UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RECONNAISSANCE GEOLOGIC MAP OF THE NOME C-2 QUADRANGLE, SEWARD PENINSULA, ALASKA

By C. L. Sainsbury, Travis Hudson,

Rodney Ewing, and William R. Marsh

Open-file report

1972

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

CONTENTS

Reconnaissance Geologic Map of the Nome C-2 Quadrangle, Seward Peninsula, Alaska

by

C. L. Sainsbury, Travis Hudson, Rodney Ewing, and William R. Marsh

INTRODUCTION

The Nome C-2 quadrangle lies immediately west of Nome, Alaska, and adjoins the area mapped by Hummel (1962a). The area contains placer and lode gold deposits. Placer gold has been produced from several creeks, as well as from buried beachsands. Lode deposits consist of sulfide-bearing quartz veins, stock works of veinlets in altered limestone where sulfides have oxidized and produced extensive gossans, and a barite-fluorite deposit of current interest. Other lode and placer deposits containing gold, base-metal sulfides, or fluorite and barite may exist.

MAPPING METHODS

The area was mapped by helicopter traverses, limited ground traverses, and low-level traverses by light aircraft using the methods developed and described by Sainsbury, Curry, and Hamilton (1972). Initially, the helicopter was used for spot-checking lithologies at approximately 150 points scattered throughout the quadrangle, and numerous samples were collected for later study. Several short traverses were made from the helicopter. Using the information gained from the helicopter stations, contacts and lithologic units were mapped from the light aircraft. Several foot traverses as long as several miles were made from the landed aircraft. During preparation of the map, the helicopter was used approximately 6 hours and the light aircraft approximately 25 hours, yielding about 3,000 miles of low-level traverse.

Ground traverses were made to gain detailed information of important relations. A traverse southwest from the ridge at the headwaters of the Penny River provided detailed observations on the main thrust fault at the base of the carbonate rocks as well as on the tectonically controlled changes in the slaty rocks. Dikes in the carbonate rocks were sampled during ground traverses, and the prospects south of the Sinuk (Sinrock) River were examined on foot. Many short traverses were used to collect rocks for chemical analyses or thin sections, which were studied in the laboratory.

Many details of the geology are omitted, especially numerous small metagabbro bodies, as well as thin lenticular limestones intercalated in the slate.

GEOLOGY

Throughout most of the map area the rocks are deformed, with development of cleavage and, locally, marked schistosity. Bedding is seldom seen; instead, contacts between rock units are parallel to a strong cleavage or schistosity, and it cannot always be determined whether the contacts are depositional, or whether they reflect deformation of contacts that could have been crosscutting prior to the dynamic metamorphism. Most contacts, cleavages, and schistosity dip west, and innumerable microfolds and dragfolds are overturned to the east, showing conclusively that tectonic transport was eastward in the deformed rocks.

The main mapped unit consists of the "York Slate" ("slate of the York region"), which was named originally by Collier (1902) where exposed in the York Mountains, some 65 miles west. In this report, rocks which were originally included in the Nome Group by Moffit (1913) and Hummel (1962a), are here referred to the York Slate. All the units shown on the map are correlative with rocks in the adjoining quadrangle (Nome C-1) mapped by Hummel (1962a). However, the formations named by Hummel have not been retained, for several of his formations are believed by Sainsbury to include parts of the York Slate as well as Paleozoic carbonate rocks and metamorphosed mafic rocks which could be as young as Early Cretaceous. As these rocks are intimately intermixed by thrust faults, it is thought best not to try to retain the functional names given by Hummel.

Stratigraphy

York Slate

This unit forms the bulk of the bedrock exposed in the quadrangle. It consists of a great thickness of graphitic fine-grained siltite, in which the silt-sized grains are mainly quartz. Chemical analyses of bulk samples of this rock show that silica ranges between 81 and 92 percent. Although the rock changes markedly in appearance in specimens from highly deformed to slightly deformed rocks, the siliceous composition is always apparent. In most outcrops, the rock is dark, slaty, and relatively hard, commonly with numerous small white quartz veinlets.

East of the Penny River the slates are relatively undeformed and are exposed along the faulted west limb of a large anticline trending north. The upper part of the unit is exposed north of the headwaters of the Penny River, where it consists of calcareous graphitic siltite with thin beds of dark limestone. Locally, calcareous graywacke beds are common. The uppermost part of the slate unit is cut off by the Penny River fault, and by the thrust fault which has thrust Paleozoic marbles eastward over the slate, and the thin-bedded limestones that normally overlie the slates are not seen.

