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GEOLOGICAL SURVEY

RECONNAISSANCE GEOLOGIC MAP OF THE NOME QUADRANGLE, SEWARD PENINSULA, ALASKA

By

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards or nomenclature.

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INTRODUCTION

The Nome quadrangle adjoins the south edge of the Teller 1:250,000-scale quadrangle (Sainsbury, 1972). The land portion of the Nome quadrangle comprises six 1:63,360-scale quadrangles, the rest being seawater (fig. 1). Of these six 1:63,360-scale quadrangles, two were published previously by Hummel (1962a, b). These quadrangles, the Nome C-1 and D-1, were partly remapped by Sainsbury in 1971, and map units were selected to correlate with map units developed and used during the regional mapping of the Seward Peninsula between 1967-1971.

With the exception of the Nome D-2 quadrangle, bounded by 165°13' and 166° W. longitude, and 64°45' and 65° N. latitude, geologic maps of all the 1:63,360-scale quadrangles have been published, or are in the open files of the Geological Survey. Because of the complexity of the geologic structure, many details of geology are omitted from this map, but the larger scale maps, and the texts accompanying them, may be consulted to augment the data presented in this report.

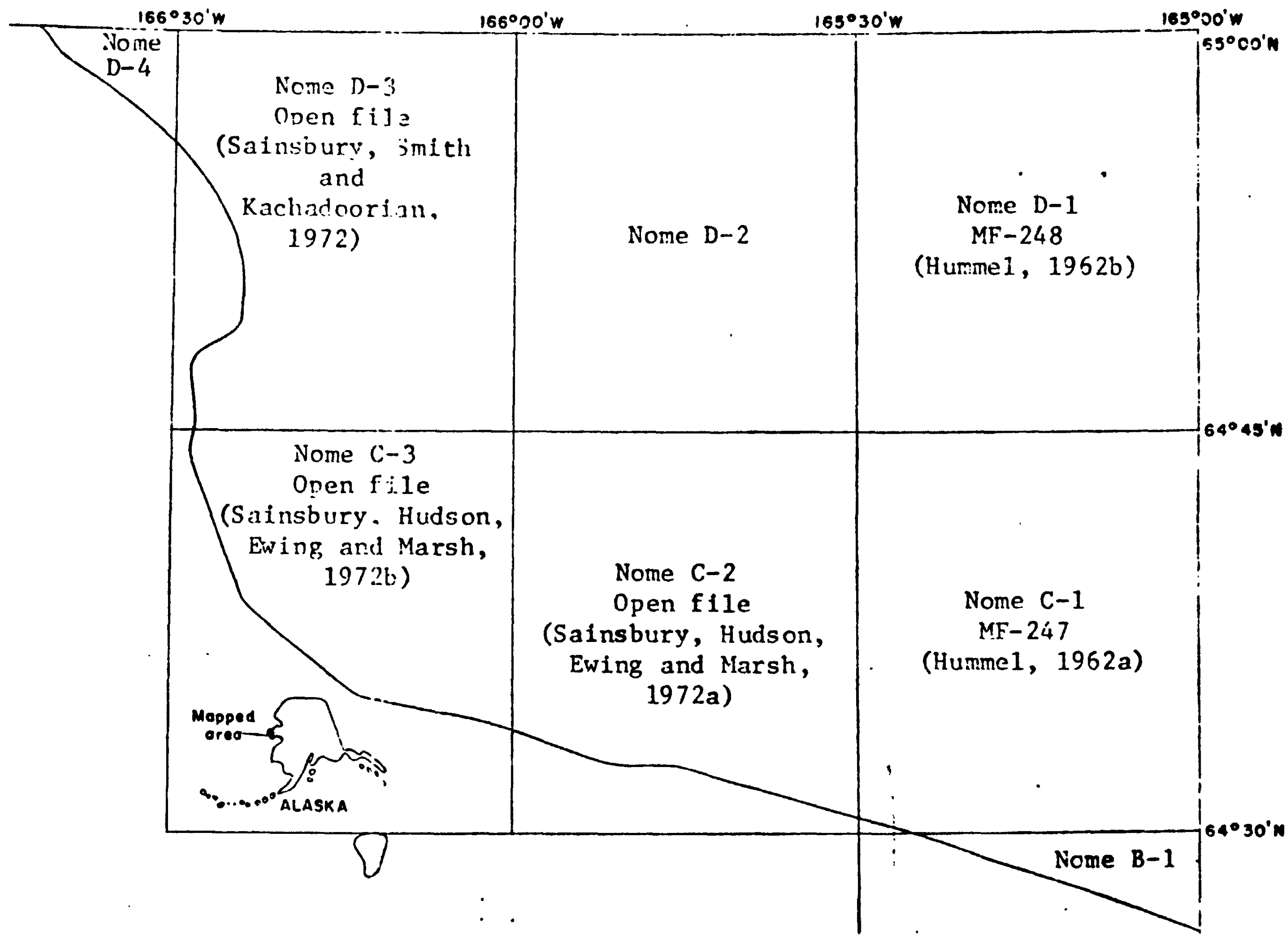

Figure 1.--Index map showing location and publication status of 1:63,360 scale-maps in the Nome Quadrangle.

