GEOLOGIC MAP OF THE TELLER QUADRANGLE, WESTERN SEWARD PENINSULA, ALASKA

By
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INTRODUCTION

The Teller quadrangle includes the westernmost tip of the North American Continent at its closest approach to Siberia. Rocks of Precambrian and Paleozoic age are intricately intermixed as the result of intense overthrust faulting in the Collier thrust belt (Sainsbury, 1969b).

Much of the early work on the Seward Peninsula was by rapid reconnaissance and is now outdated; therefore the geologic data and conclusions presented here are based principally upon my work since 1958. Except for Smith's (1910) work around Nome, the thrust relations were unrecognized during the early reconnaissance mapping; hence, rocks of widely different ages were grouped. The present report retains previous groupings where feasible; where not, older names are abandoned or modified.

GEOLOGY

GENERAL STRATIGRAPHY

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 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 1904-5, and who found the apparent stratigraphy so complex that he deferred correlations, divided the Kigluaik Group into the Tigaraha Schist and various intrusive types, and the older crystalline limestones and gneisses. Moffit (1913, p. 27) also changed the rank of the Nome Series to Nome Group, and stated that it contained principally chloritic schist and smaller amounts of feldspathic and siliceous graphitic schist.

Later workers (for example, Smith, 1910) retained these names, and added others to accommodate lithologic variations in restricted areas, so that considerable confusion resulted. As pointed out previously (Sainsbury, 1965, 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.

In the present report, established terminology is retained where possible, but, except for the Kigluaik Group, designated units are considerably restricted. Present usage is as follows:

Kigluaik Group.—The Kigluaik Group includes rocks of Precambrian age only, comprising all of Moffit's (1913) units, including the Tigaraha Schist; it includes Precambrian orthogneiss, but excludes Cretaceous igneous rocks. The Tigaraha Schist as here used includes some marbles and calcareous sequences, but excludes some graphitic, siliceous rocks now referred to the "slate of the York region."

Nome Group.—This name is restricted to rocks which are of Precambrian age, and which consist of chloritic schist and marble schist, with minor amounts of graphitic, chloritic schist and metamorphosed gabbroic rocks. Massive marble and limestone of Paleozoic and latest Precambrian age are excluded.

Kuzitrin Series.—This name is abandoned, for it included rocks correlative with part of the Tigaraha Schist, as well as younger graphitic rocks now assigned to the "slate of the York region," a term first used by Knopf (1908, p. 13).

"Slate of the York region."—This informal name is retained for graphitic, slaty, or phyllitic rocks of late Precambrian age, which originally consisted mainly of silt-sized quartz grains in a carbonaceous matrix, and which are widespread over the Seward Peninsula. Locally, these rocks include thin black limestone, calcareous graywacke, and, in the vicinity of granite, biotite-andalusite-tourmaline rocks.

Port Clarence Limestone.—This designation is abandoned, for it was expanded from the original designation to include rocks ranging in age from late Precambrian through Mississippian. In this report, each limestone unit is referred only to the system represented.

PRECAMBRIAN ROCKS

Kigluaik Group

Unnamed lower part.—The unnamed lower part of the Kigluaik Group, which is exposed at the west base of Mount Osborn just off the south border of the quadrangle, consists of banded quartz-plagioclase-biotite-garnet-paragneiss (p€gl), originally calcareous, cut by numerous pods, lenses, and dikes of granitic gneiss. The original carbonate is now calc-silicate rock, with local bits of coarse-grained calcite. The granitic gneiss dikes are folded and attenuated. The gneiss in the lower part of the Kigluaik unit has an exposed thickness of 1,500 feet on Mount Osborn; the base is not exposed, and the gneiss is transitional into an overlying coarse-grained marble (p€m), which here is about 500 feet thick. Muscovite and either olivine or monticellite are characteristic of the marble. Because of flowage and recrystallization, the marble varies in thickness, and none of the original bedding is preserved.

The marble is overlain abruptly by additional banded gneiss (p€gu), which contains calc-silicate rocks and biotite schist. The main difference between the upper and lower gneisses is that the upper gneiss contains a larger amount of calc-silicate rock and biotite-garnet schist.