Chloritic Schists

Large expanses of chlorite-albite-amphibole schist in the west half of the quadrangle are of uncertain age and origin. Equivalent rocks in nearby areas were referred to the Nome Group by Collier (1902), Moffit (1913), Smith (1910), Hummel (1962a, b), and Sainsbury, Coleman, and Kachadoorian (1970). However, the mapping by the authors in 1971 leads to the conclusion that the Nome Group as originally defined is a heterogenous unit involving intensely deformed mafic intrusive rocks which could be as young as Early Cretaceous, as well as thrust slices of Paleozoic carbonate rocks tectonically mixed with the slate of the York region. On this map and others prepared in 1971, the designation of Nome Group is abandoned.

The chloritic schists of the Nome C-2 quadrangle are mostly glistening phyllites or schists, which are completely reconstituted and which may represent a volcanic pile intercalated in the slate of the York region. However, numerous metagabbroic intrusives in the slate are surrounded by chloritic, graphitic schists which appear to have been produced by the addition of magnesium to the slates from the gabbros (see Sainsbury, 1970, for relations nearby). In some areas, for example east of Cripple River, thin beds of schistose marble with abundant chlorite are intercalated in the chloritic schists, and such schists likely are metamorphosed volcaniclastic piles deposited in a marine environment. In other places, the chloritic schists grade upward and downward to graphitic schists through transition zones hundreds of feet thick, again suggesting that the chloritic schists are metamorphosed volcanic rocks extruded into a deep-sea sedimentary basin. A genetic interpretation of origin is complicated by thrusting, which has produced thick units of chloritic, graphitic schists by tectonic mixing of intrusive gabbroic rocks, slate, and probably volcanic rocks.

On this map, the chloritic schists are assigned to the Precambrian, and metamorphosed mafic rocks that clearly intrude the slate, or carbonate rocks of the thrust sheets, are given no age assignment.

Carbonate Rocks

A belt of carbonate rocks broken by numerous normal faults trending northwest forms the high, bare hills extending northeast from the Penny River. Although relict bedding is suggested by color changes, the rocks are all deformed to schistose marble. These carbonate rocks locally contain quartz nodules which are believed to represent original chert, but no fossils have been found. Judged from the color bands, the relict chert, the obvious thickness of the original carbonate rocks, and the absence of interbeds of slate or chloritic schist, these schistose carbonate rocks are assigned to the Paleozoic, for the established Precambrian stratigraphy allows no place for such a thick section of carbonate rocks. On the other hand, deposition of carbonate rocks on the Seward Peninsula continued almost uninterrupted in Late Precambrian, Ordovician, Silurian, Devonian, and Mississippian time on the Seward Peninsula (Sainsbury, 1969).

At most places the carbonate rocks are in fault contact with slate or chloritic schist. At exposed thrust faults, such as that bounding the east side of the carbonate belt, the carbonate is tectonically mixed with the underlying rocks to form a zone of orange-weathering schistose graphitic carbonate rock. The underlying slate near the thrust is completely recrystallized to a banded quartz gneiss with most of the graphite expelled. The disturbed and recrystallized rocks form a belt over a mile wide, which is cut off by the Penny River fault. Other blocks of carbonate rocks definitely are in thrust-fault contact with either slate or chloritic schist. All thick carbonate rocks without interbedded schists are assigned to the Paleozoic; whereas thin dark schistose carbonate rocks that are surrounded by slate or schist are assigned to those units. A few carbonate rocks which could be either continuations of thrust slices, or intercalations in schist or slate, are not assigned by age.

Intrusive Rocks

The only intrusive rocks mapped in the Nome C-2 quadrangle consist of partly to completely metamorphosed mafic rocks, which form masses as much as a mile long, and very slightly metamorphosed dark dikes which are intruded into faults that trend northwest. Within the large carbonate bodies, the dikes are very straight for miles; this characteristic and the fact that they are mostly fresh and chemically similar to late mafic dikes in adjoining areas are sufficient to assign them to the Tertiary or Cretaceous Systems. The older, highly deformed mafic bodies generally are completely reconstituted, although some have massive centers that grade imperceptibly to schistose borders. Foliation planes in the mafic bodies generally conform to local and regional patterns developed during the intense overthrusting; most of these intrusives clearly are older than the thrusting. Similar rocks in nearby areas were assigned by Hummel (1962a, b) to the Paleozoic, and by Sainsbury (1969, p. 41; 1970) to the pre-Ordovician or to the Precambrian, because they were not known to intrude Paleozoic carbonate rocks. Sainsbury, Coleman, and Kachadoorian (1970, p. B-40) recognized two distinct groups of mafic intrusive rocks, the older of which is completely reconstituted to albite-epidote-chlorite-hornblende-[glaucophane]-garnet-sphene rocks. The younger rocks retain relict pyroxene and calcic plagioclase. Both were assigned to the Precambrian.