GEOLOGY

General Stratigraphic Relations and Problems

Early workers who mapped parts of the area covered by this report distinguished and named several lithologic units. Brooks (in Brooks and others, 1901) applied the name Kigluaik Series to the limestones, schists, and granites of the Kigluaik Mountains, and the name Kuzitrin Series to graphitic schists and related rocks on the north and south sides of the mountains. He believed these rocks to be of Paleozoic age or older. Brooks also named the "Nome Series," and stated that it consisted of "limestones, graphitic mica and calcareous schists with many greenstone intrusives and some chloritic schists." He considered it to be of Mesozoic and Paleozoic age. Collier (1902, p. 15) subdivided the Nome Series into the Port Clarence limestone of Silurian [now called Ordovician] age, and the Kugruk Group, which consisted of "interstratified limestones, mica schists, and graphitic schists." Moffit (1913), who mapped in the Nome area and in the Kigluaik Mountains in 1904-05 and who found the apparent stratigraphy so complex that he deferred correlations, changed the rank of the Kigluaik Series to Group, and divided it into the Tigaraha Schist, and older crystalline limestones and gneisses. Moffit also changed the rank of the Nome Series to Nome Group, and restricted it to rocks consisting principally of chloritic schist with smaller amounts of feldspathic and siliceous graphitic schist.

Smith (1910) clearly recognized thrust faults in the area east of the Nome quadrangle. However, he retained many of the names given for rock units elsewhere, but added new names for lithologic variations in restricted areas. Moreover, new names were given to thrust slices of rocks which could have been assigned to named units, thus compounding the confusion.

Hummel (1962a, b) assigned formational names to numerous map units in the Nome C-1 and D-1 quadrangles. All were referred to the Paleozoic. None are retained in this report, because all these units are included in the York Slate, here considered to be entirely of Precambrian age.

As the Kigluaik Group, the Tigaraha Schist, and the Nome Series all contain some rocks of the York Slate, or their metamorphic equivalents, they represent units which may not be stratigraphically separable. Hence, these names are not used in the present report. For comparison with terminology used herein, the Tigaraha Schist represents schistose or thermally metamorphosed York Slate (p€sm of this report). The Kigluaik Group included the units shown on the present map as paragneiss (p€gn, p€mu) and parts of the York Slate. The Nome Group included parts of several units of the York Slate (p€cl, p€ls, and p€s) as well as thrust slices of Paleozoic marble and limestone (Pzm and Pzl).

As pointed out previously (Sainsbury, 1969c), this confusion was caused because rocks of diverse age and lithology were juxtaposed or seemingly interstratified by widespread thrust faulting that affected the entire Seward Peninsula in the Cretaceous. Some geologists working on or near the Seward Peninsula have lumped Precambrian and Paleozoic rocks together because fossils at times are collected from thrust slices of Paleozoic carbonate rocks surrounded by Precambrian rocks (Patton, 1967; Miller and Elliot, 1969, p. 5). Other recent workers still refer to the "dominantly Paleozoic rocks of Seward Peninsula" (Scholl and Hopkins, 1969, p. 2074).

The map units in the present report represent Sainsbury's attempt to assign rocks to units which can be recognized elsewhere on the Seward Peninsula. The main problems still remaining also are discussed in some detail, even though they cast doubts on some age assignments made very recently (Sainsbury and others, 1970; Sainsbury, 1972), and even on some designations made in this report.

First, the validity of any age assignment older than that of the York Slate, of this report, must be questioned. This follows from the fact that thrust sheets are stacked upon one another in the Nome and Teller 1:250,000-scale quadrangles as well as elsewhere throughout the Seward Peninsula. The high-rank metamorphic rocks in the Kigluaik Mountains may represent metamorphosed thrust slices of both Precambrian and Paleozoic rocks. Hummel (written commun., 1960) believed that some of the Tigaraha schists were metamorphic equivalents of the slates exposed farther from the mountains. Our work in 1971 corroborates this belief and, in fact, strengthens it, for the large amounts of graphite and quartz in the gneisses certainly suggest that they are metamorphosed York Slate. That we are unable at this stage to resolve the problem of the stratigraphy and age of the high-rank metamorphic rocks of the Kigluaik Mountains is understandable. Ranges composed of high-rank metamorphic rocks lying in Belt Super Group terrane in Montana and Idaho are still the object of similar questions, despite intense study (J. E. Harrison, oral commun., 1971). The absence of clearly mappable thrusts in the gneisses (although some contacts have been thought to be thrust faults) reflects only the obliteration of fault contacts during the creation of the gneisses. This realization has required that thick marbles in the Kigluaik Mountains that lie within gneisses remain unassigned by age, in contradistinction to age assignments made by Sainsbury (1972). These marbles, which are discontinuous, may be either thrust slices of Paleozoic carbonate rocks, or limestones originally intercalated in the York Slate. In this report they are unassigned by age, even though the surrounding gneisses are assigned to the Precambrian, but indicated as possibly being derived from limestones in the York Slate.

Second, the age and origin of the magnesian chloritic schists and marbles formerly assigned to the Nome group, and placed within the York Slate or unassigned by age in this report, remain great problems. All previous workers in the Nome area clearly recognized that some mafic rocks intrude thick sequences of carbonate rocks, and that two cycles of intrusives are represented. As most of the thick carbonate rocks are now believed by Sainsbury to represent Paleozoic rocks (many are of unquestionable Paleozoic age; others are not so certain), it is obvious that some of these mafic intrusive rocks are younger than any of the Paleozoic rocks. One must face the possibility that all or some of the chloritic schists were derived from mafic intrusive rocks, and hence are not of Precambrian age as shown on the map of this and other recent reports (Sainsbury, 1972; Sainsbury and others, 1970).

