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GEOLOGIC MAP OF THE HOOPER BAY QUADRANGLE, ALASKA

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Introduction

The geologic map of Hooper Bay quadrangle is one of several presenting the results of regional mapping in the lower Yukon-Norton Sound region, western Alaska. Fieldwork in the quadrangle was done by helicopter in 1961 and 1963, and was concerned primarily with the bedrock. The surficial deposits have been mapped largely through the interpretation of aerial photographs.

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Bedrock

Bedrock exposed in the Hooper Bay quadrangle consists of sandstone and siltstone, granodiorite, and basalt.

Sandstone and siltstone

Sandstone and siltstone (Ks) crop out in at least three places in the Askinuk Mountains. They are surrounded by intrusive rock and are apparently roof pendants in the granodiorite pluton which makes up most of the Askinuk Mountains. The mountains have not been examined in detail and may contain other small areas of sedimentary rocks.

The interbedded sandstone and siltstone comprise roof pendants which have been thermally metamorphosed and have acquired a hornfelsic texture. The eastern roof pendants are pyritized, and the rocks are stained yellow with iron oxide. No pyrite was noted in the western pendant. Metamorphic minerals in the western pendant include small crystals and blebs of magnetite, red-brown biotite flakes, and hypersthene. No biotite was identified in the eastern pendants, but the rocks contain microscopic needles of amphibole and magnetite.

No fossils have been found in these rocks. They are assigned a Cretaceous age because they are similar to Cretaceous rocks in the adjoining Kwiguk quadrangle which contain fossil plants and invertebrates of Albian or Cenomanian age. They are obviously older than the granodiorite pluton, which is of Late Cretaceous age (see table of age determination for biotite).

Granodiorite

A granodiorite pluton (Kg) crops out over an area of at least 200 square miles in the Hooper Bay quadrangle. Geophysical data suggest that the exposed rock may be part of a large intrusive body underlying an area of 1,000 to 1,400 square miles.

The granodiorite is light gray and medium to medium coarse grained. Near the roof pendants it tends to be finer grained, darker gray, and somewhat porphyritic. Locally it contains more or less well-defined, fine-grained dark-gray areas which are partly assimilated inclusions of country rock. Scattered fragments of fine-grained porphyritic rock suggest that the granodiorite is cut by dikes of intermediate composition. Aside from these minor differences, the intrusive body appears to be homogeneous. It consists of euhedral and subhedral plagioclase of oligoclase-andesine composition with interstitial orthoclase and quartz. Biotite and hornblende occur in about equal amounts and are somewhat chloritized. Accessory minerals include sphene, apatite, and magnetite. Some of the feldspar is slightly sericitized.

The granodiorite is cut by at least two well-defined sets of fractures, the most conspicuous of which is about parallel to the ground surface. These sheeting fractures probably resulted from load relief through the erosion of overlying rock. They are so well developed in some exposures that from a distance the granodiorite resembles horizontally layered sedimentary rock. The rock is also broken by at least one set of vertical fractures trending about east-west. The intersection of the vertical and horizontal sets of fractures has locally produced rectangular blocks of granodiorite 2 to 4 feet wide and thick and 10 to 20 feet long.

The potassium-argon age of the biotite was determined by Marvin Lanphere to be 78.7 ± 4.0 million years (see table 1). According to recent compilations of the geologic time scale (Kulp, 1961, p. 1107) the age of the granodiorite is Late Cretaceous.

Basalt

Basalt (Qb) forms Ingrisarak Mountain, a volcanic vent, and also crops out near the eastern edge of the quadrangle on the flank of a similar vent in the adjoining Marshall quadrangle. Red and black fragments of basalt scoria are widespread in both areas, but no rock was found in place.

The fragments have not moved far; they are angular, unweathered, and commonly show ropy flow features.

The basalt consists of scattered phenocrysts of pyroxene and olivine in a fine-grained matrix.