The results from the present studies indicate that these two groups of mafic rocks may be of greatly different ages. Because similar rocks intrude carbonate rocks of Paleozoic age in nearby regions (T. P. Miller, oral commun., 1970), some mafic rocks may be as young as Mesozoic. If such rocks are found to contain glaucophane, then the blueschist metamorphism of the Seward Peninsula, referred by Sainsbury, Coleman, and Kachadoorian (1970) to the Precambrian, may be in part as young as late Mesozoic, and related to the thrusting which is clearly of Cretaceous age.

Structure

The Nome C-2 quadrangle is separated for convenience into 3 main structural blocks, two of which are separated by the Penny River fault. Rocks east of the Penny River fault all belong to the slate of the York region; these form the west limb of a large symmetrical anticline trending about north. West of the Penny River fault, plates of Paleozoic carbonate rocks are thrust eastward over slate, and are broken into numerous blocks by high-angle faults. In this area, cleavage, schistosity, and relict bedding all dip westerly as a consequence of the thrusting. West of Cripple River, in the third block, chloritic schist with almost horizontal schistosity and cleavage overlies the slates with a boundary that is transitional. Whether the chloritic schists are thrust over the slate or are in normal contact has not been determined, but the fact that to the north the chloritic schists transgress both slate and thick carbonate rocks of probable Paleozoic age means that the schists are either thrust eastward or represent metamorphosed intrusive rocks.

In addition to the thrust faults, several sets of normal faults are recognized. Of these, the most conspicuous trend about N. 30-45° W., and N. 20-30° E.; many of these faults are bordered by altered and stained rocks with old prospect pits. Mafic dikes are commonly intruded along the faults striking northwest.

The Penny River fault zone is marked locally by two parallel faults presumably downthrown to the west at least several hundred feet. The fault zone is best exposed on the ridgeline at the extreme headwaters of the Penny River, where two parallel faults are clearly seen. The easterly one is bordered by kaolinized, iron-stained rock. The Penny River fault is parallel to the strong Anvil Creek fault zone in the adjoining Nome C-1 quadrangle (Hummel, 1962a), and both of these faults are mineralized.

ECONOMIC GEOLOGY

Productive placer gold mines, as well as numerous lode prospects, are found in the mapped area. Most of the placer mines were operated before 1942; many were mined shortly after 1900. The placers are described best by Brooks, Richardson, and Collier (1901), Moffit (1913), and Purington (1905); they consist of auriferous gravels along present streams, and buried beach placers. Many streams that head in the slate belt between the Penny and Snake Rivers contained placer gold.

The gold in these placers most probably was derived from sulfide-bearing quartz veins in the slate, for many such veins are exposed. The veins on the ridge at the head of Penny River consist of sulfide-bearing quartz that forms discontinuous lenses and pods along the faults. The quartz contains native gold associated with stibnite, pyrite, galena, and other sulfide minerals. In places, the auriferous sulfides constitute several percent by volume of the quartz. The creek below has been mined.

Fluorite and barite, with small amounts of gold, silver, copper, lead, and zinc, replaces schistose marble interbedded with chloritic schist at a prospect near the road between the Cripple and Sinuk Rivers. Known locally as the "Sinuk River barite deposit," the prospect is under active development. It was described most recently by Brobst, Pinckney, and Sainsbury (1971).

North of the barite prospect, numerous gossans, iron-stained rocks along faults, and prospect pits in marble are collectively referred to as the "Sinuk River iron deposits," first described by Eakin (1915), who concluded that the gossans form caps over altered limestones and marble veined intricately by sulfide-bearing veinlets. Later descriptions by other workers give additional information (Mulligan, 1965; Herreid, 1966). Numerous other small prospect pits in the mapped area have not been studied. None appear as promising as the Sinuk River barite deposit, as alteration is more restricted, and ore minerals are not exposed in the pits.

SUGGESTIONS FOR EXPLORATION

On the basis of the geologic relations depicted on the map, several recommendations are made below concerning areas for exploration of known deposits and for evaluation of potential deposits.

First, although no evidence exists to suggest that the uppermost reaches of the Penny River were ever tested, the known lodes along the Penny River fault suggest the possibility of workable placer deposits there.

Second, new mapping suggests strongly that the barite-fluorite deposit could be related to a source area at depth, where mineralizing fluids escaped along the nearby normal faults. Deep mineral deposits are possible, as emphasized by Brobst, Pinckney, and Sainsbury (1971).