The distribution of the chloritic schists, and the many marble beds within them, argues strongly that they represent for the most part volcanic material present in the slate before metamorphism and thrusting. When viewed on a large scale, the chloritic schists of the Nome quadrangle crop out in a broad belt around the Kigluaik Mountains, and continue northward across the Teller quadrangle to the Chukchi Sea, everywhere either surrounded by York Slate or in close association with slate. However, within this belt are many exposures of rocks of gabbroic composition with relict pyroxenes and igneous textures. Such rocks in many places are clearly intrusive into the surrounding chloritic schists or slates, and must be younger. Some rocks definitely intrusive into slate or limestone have been converted to glaucophane-bearing rocks (Sainsbury and others, 1970).

On the other hand, if such mafic rocks were present within the Kigluaik Mountains, they would now be represented by amphibolites or pyroxenites, which do not occur, suggesting that these mafic bodies are restricted only to the belts of chloritic schists and arguing against a widespread distribution of mafic intrusives younger than the York Slate. Nevertheless, in the Bendeleben Mountains, some 125 miles east of the Nome quadrangle, amphibolites do occur in high-rank schist that is derived from York Slate. Nowhere in the high-rank gneisses of the Nome quadrangle, or of the Bendeleben quadrangle, are there large bodies of amphibolites comparable in size to even a part of the chloritic schist belts, a puzzling and troublesome fact

A condition which could explain all the facts, except the seemingly transitional boundaries between slate and chloritic schist, is that all the chloritic schists represent metamorphosed mafic rocks intruded along or near thrust faults, giving the impression of tabular bodies intercalated in slate. The degree of reconstitution and hence schistosity of these intrusives would depend on the subsequent deformation of the intrusives during the thrusting, which clearly is of pre-mid-Cretaceous age (Sainsbury, 1969b). These mafic intrusives are not assigned an age in this report. The reader should keep in mind these various possible interpretations when reading the rest of this report and when referring to the stratigraphic column of this and all other reports by Sainsbury and others published since 1969.

Stratigraphy

York Slate (p€s, p€bm, p€clg, p€ls, p€cl, p€st, p€sl and p€sm and metamorphosed equivalents p€mu and p€gn)

Included within the York Slate are diverse lithologic types ranging from a grayish-black siliceous phyllite containing as much as 92 percent SiO_2, through highly calcareous graphitic or carbonaceous phyllite, to mixed siliceous schists containing large amounts of either chlorite or graphite, or both. Siliceous rock--carbonaceous quartz siltite--forms the bulk of the unit. Near the top, gray-weathering marble and schist beds are common, and the carbonate content of the rock increases noticeably.

Within the York Slate terrane are large exposures of chloritic or feldspathic schist and semi-schist, which probably represent for the most part intercalated volcanic or volcaniclastic rocks. The contacts between chloritic schist and slate may be sharp, or transitional over hundreds of feet. Commonly, the contacts are parallel to a strong foliation impressed during the dynamic metamorphism of the rocks. As discussed previously, it is entirely possible that these schists are metamorphosed intrusive rocks of age much younger than the York Slate. Slate and chloritic and feldspathic schists are so intimately intermixed in many places that it is impractical to separate them, and numerous small exposures of chloritic schist have been mapped with the York Slate. In the Nome D-1 quadrangle, the contact between chloritic schist and slate in the area east of the Nome River is sketched in and questioned, because severe weather prevented the mapping of this contact; earlier detailed mapping by Hummel (1962b) did not distinguish such a contact.

Where thermally metamorphosed near the Kigluaik Mountains, the York Slate is converted to quartz-biotite-andalusite schist with abundant graphite, or to graphitic calc-silicate rock in the calcareous parts. Where intensely deformed, especially near major thrust faults, the rocks are converted to quartz gneiss with little graphite. A wide belt of such rocks on the western end of the Kigluaik Mountains has been metamorphosed, creating a layered quartz-biotite-graphite semi-gneiss (p€st). These rocks were included in the Tigaraha Schist by Moffit (1913).

Within the Kigluaik Mountains, the graphitic rocks are transitional from biotite schist to paragneiss containing quartz, biotite, garnet and plagioclase feldspar. The zone in which biotite schist predominates is several miles wide. These rocks formerly were designated the Kigluaik Group by Moffit (1913).

For more detailed descriptions of the many variations within the York Slate, and the diverse rock types which resulted from tectonic mixing of slate, chloritic schist and carbonate rock, see Hummel (1962a, b).

Age: The York Slate is assigned a Precambrian age based upon stratigraphic relationships and lack of fossils. Several whole-rock rubidium-strontium ages of the gneisses in the Kigluaik Mountains, which may represent metamorphosed York Slate, cluster in the neighborhood of 730 million years (Sainsbury and others, 1971). A date using the potassium-argon method on biotite separated from the biotite schists was determined as 100 million years (John Obradovich, oral commun., 1969), an age consistent with the assumed metamorphism that accompanied the intrusion of the granitic rocks of the Kigluaik Mountains. This age, therefore, is likely a "reset" age, and the Precambrian rocks are assigned an age based upon the rubidium-strontium determinations.