The basalt is assigned a Quaternary age because it is very fresh appearing and because the volcanic vents, although modified, are still physiographically expressed. Paleomagnetic measurements on oriented specimens from similar volcanic vents in the adjoining Marshall and Kwiguk quadrangles show that the basalt is normally magnetized. The physiographic expression

and normal magnetic polarity suggests that the basalt was extruded during the latest (Brunhes) normal polarity epoch (Cox and others, 1964, 1965). Recent studies (Dalrymple and others, 1965, Doell and others, 1966) indicate that the Brunhes epoch began about 0.7 million years ago.

Structure

The granodiorite pluton contains several northwest-trending lineaments which are interpreted as fault traces. The sense of movement on the faults is not known, but they parallel numerous faults in the Kwiguk quadrangle 150 to 200 miles northeastward, some of which show left-lateral displacement. However, one of the traces in the Askinuk Mountains crosses a roof pendant without apparent displacement.

Ingrisarak Mountain is traversed by an indistinct, northwest-trending lineament which is interpreted as a possible fault trace because it parallels the well-defined lineaments in the intrusive rocks of the Askinuk Mountains.

Surficial deposits

The surficial deposits in the Hooper Bay quadrangle are mostly fluvial, but include small areas of glacial deposits in the Askinuk Mountains. The fluvial deposits include both old coastal-plain deposits and deltaic deposits laid down by the ancestral Yukon River and its distributaries. Locally the fluvial deposits have been reworked by ocean currents and wind to form beaches, bars, spits, and dunes.

Except for the glacial and colluvial deposits in the Askinuk Mountains the surficial deposits are mostly silt and fine sand with admixed woody material.

Deposits mapped as old alluvial deposits south of Kokechik Bay are apparently the westernmost remnant of a coastal plain which rises gently eastward toward the mountains. The area mapped as old flood-plain deposits north of the Askinuk Mountains is probably part of an ancient delta of the Yukon River. The trend of ancient abandoned river channels in the area east of the Hooper Bay quadrangle suggests that part of the area south of Ingrisarak Mountain may also have been an ancient delta of the Yukon River.

Permafrost is present in most of the deposits and apparently extends to a depth of 200 to 300 feet. Surficial thawing of the deposits has produced most of the myriad lakes.

Local examination of the deposits shows that they cannot be easily subdivided on the basis of composition or texture. However, they can be subdivided and mapped on the basis of physiographic expression and origin through the study of topographic maps and air photos. Except for the glacial and colluvial deposits, the six map units more nearly mark stages in the evolution of the delta region rather than lithologic differences. The map units are commonly sharply defined by erosional scarps, but elsewhere there are transitional stages, and the contacts have been arbitrarily drawn.

The maximum thickness of the deposits is not known. Bedrock "islands" within the quadrangle suggests that the thickness is highly variable. On Napatuk Creek, about 71 miles southeast of the quadrangle, drilling operations penetrated as much as 1,000 feet of unconsolidated deposits.

The age of the surficial deposits ranges from Pleistocene to Recent. There are unconfirmed reports of fossil bones found near Hooper Bay village, but the age and identity of the bones are not known. Fossil mammoth remains have been found in the upper part of the old alluvial deposits elsewhere in the delta region. If the fossils have not been recently reworked, the deposits are at least 10,000 years old, because the mammoth became extinct about 10,000 years ago (Hester, 1960). Wood obtained at a depth of about 600 feet in a hole drilled 5 miles west of Bethel (about 110 miles southeast of the Hooper Bay quadrangle) yielded a carbon-14 age of more than 34,000 years (Ives and other, 1964).

Old alluvial deposits

Old alluvial deposits (Qoa) consist chiefly of silt and sand accompanied at depth by clay and minor amounts of fine gravel. Locally they contain peat and fossil mammal bones. They are the oldest coastal-plain deposits and are probably mostly fluvial with some wind-reworked deposits.

The driller's log of a water well drilled by the Alaska Native Service at Hooper Bay village to a depth of 349 feet shows 65 feet of unfrozen ground underlain by 70 feet of ice underlain by 201 feet of frozen muck and silt with sand layers. The well bottomed in 12 feet of unfrozen clay containing a 1-foot sand layer.