Third, because several altered fault zones strike into the general area of the gossans (the Sinuk River "iron deposits"), and because there is a sufficiently large volume of altered limestone containing oxidized sulfide minerals to sustain a large-tonnage operation, further study in this area is warranted.

Fourth, geophysical work across the upper Cripple and Sinuk Rivers might locate drift-covered preglacial channels in bedrock that contain placer gold. Several small placers in thin drift show that gold is concentrated, at least locally, on bedrock beneath the drift.

The discontinuous mining along the buried beaches shows that portions of the auriferous beaches probably remain, but present-day economics probably preclude their mining.

REFERENCES CITED

Brobst, D. A., Pinckney, D. M., and Sainsbury, C. L., 1971, Geology and geochemistry of the Sinuk River barite claims, Seward Peninsula, Alaska: U.S. Geol. Survey Open-file rept., 29 p.

Brooks, A. H., Richardson, G. B., and Collier, A. J., 1901, A reconnaissance of the Cape Nome and adjacent gold fields of Seward Peninsula, Alaska, in 1900, in Brooks, A. H., Richardson, G. B., Collier, A. J., and Mendenhall, W. C., Reconnaissances in the Cape Nome and Norton Bay regions, Alaska, in 1900: U.S. Geol. Survey Special Paper, 185 p.

Collier, A. J., 1902, A reconnaissance of the northwestern portion of Seward Peninsula, Alaska: U.S. Geol. Survey Prof. Paper 2, 70 p.

Eakin, H. M., 1915, Iron deposits near Nome: U.S. Geol. Survey Bull. 622-I, p. 361-365.

Herreid, Gordon, 1966, Preliminary geology and geochemistry of the Sinuk River area, Seward Peninsula, Alaska: Alaska Div. Mines and Minerals Geol. Rept. 24, 11 p.

Hummel, C. H., 1962a, Preliminary map of the Nome C-1 quadrangle, Seward Peninsula, Alaska: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-247.

_____ 1962b, Preliminary geologic map of the Nome C-2 quadrangle, Seward Peninsula, Alaska: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-248.

Moffit, F. H., 1913, Geology of the Nome and Grand Central quadrangles, Alaska: U.S. Geol. Survey Bull. 533, 140 p.

Mulligan, J. J., and Hess, H. D., 1965, Examination of the Sinuk iron deposits, Seward Peninsula, Alaska: U.S. Bur. Mines Open-file rept., (no number).

Purington, C. W., 1905, Methods and costs of gravel and placer mining in Alaska: U.S. Geol. Survey Bull. 263, 273 p.

Sainsbury, C. L., 1969, Geology and ore deposits of the central York Mountains, western Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 1287, 101 p.

_____1970, Geologic map of the Teller 1:250,000 quadrangle, Alaska: U.S. Geol. Survey Open-file rept., map and text (in press as I-685, 1972).

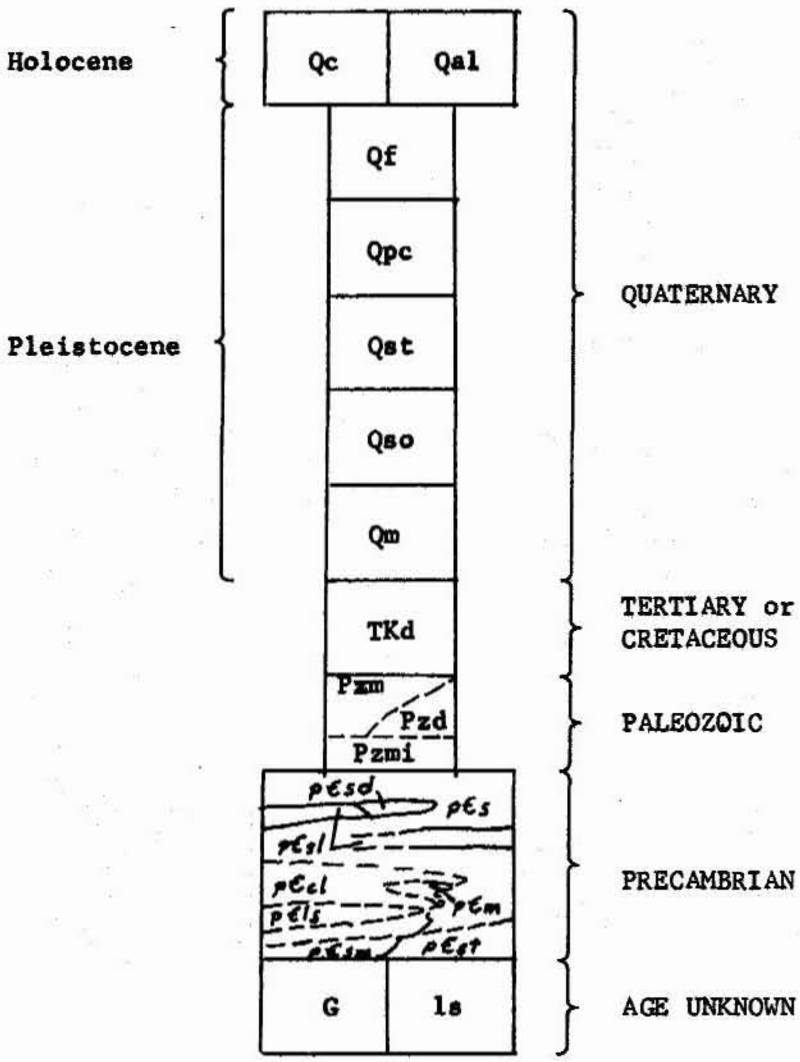
Sainsbury, C. L., Coleman, R. G., and Kachadoorian, Reuben, 1970, Blueschist and related greenschist facies rocks of the Seward Peninsula, Alaska: U.S. Geol. Survey Prof. Paper 700-B, p. B33-B42.

