Denbigh (fig. 2), resemble Iyatayet Creek after its valley was filled with congeliturbate. Minor streams within the hills in the Koyuk-Kwik area meander across flat, debris-choked valley bottoms (pl. 4). Longitudinal profiles of the valleys are steep. The streams debouch onto adjoining coastal lowlands across broad debris fans similar to that inferred at the mouth of Iyatayet Creek. A small rise in sea level in the Koyuk-Kwik area would subject the unconsolidated fans to erosion by waves and longshore currents, and the fans would be removed rapidly to the edges of the bedrock hills. Stream gradients at the mouths of the valleys would be steepened, and the streams then would re-excavate the valleys, leaving remnants of the valley fill as terraces like those in Iyatayet Valley.

The podzol soil profile, developed in the congeliturbate during a warm interval while Iyatayet Valley was occupied intermittently by people of the Denbigh flint culture, records a brief but important interruption in the filling of the valley. The profile indicates a period of soil stability during which soil movements ceased on the adjoining slopes, to be resumed when the podzol with its included artifacts was buried and folded beneath sandy silt washed in from the walls. The precise climatic significance of the podzol is uncertain. Podzols are most widely distributed in Alaska in areas with a warmer summer temperature than that in the Norton Bay region, but Subarctic Brown Forest soils are abundant in the same areas (Kellogg and Nygard, 1951, pp. 51-83). It seems certain that the climate of the interval during which podzol formed at Iyatayet was at least as warm as, and possibly slightly warmer than, the present climate. The shallow depth of profile development suggests that the warm period was brief compared with later intervals during which Subarctic Brown Forest soils were formed.

The sandy silt that covers the Denbigh culture layer marks the return of a cold climate that terminated the development of the podzol. Renewed intense frost action reactivated soil lobes higher on the valley slopes. Silt washed from the advancing soil lobe fronts was deposited lower on the slopes and on the terrace surface, which at that time still formed the valley bottom. The buried podzol, the Denbigh culture layer, and part of the sandy silt were tightly folded as soil movement progressed.

The thin peat and underlying Subarctic Brown Forest soil exposed in pit Z-4 probably record a warm interval that interrupted the prevailingly cold period during which the sandy silt was deposited. Because this buried profile appears in only one of the many good exposures of the full thickness of the sandy silt layer, it could be considered to have formed in a local area of stable soil at a time when solifluction was active in adjoining areas. Poorly drained silt, however, is particularly subject to frost heaving. Stirring due to frost heaving prevents the formation of a stratified soil profile in silt underlain at a depth of 2 or 3 feet by perennially frozen ground on Seward Peninsula (Hopkins and Sigafoos, 1951, pp. 61, 63). The sandy silt in which the buried Subarctic Brown Forest soil appears lies at the base of a slope in a position where, if perennially frozen ground were present, it would maintain a high water content throughout most of the year. It is extremely unlikely that any part of the sandy silt on the old valley floor of Iyatayet Creek would have remained sufficiently stable to permit formation of a well-developed Subarctic Brown Forest soil profile during a period when frost action was intense a few feet away. Consequently, the buried soil exposed in pit Z-4 is believed to have formed during a warm interval, when soil movements ceased throughout Iyatayet Valley. The profile probably developed in the sandy silt throughout the valley but was obscured by frost stirring during the ensuing cold period except in areas where it was later buried by an exceptionally large thickness of sandy silt.

Deposition of the sandy silt was terminated finally by the period of warmer climate that has extended with only minor fluctuations to the present. Sea level rose and the shore line approached its present position. The alluvial fan assumed to have covered the floor of Iyatayet Cove was removed by waves and longshore currents. Iyatayet Creek re-excavated its valley to bedrock, leaving remnants of the valley fill as terraces. Well-developed soil profiles beneath Paleo-Eskimo ground levels indicate that soil movements had ceased and that a warm climate had prevailed for a long time prior to Paleo-Eskimo occupation.

A minor climatic fluctuation during the past 2,000 years is suggested by the difference in preservation of organic material in Paleo-Eskimo and Neo-Eskimo middens. The Paleo-Eskimo midden is earthy, but friable fragments of bone and antler and soft fibers of wood testify to a former abundance of organic material now largely rotted away. The Neo-Eskimo midden, on the other hand, is peaty in character; organic material is well preserved and makes up much of the bulk of the deposit. The contrast in preservation of organic material indicates a climate slightly warmer than at present during and after Paleo-Eskimo occupation and a return to slightly cooler conditions during and after Neo-Eskimo occupation.