Schistose argillaceous dolomitic limestone and marble (p€l)

This rock sequence is exposed in the Nome quadrangle only at the eastern margin, near latitude 64°50' N.; this exposure is the westernmost continuation of a large expanse of such rocks in the Solomon D-6 quadrangle, which adjoins the Nome D-1 quadrangle on the east (Sainsbury and others, 1972). Where exposed in both the Nome and Solomon D-6 quadrangles, this unit consists of schistose argillaceous and dolomitic limestone that weathers limonitic yellow. The argillaceous bands which alternate rhythmically with carbonate, are very micaceous. Throughout the unit, small vitreous quartz veinlets are common, especially near the base where a transitional zone several hundred feet thick is darker and more slaty, and where one or more bands of graphitic, calcareous quartz siltite occur. The quartz in these veinlets probably represents silica mobilized from the argillaceous and siliceous parts of the unit. The large- and small-scale deformation of the argillaceous limestone precluded a determination of its true thickness, but it is at least several hundred, and possibly several thousand, feet thick. For a detailed description of this unit where best exposed in the York Mountains some 70 miles west of the Nome quadrangle, see Sainsbury (1969a, p. 9). In the Nome quadrangle, the argillaceous and dolomitic limestones are cut out by chloritic schist, some of which clearly is of igneous origin. Chloritic schist that represents completely recrystallized and schistose dikes or plugs is found at numerous places in the argillaceous limestone, especially in the Solomon D-6 quadrangle (see Sainsbury and others, 1972).

Age: Because the argillaceous limestone is transitional above the York Slate, and because it is unfossiliferous, it is assigned a late Precambrian age. This assignment is supported by the fact that all the known Ordovician, Silurian, Devonian and Mississippian rocks of the Seward Peninsula are fossiliferous and are not similar to the argillaceous limestone of late Precambrian age. Therefore, this unit must be of pre-Ordovician or post-Mississippian age. Because it is transitional above the York Slate, it must in part be of similar age; hence, it is assigned to the late Precambrian.

Marble, Schistose marble, dolomite, and limestone (Pzl, Pzm, Pzms)

Large expanses of marble, partly recrystallized limestone, and silicified limestone and marble south of the Kigluaik Mountains are assigned to the Paleozoic, but no fossils have been found in these rocks, and the age assignments are subjective. Within the larger areas of carbonate rocks bedding and lithologic variations are clearly visible locally. If fossils are to be found, they should be sought in such areas, a few of which are mentioned below.

Along Independence Creek, a tributary of the Sinuk River, a sequence of limestone and marble varying from thin to medium-bedded, and from medium-gray to dark-gray, crops out continuously for several miles. These rocks contain some very dark gray limestone beds, which in appearance are similar to Devonian limestone known elsewhere on the Seward Peninsula. However, they are metamorphosed and recrystallized to varying degrees.

Color differences reflecting original bedding are apparent at many places in the large area of carbonate rocks in the thrust sheet between the Feather and Sinuk Rivers, north of the rocks just described. Although the carbonate rocks are intensely contorted and largely converted to marble that is dolomitized near faults, they may contain still-recognizable fossils, especially in the dolomitized parts[1/].

Dark limestone and marble at the south end of the thin sliver of silicified limestone (Pzms) east of this large thrust sheet, and bounded by northwest-trending normal faults should be searched for fossils, especially where the silicified limestone merges with the dark marble on the south end.

Structures suggestive of fossils were found in carbonate rocks west of the Penny River, and detailed search in the dolomitized parts of these rocks may yield recognizable fossils.

The carbonate rocks of the Mt. Distin area, in the Nome D-1 quadrangle, were discussed in detail by Hummel (unpub. data, 1960), and assigned with reservations to the Paleozoic. Because the writers also believe these rocks are principally Paleozoic, all are so assigned on the present map. However, the top of Mt. Distin is composed of buff-weathering calcareous quartzite that contains phengitic white mica

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[1/] Sainsbury and Hudson have recovered fossils from dolomitized limestone at many places on the Seward Peninsula even where the surrounding rocks are schistose marble, especially where dolomite is localized along normal faults or above thrust faults. Once formed, dolomite resisted deformation, and fossils commonly were preserved in dolomite which may be surrounded by schistose marble.

interbedded with dark siliceous quartz siltite similar to the upper part of the York Slate. Such small areas of rocks of probable Precambrian age within the larger sequences have not been differentiated on this map.

Rocks of unassigned age (G, Mgd, M, Ls)

Many rocks mapped in the Nome quadrangle cannot be assigned by age. These include all the highly deformed garnet-bearing rocks which represent gabbro, metagabbro, and possibly metamorphosed mafic volcanic rocks (G). These rocks were discussed on pages 4-5. They are younger than any of the Paleozoic carbonate rocks, but how much younger cannot be determined. Several metamorphosed intrusive rocks of dioritic composition (Mgd) were mapped by Hummel in the Nome D-1 quadrangle; copper minerals in small amounts are associated with them. Hummel assigned these to the Paleozoic, but they may be younger, and are not assigned an age in this report.

Small expanses of marble, schistose marble, and cleaved limestone have been mapped separately (M, Ls). These may be either deformed thrust slices of Paleozoic carbonate rocks, or deformed equivalents of the limestone intercalated in the York Slate--all are unassigned by age, but they likely belong to one of the known units.