The deposits form an undulating, barren, tundra-covered plain pitted by many small thaw lakes. The plain is separated from younger deposits by steep outward-facing scarps 10 to 30 feet high. The average elevation of the plain is 30 to 70 feet above sea level and only locally are there isolated points 100 to 128 feet high. The plain extends from Dall Point on the west to just beyond the east edge of the quadrangle. Isolated remnants of the plain in the vicinity of the Kokechik River show that the plain formerly extended northward at least to the Askinuk Mountains. It probably also extended far south of Ingrisarak Mountain but has been removed by the ancient channel of the Yukon River.

Glacial and colluvial deposits

Glacial and colluvial deposits (Qgc) consist mostly of sand, gravel, boulders, and angular talus blocks. The unit also includes a minor amount of fan gravel. These poorly sorted deposits typically occur on the flanks and in the valleys of the Askinuk Mountains.

A well drilled by the Air Force at the airstrip on Cape Romanzof penetrated glacial till and granite slide rock to a depth of 96 feet (J. R. Williams, written communication, 1963).

The age of the glacial deposits is not known but they probably were laid down during one of the earlier glacial intervals when sea level was lower and the sea coast was 200 to 300 miles farther west (Hopkins, 1959). The age relationship of the glacial deposits and the old alluvial deposits is unknown in the Hooper Bay quadrangle because the two units have not been found in contact. In the map explanation the two units are shown as being about the same age because both are overlain by younger estuarine and flood-plain deposits. In the valley of the Kwinhagak River, about 200 miles southeastward, the old coastal-plain deposits are incised by outwash channels and overlain by glacial deposits

(Hoare and Coonrad, 1961). The modified physiographic expression of these glacial deposits and outwash channels suggests that they may be early Wisconsin in age. They were almost certainly preceded by a yet older and more extensive glacial advance which was probably older than at least the upper part of the old coastal-plain deposits. These two older glacial advances were succeeded by two or more younger advances which left less modified deposits in the upper valley of the Kwinhagak River.

The glacial deposits in the Askinuk Mountains were probably laid down during one of the earlier glacial intervals, because they are highly modified and largely overlain by colluvial deposits. Also the glaciated aspect of the mountains has been greatly modified or erased by stream erosion and mass wastage by frost action.

Old flood-plain and delta deposits

The deposits mapped as old flood-plain and delta deposits (Qof) are chiefly silt, sandy silt, and bog deposits. Comparable deposits east of the Hooper Bay quadrangle occupy former channels and distributaries of the ancestral Yukon River. These old channels incise the old alluvial deposits and probably were cut when sea level was considerably lower than at present.

In the Hooper Bay quadrangle the origin of the old flood-plain and delta deposits is not quite so clear. North of the Askinuk Mountains they are probably part of an old subdelta of the Yukon because they form part of a large arcuate area which is 20 to 25 feet above sea level and well above the adjoining younger alluvial deposits. The subdelta was probably formed by a major distributary of the ancestral Yukon River which flowed across the northwest corner of the Marshall quadrangle about 20 miles farther east. South of the Askinuk Mountains the unit may also be mostly deltaic or estuarine deposits related to the ancestral Yukon. It probably also includes areas where the old alluvial deposits have been stripped off and reworked by minor distributaries of the ancestral Yukon.

The top of the old flood-plain and delta deposits is generally 10 to 25 feet above sea level. They are separated from the preexisting old alluvial deposits by a sharp scarp. They are commonly separated from younger estuarine and beach deposits by a low scarp but locally are transitional. The surface of the deposits is characterized by countless small lakes, a few large lakes, and numerous meander scars and abandoned stream channels.

Most of the unit is probably Pleistocene in age; some may be Recent.

Old beach deposits

Silt and sandy silt mapped as old beach deposits (Qob) fringe the old flood-plain and delta deposits both north and south of the Askinuk Mountains. The old beach deposits are characterized by beach ridges which resemble cheniers (Gould and McFarlan, 1959, p. 263, 264) but are made of the same fine material as the intervening swales.