Tigaraha Schist.—Within the area of the Teller quadrangle, the Tigaraha Schist (p€b) is composed principally of graphitic biotite schist, calcareous biotite schist, and biotite-garnet schist, and it also contains several calcareous sequences. Numerous variations were noted on the south side of the Kigluaik Mountains, where staurolite schist, siliceous graphitic schist, and calc-silicate rocks occur. Moffit (1913, p. 21) included graphitic siliceous schist that is widespread on the south side of the Kigluaik Mountains with the Tigaraha Schist, whereas earlier workers considered this graphitic schist to be part of the Kuzitrin Series. (In the present report, these siliceous, graphitic rocks are referred to the "slate of the York region.")

Within the Tigaraha Schist are several calcareous sequences of considerable thickness. One sequence is conspicuous along

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the north front of the Kigluaik Mountains, and was mapped separately as a calcareous subunit (p€bm) of the Tigaraha Schist. A section measured in the headwaters of a small unnamed stream flowing into Windy Cove of Imuruk Basin from just east of the small body of fine-grained granite consists of a lower unit 80 feet thick of marble containing rolled quartz "rods," a middle unit 360 feet thick of quartz-biotite schist with calcareous lenses, pods, and thin beds, and an upper unit 550 feet thick of marble.

Orthogneiss.—The Kigluaik Group rocks are intruded by numerous igneous rocks including a quartz-biotite orthogneiss (p€gn) with numerous associated coarse-grained pegmatites that contain dark tourmaline and, locally, beryl (Moffit, 1913, p. 26), as well as by younger granite and dike rock.

Age.—The Precambrian age of the Kigluaik Group rocks is based on geologic evidence and on two age dates, each 750 m.y. (million years), by C. E. Hedge, U.S. Geological Survey (written commun., 1969), who, using the whole-rock rubidium-strontium method, dated a sample of the orthogneiss (p€gn) from the southeast corner of the Teller quadrangle and a sample of the granitic dikes cutting the lower gneiss on the west face of Mount Osborn, just off the south border of the map area east of the Cobblestone River. Hedge stated, "From my experience in dating rocks of this type from other areas, I interpret this age as being the time of metamorphism. I believe a Precambrian age for these rocks is strongly suggested but not conclusively proved at this time."

On the basis of these age dates and the abundant geologic evidence that the rocks are much older than the "slate of the York region," which is itself older than unfossiliferous rocks below the Lower Ordovician limestones of the York Mountains (Sainsbury, 1965, 1969c), I consider the Precambrian age established.

Nome Group

The Nome Group (p€n), originally named and described by Brooks, Richardson, and Collier (1901), but restricted here to rocks of Precambrian age, consists of greenish schist with numerous intercalated layers of marble and marble schist, all of which are intruded by numerous dikes and plugs of altered mafic rocks. For the most part, the schist (p€nc) is composed of magnesian chlorite, epidote, albite, quartz, calcite, amphibole, and sphene; locally, garnet and glaucophane occur, particularly in the east part of the quadrangle. The marble schist (p€nl) displays abundant drag folds overturned to east or north; those overturned east normally have horizontal axes with an intense *ac*-plane lineation that consists of striations and elongated new minerals. Almost everywhere a second plane of foliation crosscuts the earlier schistosity, clearly recording two metamorphic cycles. All the marble schist layers contain numerous grains of quartz, which differentiates them from the Paleozoic carbonate rocks. The schist of the Nome Group has not been found in an unquestionable depositional contact over the older Kigluaik Group, but it nowhere is converted to gneiss and therefore it probably is younger than the Kigluaik Group.

Upper Precambrian rocks

Rocks of this age consist of the "slate of the York region" (p€s) and an overlying sequence of interbedded, thin-bedded dolomitic limestone and argillaceous limestone (p€l). Included within the "slate of the York region" are diverse lithologic types such as graywacke, slate, carbonaceous siltite, and thin carbonaceous limestone, but either siliceous slate or carbonaceous siltite forms the bulk of the unit. Although locally the unit is intensely deformed, especially near thrust faults, much of it still displays original silt-sized quartz grains and relict depositional features, which is in sharp contrast to rocks of the Nome Group, whose original sedimentary features are seldom seen.

Above the slate, with a contact that in the York Mountains is transitional (Sainsbury, 1965, 1969c), is a thick sequence of thin-bedded dolomitic limestone with rhythmically interbedded argillaceous limestone (p€l) which contains ubiquitous small quartz veinlets. This limestone sequence is so deformed that its true thickness cannot be determined, but it is at least several hundred feet thick. The quartz veinlets distinguish these rocks from lithologically similar Ordovician rocks.