Cretaceous(?) Rocks (Kc)

A small exposure of coal-bearing rocks (Kc) of Cretaceous(?) age that are exposed poorly in the bed of a small gulch that is tributary to the Sinuk River was described by Collier and others (1908, p. 83-85). These rocks were not studied further for this report, and the description of them is taken from Collier and others. The rocks are principally conglomerate containing pebbles of schist and vein quartz, as well as large rounded boulders of greenstone (metagabbro?). Within the conglomerate are beds of finer sediments made up largely of schist fragments, as well as several coal beds ranging from 3 to 16 inches thick. Fire clay lies at the base of the coal. Granitic rocks are absent from the conglomerate, suggesting that it is older than the mid- to late-Cretaceous intrusive rocks, or that all clasts are of purely local derivation.

Crushing and shearing of these beds shows that they were dynamically deformed after deposition.

Granitic Rocks of Cretaceous Age
(Kgn, Ki, Kg, Kgm, Kgf, and Kgfn)

Numerous intrusive rocks of granitic composition form stocks and a composite batholith in the Kigluaik Mountains, as well as numerous small dikes and sills in the Nome C-1 and D-1 quadrangles (Hummel, 1962a, b). Only the larger bodies are shown on the map and discussed briefly here.

The oldest granitic rocks are bodies of gneissic to cataclastic-textured biotite granite ranging from medium-grained to porphyritic (Kgn). These bodies clearly were deformed dynamically, and must be older than the nonfoliated granites and quartz-monzonites shown on the map.

The large intrusive complex (Ki) in the core of the Kigluaik Mountains is a composite body with a darker border facies containing hornblende, and a core of lighter colored rock in which biotite predominates over hornblende. Numerous mafic to andesitic dikes intrude the complex, as do small bodies of younger, fine-grained granite (Kgf). These younger granites are not all shown but can be identified in the field by the general limonitic-staining of their border facies. Outside the intrusive complex, these younger granites are mapped separately. Alkalic rocks, which are common in granitic complexes on the eastern Seward Peninsula (Patton, 1967; Miller, 1970) were not found in this complex.

Unfoliated granite (Kg) forms a prominent stock with a capping roof of metamorphosed York Slate at the west end of the Kigluaik Mountains. The stock is composite, consisting of medium-grained biotite granite containing 72.4 percent SiO_2 grading to coarse-grained biotite granite containing 75 percent SiO_2. Hornblende-bearing quartz monzonite (Kgm) forms Sledge Island in Norton Sound. The pluton is unfoliated.

The youngest suite of granitic rocks consists of numerous plutons of fine to medium-grained biotite granite (Kgf), which tend to be unusually rich in thorium (Bunker, C. M., unpublished data), and which are characterized by uncommonly large amounts of brownish-red allanite.

Some granite rocks contain small amounts of clinopyroxene, but hornblende has not been observed. Similar rocks extend eastward for more than 50 miles into the Bendeleben 1:250,000 quadrangle. They tend to form small stocks and plutons; a few are weakly foliated (Kgfn) and a few exhibit faint crushing.

Rocks of Tertiary or Cretaceous age (TKd)

Dikes of diabase and lamprophyre (TKd), some of which are more than a mile in length, occur at numerous localities in the Nome quadrangle. Only a few of the most prominent are shown on the map. Titaniferous augite is a common pyroxene in most of the diabase dikes. Dikes in the limestone and marble are readily visible, and as a consequence seem especially numerous.

Surficial Deposits (Qm, Qso, Qf, Qsb, Qst, and Qc)

Much of the bedrock of the Nome quadrangle is mantled completely by surficial deposits comprising moraine (Qm), outwash silts and gravels (Qso), and by sands, gravels, and black silts (Qsb, Qst) that overlie the extensive marine terraces beneath the coastal plain. These deposits generally are covered almost completely by tundra (Qc) (not shown over these deposits on the map), but innumerable exposures in the banks of thaw lakes, cutbanks along streams, and material in frost boils, are spaced sufficiently close that the extent of these deposits can be mapped accurately.

The extensive moraines shown belong principally to the Nome River glaciation (Hopkins and others, 1960); these moraines are truncated by the Sangamon shoreline, as well as older marine strandlines farther landward. For a complete discussion of the unconsolidated deposits near Nome and the marine strandlines, see Hopkins and others (1960).

Structure

The geologic structure of the Nome quadrangle, and, in fact, the entire Seward Peninsula, is dominated by overthrust faulting with early thrust sheets moving eastward and later ones northward. The younger thrust sheets are restricted to the York Mountains, approximately 70 miles west of Nome. Thrusting was first surmised by Collier

(1902, p. 18) on the western Seward Peninsula, proved in the Solomon area, east of the Nome quadrangle by Smith (1910), and extended throughout the Seward Peninsula by Sainsbury and coworkers between 1961-1971 (Sainsbury, 1965, 1969a, 1969b, 1972; Sainsbury and others, 1969; Sainsbury and others, 1972; and other reports in publication by Sainsbury and coworkers). This widespread thrusting is now documented by geologic mapping across the entire Seward Peninsula, and will not be dwelt on here. Suffice it to say that purely as a function of overthrusting, many complications were introduced into the stratigraphic sequence of the Nome quadrangle (and elsewhere), and dynamic metamorphism, with superposed thermal metamorphism, has created many variants of most rock units. Because of thrusting, metasedimentary, sedimentary, possibly volcanic, and mafic to intermediate intrusive rocks were juxtaposed and tectonically mixed. Efforts to establish a stratigraphic sequence based upon geologic relations in an area the size of the Nome quadrangle were doomed to failure, and even with the benefit of 11 years continuous mapping covering most of the Seward Peninsula, the senior author still is not certain of the stratigraphic sequence in rocks below the upper part of the York Slate. Although local units were mapped in the Nome quadrangle by Hummel (1962a, 1966b), and well described in his unpublished text (Hummel, written commun., 1960), the stratigraphic sequence he described did not consider thrust relations.