LATE QUATERNARY CLIMATIC FLUCTUATIONS ON SEWARD PENINSULA AND IN THE FAIRBANKS DISTRICT

The climatic fluctuations recorded at Iyatayet undoubtedly were common to other parts of Alaska. Glacial sediments mapped by Hopkins in the Kigluaik Mountains of Seward Peninsula (field notes, 1949, 1950) may have been deposited during one or more of the cold periods recorded at Iyatayet. Unfortunately, the glacial deposits of Seward Peninsula at present can be neither dated nor correlated with certainty with glacial deposits of known age elsewhere in Alaska.

Sequences of silt and muck (silt rich in organic material) exposed in placer mine excavations record climatic fluctuations in unglaciated areas of Seward Peninsula and central Alaska. Hopkins has studied silt and muck stratigraphy in some unglaciated valleys in central and northern Seward Peninsula. Muck layers present in many valleys have been dated by carbon-14 analyses of wood specimens from three localities. Péwé (1952) has studied more thoroughly the stratigraphy of unconsolidated sediments in upland valleys in the Fairbanks district. Carbon-14 analyses of wood from several different muck layers provide data by which several climatic fluctuations during the past 20,000 years can be dated.

Silt layers in upland valleys in the Fairbanks district consist of loess deposited on valley slopes and ridge tops and carried into valley bottoms during glacial episodes in the nearby Alaska Range (Péwé, 1950). Muck layers consist of stream and mudflow deposits and residual peat and forest beds that accumulated in stream valleys during periods when glaciers in the Alaska Range were less extensive and when the climate was at least as warm as at present. Péwé recognizes three muck layers separated by two silt layers which record three warm intervals and two glacial intervals.

The oldest muck layer rests on auriferous gravel in valley bottoms and is at least 20,000 years old. A thick layer of slightly reworked loess overlying the oldest muck is more than 16,000 years old. Overlying the loess is a second muck layer from which samples of organic material 12,000 to 16,000 years old have been collected. A second loess layer less than 12,000 and more than 4,200 years old overlies the second muck layer and is overlain in turn by a third muck deposit from which samples of organic material 3,500 to 4,200 years old have been collected. The cold period represented by the second, upper loess deposit probably is equivalent in age to the Mankato substage of glaciation in north-central United States considered by Flint and Deevey (1951, pp. 261-267) to have occurred about 11,000 years ago.[6] At least part of the middle muck layer of the Fairbanks district was deposited during the interstadial interval between the Cary and Mankato substages as recognized in north-central United States.

Two muck units of different ages are tentatively distinguished by Hopkins in unglaciated creek valleys of central and northern Seward Peninsula. Specimens collected at Claim No. 4 above Discovery on Coffee Creek, a tributary of the Kougarok River 60 miles north-northeast of Nome, at the head of Black Gulch, a tributary of the Noxapaga River 80 miles north-northeast of Nome, and in the valley of Mud Creek near the southeast shore of Kotzebue Sound (fig. 1) have been dated by carbon-14 analysis by J. L. Kulp, Lamont Geological Observatory, Columbia University. Wood collected at Coffee Creek in the older muck unit is 8,350 ± 200 years old; wood collected at Black Gulch in the older muck is 8,800 ± 200 years old; and wood collected at Mud Creek in the younger muck is 3,600 ± 200 years old.

The dated specimen from Coffee Creek was collected from frozen muck free of large ice masses that overlies blue-gray silt containing ice wedges arranged in a polygonal pattern. The blue-gray silt contains little or no organic material and is thought to consist either of wind-blown silt or of silt derived from frost-rived bedrock farther

[6] A different opinion is offered by Schultz, Lueninghoener, and Frankforter (1951, pp. 34-36), who argue that the "Mankato climax may have been as recent as eight or even seven thousand years ago." Pollen sequences indicate, however, that Mankato ice had retreated in Minnesota and that spruce and fir grew in the glaciated area as early as 8,000 years ago (Flint and Deevey, 1951, pp. 272-273).

upslope, at a time when the climate was colder than at present. The overlying muck contains abundant willow wood, a few sticks of poplar (R. S. Sigafoos, botanist, U. S. Geological Survey, oral communication), and a log chewed by a beaver whose incisors were no larger than the incisors of *Castor canadensis,* the modern beaver in Alaska (H. W. Setzer, zoologist, United States National Museum, oral communication).

The dated specimen from Black Gulch was collected in muck generally similar to, but less well exposed than, the muck at Coffee Creek. Ice wedges are present in the muck at Black Gulch. Wood in the muck includes a few logs as large as 6 inches in diameter. The dated specimen was identified by Sigafoos as poplar wood.