In the southern area the beach ridges have been largely destroyed by the development of thaw lakes. The deposits are mostly 6 to 10 feet above sea level and separated from the preexisting old flood-plain and delta deposits by a low scarp.

In the northern area the beach ridges are better preserved and most of them are probably younger. They constitute the southern end of a belt of beach ridges about 65 miles long which extends northeastward across the Black quadrangle. They are as much as 25 feet above sea level in the west but are progressively lower and less well preserved eastward where they apparently grade into old deltaic deposits of this map unit.

The probable origin and age (less than 3,000 to 5,000 years) of the northern group of beach ridges is discussed in the text accompanying the geologic map of the Black and Kwiguk quadrangles (Hoare and Condon, 1966). The source of the material forming the southern group of the beach ridges is not known. They are apparently younger than the old flood-plain deposits on the east and older than the deposits which flank them on the west. They probably formed after sea level rose to about its present height 3,000 to 5,000 years ago (Hopkins, 1959, p. 1525; Gould and McFarlan, 1959, p. 264; Coleman and Smith, 1964) and are approximately as old as the northern group of beach ridges.

Estuarine deposits

Estuarine deposits (Qe) consist of fluvial silt and sandy silt which has been reworked and redeposited by tidal currents and wave action. They surround numerous residual "islands" of the older deposits, many of which are too small to show on the geologic map. East of Angyoyaravak Bay they include several low, obscure ridges which may be old beach ridges. Most of them were laid down in relatively quiet brackish estuaries and around the sides and heads of bays. They range in elevation from 3 to 10 feet above sea level, slope gently seaward, and are now generally above normal tide range. Low scarps separate them from present tidal flats and from old beach deposits and old flood-plain and delta deposits. East and north of the Hooper Bay quadrangle, however, they extend far inland in former estuarine channels of the ancestral Yukon and merge with the old flood-plain and delta deposits.

The estuarine deposits are pitted by innumerable tiny thaw lakes and traversed by many small straight streams and a few large meandering streams. At their contact with the present-day tidal mud flats on the northeast side of Hooper Bay, there are five or six small conical mounds perhaps 10 to 20 feet high. Photointerpretation suggests that they are either mud volcanoes or pingos.

The oldest of the estuarine deposits were laid down in the former mouths of ancestral channels of the Yukon River. Deposition probably began with the rise in sea level following a major glacial interval and has continued up to the present. Most of the deposits probably postdate the latest rise in the sea level which ended 3,000 to 5,000 years ago (Hopkins, 1959, p. 1525; Gould and McFarlan, 1959, p. 264; Coleman and Smith, 1964) but some may date from earlier high stands of sea level.

Young beach deposits

The silt, sand, and sandy silt mapped as young beach deposits (Qyb) transported and deposited predominantly by ocean currents, although some wind-reworked material is included. They form narrow beaches on some of the headlands, baymouth spits, bars, and islands. The deposits probably represent

a very small part of the great amount of alluvium being deposited in the Bering Sea by the Yukon River about 30 miles north of the Hooper Bay quadrangle.

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TABLE 1.— *Age determination for biotite from granodiorite in the Hooper Bay Quadrangle, Alaska*

[Constants: $K^{40}/K = 1.19 \times 10^{-4}$; $K^{40} = 0.585 \times 10^{-10}$/year; $K^{40} = 4.72 \times 10^{-10}$/year]

Field No.	Latitude and Longitude	Geologic Unit	K_2O percent	A^{40} (moles/gm)	$\frac{Ar^{40}_{rad}}{Ar^{40}_{total}}$	Age (million years)
61AHr 91	61°45′ N. 165°09′ W.	Granodiorite	7.39	8.757×10^{-10}	0.80	78.7 ± 4.0

Argon analysis and age calculation: M. A. Lanphere, 1964
Potassium analyses: H. C. Whitehead and L. B. Schlocker, 1964