Probably the most obvious proof of the thrust relations throughout the Seward Peninsula is the "unmatched" stratigraphic sequences which result when ages are assigned in different areas on the basis of apparent stratigraphic position. Practically every rock type can be found both above and below, or within, every other rock type somewhere on the Peninsula. Only by thrusting can this situation arise. In a visit to the area in 1971, Richard H. Jahns termed this "disjunctive geology" (R. H. Jahns, oral commun., 1971).

As clearly recognized by Hummel (1960, unpub. data), the Nome quadrangle is dominated by two sets of folds. Older folds (folded thrust plates?), cleavage, schistosity, relict bedding, dragfold axes and microfold axes tend to trend northwest to north in areas some distance from the Kigluaik Mountains. These structures were formed during eastward thrusting. Near the mountains, which were formed by uplift and arching or an east-west axis, the earlier structures are folded into easterly trends, and cut off by a strong set of faults that parallels the mountain front. Such structures were formed during northward thrusting.

A glance at the map reveals several distinct trends for sets of high-angle faults that formed later than the thrusting. Many of the thrust plates are cut by faults trending N. 30°-45° W. Diabase dikes are intruded along some, and the wall rocks of many faults are altered. The faults most important for economic reasons are the Anvil Creek (Anvil-Hunker in Hummel, 1960, unpub. data), Engstrom, Penny River, and an unnamed fault southeast of the Anvil Creek fault. Many creeks that lie along or that cross these faults were large producers of placer gold, and small gold-bearing veins with sulfide minerals occur in or near these faults. Anvil Creek alone produced several million dollars in gold.

The normal faults along the south front of the Kigluaik Mountains are downthrown to the south; mineral deposits are not known to be associated with them. In the Kigluaik Mountains many faults trend slightly east of north; many are bordered by kaolinized rocks, and in some (for example, the strong fault cutting the p€bm at longitude 165°58' W. and latitude 64°53' N. in the Nome D-2 quadrangle) large amounts of chalcedonic silica and quartz were introduced. Faults of this set are very well expressed in the eastern part of the Teller 1:250,000 quadrangle (Sainsbury, 1972), both within the Kigluaik Mountains and as much as 50 miles north. That structural deformation in the Nome quadrangle continued into the Cretaceous(?) is shown by deformed coal-bearing beds of Cretaceous(?) age.

ECONOMIC GEOLOGY

Numerous descriptions of the placer gold deposits of the Nome quadrangle have been published, as well as good summary reports that describe the lode deposits which contain gold, base metals, antimony, and silver. No attempt is made here to repeat these descriptions, for none of the lodes have produced significant amounts of metal. Appropriate symbols are placed on the map at the sites of the more important or extensive former placer gold mines, as well as at sites where auriferous lodes are especially prominent. For a detailed plot of lode prospects in the Nome C-1 and D-1 quadrangles, see Hummel (1962a, b). For a good recent summary of the placer deposits near Nome, see Cobb (1972).

A common saying around Nome is "If you draw a circle on the map with a radius of 15 miles, centered at Nome, it includes 80 percent of the gold produced." By reference to the geologic map, two factors can be seen to be of importance in this well-documented location of placer gold deposits. First, most of the gold placers occur in gravels associated with the outcrop area of the York Slate. Without exception, all the early workers who studied the gold deposits of the Seward Peninsula noted that gold placers, as well as auriferous veinlets, were particularly common in the black "slate" (Smith, 1909, p. 311; 1910, p. 149), often near contacts with limestone (Brooks, 1908, p. 122). The regional mapping has strengthened this conclusion, and it holds true for the entire Seward Peninsula, with one major modification--that areas of York Slate cut by major thrust faults, or intruded by granitic stocks, are at least as favorable as contacts between limestone and schist or slate for the formation of placer gold deposits.

The second important factor in localizing the gold placers in the Nome area certainly appears to be the large fault zones (Anvil Creek, Engstrom, Penny River, etc.) along which lodes are common, and which very nearly bound the area of richest stream, bench, and beach placers. Although Nelson and Hopkins (1969) ascribe the source of the marine placers offshore at Nome to a source in glacial moraine, all workers onshore have clearly recognized that the Nome gold originated from nearby lodes. Numerous placers were mined up the stream as stream placers, thence upslope as eluvial placers, and end in shallow lode "mines" where auriferous veinlets or veins were mined to shallow depths. Hence, if the placer gold offshore is related to moraine, it is merely because pre-existing stream, eluvial, and lode deposits were eroded during the glaciations, and auriferous material incorporated into the moraines. The almost total absence of workable placer gold deposits in the large expanses of moraine between the Feather and Sinuk Rivers is noteworthy in considering the source of placer gold. Hummel (written commun., 1960) clearly recognized the importance of the Anvil Creek fault in localizing ore deposits, both lode and placer.