The dated specimen from Mud Creek was collected near the inner edge of a rolling coastal plain at the southeast corner of Kotzebue Sound, 2 miles west of Candle, Alaska. The specimen consists of wood from a buried beaver dam at the base of a deposit about 30 feet thick of interbedded muck and fibrous peat. The organic sediments are underlain by Quaternary gravel many tens of feet thick. Mining operations in 1949 exposed the surface of an ancient floodplain upon which the beaver dam was built. Sedge turf, willow or alder thickets, and a birch stump 6 inches in diameter were seen rooted in place in the vicinity of the beaver dam. Sticks in the beaver dam had been carved by beavers whose incisors were comparable in size with those of *Castor canadensis.*

Sparse willow shrubs grow today in the valleys of Coffee Creek, Black Gulch, and Mud Creek, but poplar and birch trees do not. Willows are much less abundant on the modern surface of the valley of Mud Creek than on the exhumed flood plain on which the dated wood was collected. The western limit of beaver during the past 50 years has been 100 miles to the east of Coffee Creek and Black Gulch and more than 50 miles to the east of Mud Creek. The older muck, represented by the muck at Coffee Creek and Black Gulch, and the younger muck, represented by the muck at Mud Creek, must have accumulated at times when the climate was warmer than at present, and when trees and large shrubs grew in areas that now support tundra vegetation, with only a few dwarf shrubs.

The dated muck of Seward Peninsula and the youngest muck in the Fairbanks area may have accumulated during a single, long, post-Mankato warm interval that extended from about 9,000 to about 3,500 years ago. Alternately, the muck at Coffee Creek and Black Gulch may have accumulated during a brief, early post-Mankato warm interval 8,000 to 9,000 years ago, and the muck at Mud Creek and the youngest muck in the Fairbanks district may have accumulated during a separate, much later warm interval 3,500 to 4,500 years ago.

CORRELATION BETWEEN LATE QUATERNARY EVENTS AT IYATAYET AND IN NEARBY PARTS OF ALASKA

Forty feet of congeliturbate accumulated in Iyatayet Valley during a period when the climate was cold and frost action and solifluction were intense. Sea level stood much lower than at present, suggesting that a major, world-wide, glacial event is represented. The lack of a recognized break in deposition suggests that accumulation was not interrupted by a period of stability and thus that the congeliturbate accumulated during a single, late Wisconsin substage of glaciation. Exposures are poor, however, and it is entirely possible that more than one substage is represented by the congeliturbate.

The podzol beneath the Denbigh culture layer formed during a brief warm interval that interrupted the prevailing cold climate and marked the end of deposition of the rocky congeliturbate. The distribution of the buried soil and culture layer suggests that the surface of the 40-foot terrace still formed the floor of Iyatayet Valley during the warm interval. This lack of dissection of the terrace suggests that sea level had not yet risen to its present position. The later cold interval during which the Denbigh culture layer was covered and folded appears to have been briefer and less intense than the cold interval during which the rocky congeliturbate was deposited, because the layer of sandy silt that was added to the surface is thin and is different in character from the rocky congeliturbate. Accumulation of the sandy silt probably was interrupted briefly by another warm period during which the peat and Subarctic Brown Forest soil exposed in pit Z-4 were formed.

Comparison of the Denbigh flint complex at Iyatayet with flints in the oldest culture layer recognized in the Trail Creek caves suggests that the Denbigh culture layer is more than 6,000 years old. Evidence that Iyatayet Valley had not yet been dissected, and thus that sea level had not yet risen to its present position, also suggests that the Denbigh culture layer and the associated podzol are older than 6,000 years. Sea level is believed to have been a few feet higher than at present in most unglaciated areas at the beginning of the post-Mankato thermal maximum as recognized in the United States and Europe. Flint and Deevey (1951, p. 258) estimate that the thermal maximum in the United States began about 6,000 years ago.