Sainsbury, C. L., Curry, K. J., and Hamilton, J. C., 1972, An integrated system of airborne geologic mapping and geochemical sampling: U.S. Geol. Survey Bull. 1361 (in press).

Smith, P. S., 1910, Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 433, 234 p.

EXPLANATION

Correlation of map units



Description of map units

Qc	Surficial cover - principally tundra and soil, locally frost-riven regolith and colluvium partly covered by tundra
Qal	Alluvium
Qf	Alluvial fan deposits - only larger fans shown on map
Qpc	Conglomerate - found only in valley of the Penny River
Qst	Tundra-covered sand and silt - deposits on a wave-planed platform of Sangamon age and an older platform of pre-Sangamon age
Qso	Sand and outwash gravel - well-washed stratified sands and outwash gravels with lenses of gray silt
Qm	Morainal deposits - northwest of Sinuk River principally terminal moraine; elsewhere principally ground moraine. Shown only where bedrock is completely mantled. Referred to Nome River Glaciation
	Mafic dikes - faintly schistose to unfoliated diabase and lamprophyre, locally hydrothermally altered

MARBLE, SCHISTOSE MARBLE, AND DOLOMITE

Pzm	Marble and schistose limestone with local relict bedding and structures suggestive of fossils; weathers light gray to gray; forms hills bare of tundra
Pzd	Dolomite and dolomite breccia of tectonic origin
Pzmi	Calcite-mica-graphite schists at base of thrusts; formed by tectonic mixing of carbonate and underlying rocks

YORK SLATE

p€s	Faintly to moderately foliated graphitic siltite, phyllite, and calcareous graywacke
p€sl	Medium- to dark-gray limestones that weather medium gray where undeformed; where deformed are schistose marbles. Most common in uppermost part of unit
p€sd	Dolomitized p€sl
p€cl	Chlorite-albite-epidote-actinolite schists, in part of volcanic origin, and less schistose chlorite-epidote-amphibole-plagioclase rocks, which may represent intrusive rocks of much younger age

YORK SLATE - Continued

p€ls Schistose limestone or marble apparently intercalated in p€cl unit; commonly contains quartz grains and chlorite

p€m Marble and silicified marble apparently intercalated in p€cl unit, but which may be a thrust sheet

p€st Tectonic equivalent of p€s; varies from highly lineated phyllites to markedly deformed rocks with rolled quartz rods, and, near major thrusts, to quartz gneiss with most of the graphite expelled. Shown on map only where best exemplified

p€sm Metamorphosed equivalent of either of the units p€s, p€st; mainly biotite bearing

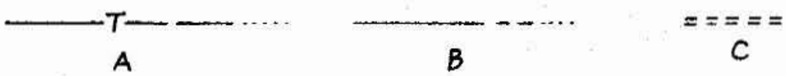
UNITS OF UNKNOWN AGE

Gabbro, metagabbro, and related mafic rocks - locally intrude thrust sheets of Paleozoic carbonate rocks, as well as chloritic schists; some are garnet bearing. In earlier reports, these were referred to the Precambrian, but they may be as young as Early Cretaceous and intruded in early stages of the thrusting. Only the more conspicuous occurrences are shown on map

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

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



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

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