AGE OF MINERAL DEPOSITS

All the recognizable ore deposits, excepting those that Hummel (written commun., 1960) classified as metamorphosed contact-metamorphic deposits at margins of granitic and metagranitic intrusives in the Nome C-1 and D-1 quadrangles, must be at least as young as the thrust faulting. Because rocks of Early Cretaceous age are involved in the thrusting, and the thrust sheets are intruded by granitic rocks as old as 100 m.y., the eastward thrusting probably occurred in the Early to Mid-Cretaceous. Inasmuch as the age of all the high-angle faults that cut the thrust plates is younger than the thrusting, all the vein-type deposits are Mid-Cretaceous or younger in age.

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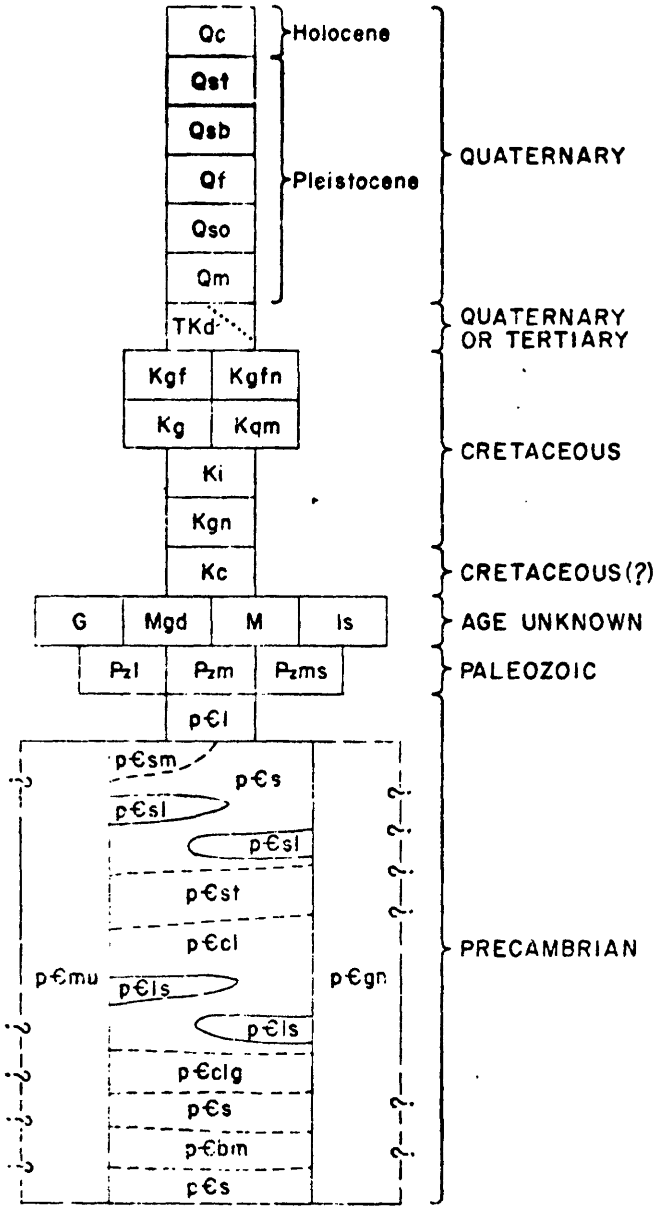
EXPLANATION
Correlation of map units



DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qc — Surficial cover - principally tundra and soil, locally frost-riven regolith and colluvium partly covered by tundra

Qst — Tundra-covered sand, silt, and gravel deposits on a wave-planed platform of Sangamon age, and an older platform of pre-Sangamon age. Includes alluvium along major streams where they cross the platforms, and the modern beach

Qsb — Sand and gravel along the Sangamon beachline where well exposed between the Sinuk and Feather Rivers

Qf — Alluvial fan deposits - only large well-exposed fans are shown

Qso — Sand and outwash gravel - well-washed stratified sand and outwash gravel with some gray silt. Shown only where extensive deposits are formed along the Sinuk River, where they include modern stream gravels and alluvium

Qm — Morainal deposits and stream alluvium composed principally of reworked morainal deposits - northwest of Sinuk River principally terminal moraine; elsewhere principally ground moraine and reworked ground moraine. Shown only where bedrock is completely mantled. Principally of Nome River (Hopkins, 1960) age, but includes younger moraines in the Kigluaik Mountains. Mostly covered by tundra (not shown on moraine)

ROCKS OF TERTIARY OR CRETACEOUS AGE

TKd	Mafic dikes - faintly schistose to unfoliated diabase and lamprophyre, locally hydrothermally altered. Only very long dikes shown

GRANITIC ROCKS OF CRETACEOUS AGE

Kgf	Fine-grained granite - unfoliated biotite granite that forms numerous stocks and dikes all very similar and all containing unusually large amounts of allanite. Some medium-grained or faintly porphyritic granite is included
Kgfn	Fine-grained granite with noticeable foliation
Kg	Granite and quartz monzonite - varies from medium-grained biotite granite to coarse-grained biotite granite
Kqm	Quartz monzonite of Sledge Island - medium- to coarse-grained biotite-hornblende quartz monzonite that grades to biotite granite
Ki	Kigluaik igneous complex - composite intrusive complex with noticeably darker and more mafic borders grading to monzonite(?) core. Intruded by younger plutons of fine- to coarse-grained granite, and cut by many mafic to granitic dikes
Kgn	Gneissic and cataclastic-textured coarse-grained to porphyritic biotite granite, and a gneissic garnet-bearing sill on the north side of the Kigluaik Mountains that may be much older