Two possible correlations must be considered for the deposits of the pre-Christian era in Iyatayet Valley (table 2). The rocky congeli-

TABLE 2.—*Suggested correlations between features of Iyatayet Valley and late Quaternary deposits elsewhere in Alaska*

A. *Favored correlation*

Features of Fairbanks area (F) and Seward Peninsula (SP)		Features of Iyatayet Valley	
Name	Age in years	Name	Age and date in years
		Neo-Eskimo midden	350-850* (A.D. 1100-1600)
		Paleo-Eskimo midden	1,500-2,000† (A.D. 1-500)
		Sandy silt	2,000-3,500 (1500-1 B.C.)
Youngest muck (F)	3,500-4,200	Subarctic Brown Forest soil in pit Z-4	3,500-4,200 (2200-1500 B.C.)
		Sandy silt and folds in Denbigh culture layer	4,200-8,500 (6500-2200 B.C.)
Older muck (SP)	8,500	Denbigh culture layer and podzol	8,500 (6500 B.C.)
Younger loess (F)	4,200-12,000	Rocky congeliturbate	More than 8,500 (Earlier than 6500 B.C.)

* Age determined by typological correlation with Kobuk River sites.

B. *Alternate correlation*

Features of Fairbanks area (F) and Seward Peninsula (SP)		Features of Iyatayet Valley	
Name	Age in years	Name	Age and date in years
		Neo-Eskimo midden	350-850* (A.D. 1100-1600)
		Paleo-Eskimo midden	1,500-2,000† (A.D. 1-500)
		Sandy silt	2,000-3,500 (1500-1 B.C.)
Youngest muck (F) Older muck (SP)	3,500-4,200 8,500	Subarctic Brown Forest soil in pit Z-4	3,500-8,500 (6500-1500 B.C.)
Younger loess (F)	4,200-12,000	Sandy silt and folds in Denbigh culture layer	8,500-12,000 (10000-6500 B.C.)
Middle muck (F)	More than 12,000	Denbigh culture layer and podzol	More than 12,000 (Earlier than 10000 B C.)
Older loess (F)	More than 16,000	Rocky congeliturbate	More than 16,000 (Earlier than 14000 B. C.)

† Age determined by carbon-14 samples collected at Iyatayet.

turbate may have been deposited more than 16,000 years ago during the cold interval represented by the lower, pre-Mankato loess in the Fairbanks area (correlation B, table 2). The buried podzol may have formed and the Denbigh culture layer may have been deposited about 12,000 years ago, during part of the warm interval recorded by the middle muck in the Fairbanks area. The culture layer then would have been covered and folded during the Mankato substage at the same time that part of the upper loess of the Fairbanks area was deposited. The buried peat layer and Subarctic Brown Forest soil layer exposed in pit Z-4 would have formed during a single, long, warm interval 9,000 to 3,500 years ago represented by the dated mucks of Seward Peninsula and by the youngest muck in the Fairbanks area.

It is alternately possible that part or all of the rocky congeliturbate was deposited during the Mankato substage while the upper loess was being deposited in the Fairbanks area (correlation A, table 2). The podzol and the Denbigh flint layer may have formed during a brief warm interval about 8,000 to 9,000 years ago that is represented by the dated muck at Coffee Creek and Black Gulch, Seward Peninsula. The culture layer then would have been covered and folded during a minor cold interval between 8,000 and 4,200 years ago, and the peat and Subarctic Brown Forest soil exposed in pit Z-4 would have formed during a later warm interval 4,200 to 3,500 years ago, represented by the dated muck at Mud Creek and the youngest muck of the Fairbanks area.

The writers favor correlation of the podzol and the Denbigh culture layer with the older muck of Seward Peninsula, deposited 8,000 to 9,000 years ago, because the thinness of the podzol at Iyatayet suggests that the warm period during which it formed was very brief. The middle muck layer in the Fairbanks area, with which the podzol and culture layer instead may be correlative, represents a warm period that lasted at least 4,000 years. Moreover, the sandy silt which overlies the Denbigh culture layer appears to represent a relatively minor cold interval compared with the cold interval during which the congeliturbate was deposited. The thickness of the upper loess of the Fairbanks area suggests that the Mankato substage was a major cold interval in Alaska. The archeological relationships are more readily explained if the Denbigh flint complex at Iyatayet is assumed to be about 8,500 years old, but they do not rule out the alternate assumption that the culture layer is more than 12,000 years old. The possibility cannot be eliminated that Iyatayet was occupied by people of the Denbigh flint complex during an interstadial interval earlier than the Mankato substage.

Evidence that the climate at Iyatayet was warmer than at present during and after Paleo-Eskimo occupation from A.D. 1 to 500 is matched by evidence for a warm or dry climate near this time in Greenland (Brooks, 1949, pp. 342-343), southwestern United States (op. cit., pp. 356-357), Ohio, and the Valley of Mexico (Sears, 1951). The cooler period during and since the Neo-Eskimo occupation from about A.D. 1100 to 1600 corresponds broadly to the "little ice age" (Matthes, 1942), recognized in several places in Alaska (Lawrence, 1950; Péwé, 1951; Sharp, 1951) and in nearly every glaciated mountain range in the Northern Hemisphere (Manley, 1951).