ROCKS OF CRETACEOUS(?) AGE

Kc — Conglomerate, microconglomerate, and thin coal beds with fireclay

ROCKS OF UNASSIGNED AGE

g — Gabbro, metagabbro, and metamorphosed dark igneous rocks - locally intrude thrust sheets of Paleozoic carbonate rocks, as well as chloritic schists; many are garnet-glaucophane rocks. In an earlier report (Sainsbury and others, 1970) these were referred to the Precambrian, but some may be as young as Early Cretaceous, and intruded in the early stages of the thrusting. Only the more conspicuous bodies are shown

m — Marble and marble schists surrounded by high-rank para-gneisses - most contain monticellite or olivine and several high-density minerals. May represent either carbonate rocks of Precambrian age, or metamorphosed thrust plates of Paleozoic carbonate rocks

ls — Schistose limestone and marble - isolated exposures which cannot be assigned but which likely belong to one of the known units

mgd — Metamorphosed intrusive rocks of dioritic to monzonitic composition

MARBLE, SCHISTOSE MARBLE, DOLOMITE, AND LIMESTONE

Pzl	Limestone and marble - has readily discernible bedding. Consists principally of medium-bedded gray to dark-gray limestone, weathering medium gray
Pzm	Marble and schistose marble - local relict bedding and structures suggestive of fossils or chert nodules. Local color variations reflect original lithologic differences. Where close to chloritic schist, may contain noticeable chlorite; where close to main thrust fault, consists of micaceous, siliceous, or graphitic marble schist, or dolomite or dolomite breccia
Pzms	Silicified marble - weathers white

SCHISTOSE ARGILLACEOUS DOLOMITIC LIMESTONE AND MARBLE

p€l	Thin-bedded schistose argillaceous and dolomitic limestone. Generally highly deformed, and contains many vitreous quartz veinlets. Weathers to thin slabs and fragments stained limonitic yellow

YORK SLATE

p€s	Faintly to moderately foliated graphitic siltite, phyllite, and calcareous graywacke
p€sl	Medium- to dark-gray limestone and marble that weather medium gray where least deformed. Most common in upper part of p€s unit

p€st	Layered quartz gneiss, quartz-biotite semi-gneiss, and graphitic quartz schist; tectonic equivalent of p€s
p€sm	Biotite-quartz-graphite schist, graphitic siliceous calc-silicate rock, and andalusite-biotite schist; all represent metamorphosed equivalents of p€s, p€st
p€cl	Chlorite-albite-epidote-amphibole schist, in part of volcanic origin, and less schistose epidote-plagioclase-amphibole rock which may represent metamorphosed intrusive rock of much younger age
p€ls	Schistose marble surrounded by chloritic schist; may represent limestone originally intercalated in a marine volcaniclastic sequence. Commonly contains chlorite and quartz grains
p€clg	Chloritic schist with graphite or quartz; may represent tectonic mixing of p€s and p€cl, or may be metamorphosed, originally impure rocks
p€bm	Marble and marble schist that form continuous bands on the west and northwest end of the Kigluaik Mountains. May represent limestone equivalent to p€sl, but are more continuous, more highly schistose, and thicker. Includes thick units of highly calcareous biotite schist

PARAGNEISS AND UNDIFFERENTIATED METAMORPHIC ROCKS

| p€gn | Quartz-biotite-graphite-plagioclase-garnet paragneiss and semi-gneiss, locally containing sillimanite. Many small bodies of younger granitic bodies are unmapped. Boundaries with p€sm and p€st are gradational suggesting gneiss is a high-rank equivalent of the York Slate |
| p€mu | Paragneiss, biotite schist, and thermally metamorphosed equivalents, undifferentiated. |

A B C D

Veins and mineralized areas

A. Mineralized faults with old prospect pits or trenches containing elements as shown

B. Widespread gossans with old prospect pits or trenches; contained elements unknown

C. Placer gold mine extending along stream or beach as shown

D. Placer gold mine of localized extent. On coastal plain symbol represents surface placers as well as old drift mines on buried beaches. Symbols for metals contained in prospects or mines: Au, gold; Ag, silver; Pb, lead; Sb, antimony; Zn, zinc; Cu, copper; CaF_2, fluorite.

A B C

Contacts

A. Transitional over a few feet to hundreds of feet

B. Sharp contact well exposed

C. Open ends indicate that bed continues an unknown distance beyond exposure

All contacts dashed where inferred or approximately located, dotted where concealed

A B

Faults

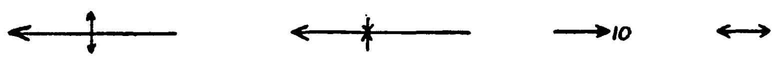
A. Thrust fault; sawteeth on upper plate. Dashed where approximately located, dotted where concealed, queried where inferred or doubtful

B. High-angle fault, showing dip. U, upthrown side; D, downthrown side. Dashed where approximately located or inferred, dotted where concealed, queried where doubtful

A B C D

Strike and dip of foliation or cleavage

A. Strike and dip estimated by observation from low-flying aircraft
B. Strike and dip direction as determined by observation from low-flying aircraft
C. Strike and dip as measured on the ground
D. Strike and dip direction as determined on the ground



Anticline Syncline Drag folds

Folds

Showing approximate crestline and direction and amount of plunge where known

Prospect pit or trench

Abandoned dredge

Sinkhole

Cold-water spring