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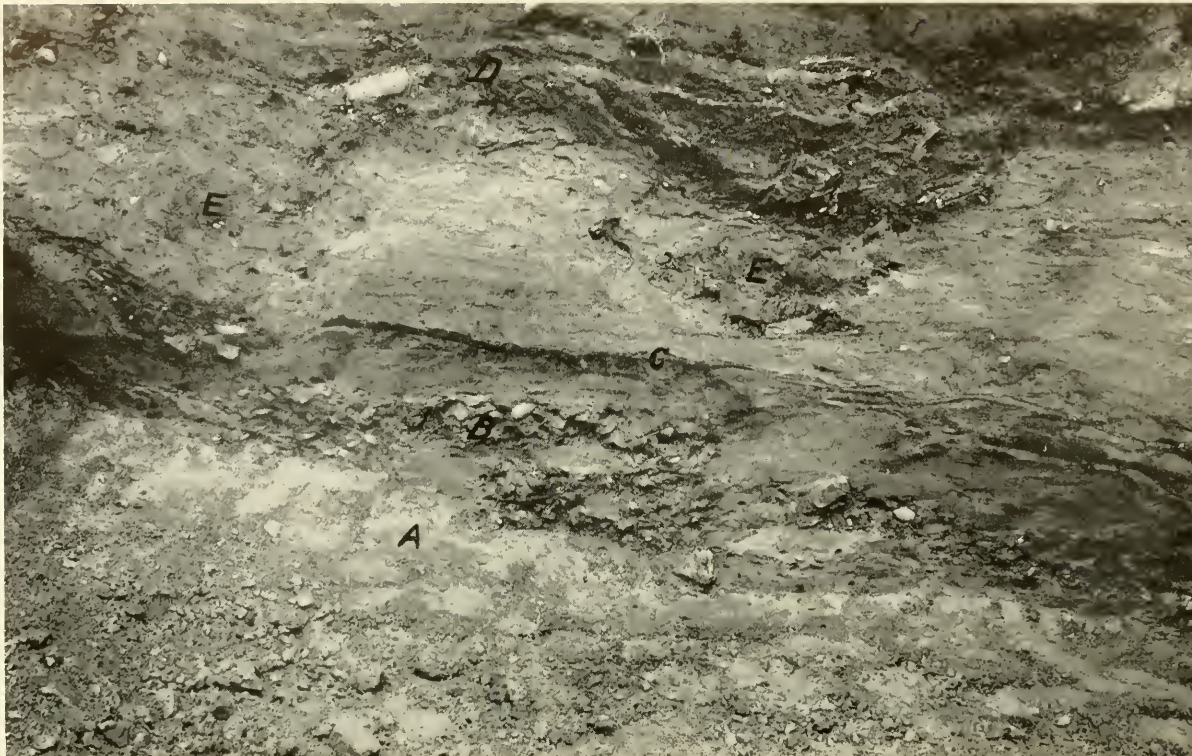
IYATAYET COVE AND IYATAYET VALLEY

Denbigh culture layer was found on 40-foot terrace at left side of valley mouth just above tents. Lower valley walls are covered with dense stand of tall alders. Upper slopes (near skyline at left) are covered with sedges, *Equisetum*, and small alder shrubs arranged in stripes. Lower slopes are free of soil movements, but upper slopes probably are subject to active solifluction.



FLOOR AND EAST WALL OF PIT Z-4

A, Congeliturbate in floor of pit. *B*, Denbigh culture layer, unusually thick at this locality. Note recumbent fold just left of *B*. *C*, Buried turf layer, enclosed in sterile sandy silt. *D*, Buried Paleo-Eskimo ground level. *E*, Filled Paleo-Eskimo excavations. Portion of wall shown here is about 2 feet high. Location of pit is shown on figure 3.

SURFACE OF DENBIGH CULTURE LAYER EXPOSED ON FLOOR OF PIT PE-4

Ridges near hammer are anticlinal folds in the Denbigh culture layer; "caves" are undersides of folds from which infolded sterile silt has been removed.

SMALL VALLEY DRAINING HILLS BETWEEN BALD HEAD AND KOYUK RIVER VALLEY

Note wide, swampy valley floor and gently sloping alluvial fan at mouth of valley. Beach at left is shore of Norton Bay. Before bottom of Iyatayet Valley was dissected to form 40-foot terrace, it resembled this valley.