Gabbro (p€g) as dikes, sills, and irregular plutons intrudes the slates in many places and the argillaceous limestones at one place. Gabbro and related rocks are of two ages—the older is completely recrystallized, and the younger retains a relict igneous texture. In the east part of the Teller quadrangle, the older mafic rocks and the enclosing Nome Group rocks locally have been converted to glaucophane-garnet rocks of the blueschist facies (Sainsburgy and others, 1970). The gabbros do not intrude the Paleozoic rocks.

Age.—The slate and overlying limestones are dated as Precambrian because the rocks are unfossiliferous and more deformed than the overlying Lower Ordovician limestones, contain quartz veins, and are intruded by numerous gabbros that do not intrude the Lower Ordovician limestones.

PALEOZOIC ROCKS

The oldest Paleozoic rocks consist of a very thick sequence of unmetamorphosed fossiliferous limestone, dolomitic limestone, and argillaceous limestone (Ol, Oal) of Early Ordovician age. Where studied in detail in the York Mountains (Teller B-4 and C-4 quadrangles),[1] these rocks aggregate at least 7,000 feet in thickness, and may reach nearly 13,000 feet (Sainsbury, 1969c). The Lower Ordovician limestone is transitional into an overlying thin, black, fissile shale 50-100 feet thick, which is transitional into overlying dark limestone (Oshl) and dolomitic limestone (Oshd). The time boundary between Early to Middle Ordovician occurs just below the black shale. The Middle Ordovician rocks exceed 2,400 feet in thickness. Overlying these are fossiliferous dark limestone and dolomite limestone of Late Ordovician age which are best exposed west of the Don River, in the Teller B-4 quadrangle, although they occur elsewhere. Fossils suggest that Lower Silurian rocks are absent. A disconformity at the top of the Ordovician is recognized at many places in the Soviet Union (Boucot, 1969). Because the time boundary lies within the uppermost dark limestone, and is not mappable on lithology, the map unit includes some Silurian rocks, and hence is shown as SOdl. The dark limestone appears transitional into overlying Silurian limestone (Sl), which is light brownish gray. The Upper Ordovician and Silurian rocks together exceed 1,000 feet in thickness.

The Devonian System is represented by dark-colored sparsely fossiliferous limestone and dolomitic limestone (Dl) aggregating several hundred feet in thickness exposed in a window in thrust sheets of undifferentiated limestone of late Precambrian and Early Ordovician age north of the Agiapuk River. Devonian limestone is exposed also in the Bendeleben quadrangle 1:250,000 which adjoins the Teller quadrangle on the east.

The Mississippian System is represented by intricately deformed and recrystallized limestone with subordinate shale (Ml) near Cape Mountain at the westernmost tip of the Seward Peninsula (Collier and others, 1908). The rocks of Mississippian age, which form the upper plate of the Wales thrust fault, were isoclinally folded during eastward thrusting, and shale beds are broken into isolated and discontinuous fragments. No estimate of thickness is possible; the rocks are so tectonically deformed that for the most part they are converted to banded marble. They are, however, sparsely fossiliferous. Collier, Hess, Smith, and Brooks (1908, p. 81) reported interbedded "dark mica schists or phyllites," as well as quartzite; however, this "quartzite" is a banded fine-grained quartz which has replaced the limestone immediately above the Wales thrust fault, and the phyllite is believed to be infolded thrust slices of the "slate of the York region."

[1]Quadrangles of 1:250,000 scale in Alaska are divided into 1:63,360-scale quadrangles by division along latitude and longitude lines as follows: Beginning from the southeast corner, each 15 minutes of latitude marks the north boundary of a line of quadrangles numbered A, B, C, D; to the west, each 30 minutes of longitude marks the west boundary of a line of quadrangles numbered 1, 2, 3, 4, 5, 6, 7, 8.

CRETACEOUS ROCKS

Exposed rocks of Cretaceous age consist of intrusive rocks ranging from gneissic granite to diabase. Granitic rocks of at least two ages are known. The older rocks consist of a thick and continuous sill of garnet-bearing gneissic granite (Kgn) exposed for miles along the north side of the Kigluaik Mountains, and the younger forms stocks and dikes of unfoliated biotite granite (Kg, Kgf) in the Kigluaik Mountains and elsewhere in the quadrangle. The gneissic granite is assumed to be of Early Cretaceous age (although it may be older); the stock at Brooks Mountain (east headwaters of the Mint River) was dated by Marvin Lanphere, U.S. Geological Survey (written commun., 1967), who used the K-Ar method on biotite and obtained a calculated age of 75.1 ± 3 m.y.

CRETACEOUS AND TERTIARY(?) ROCKS

Numerous dikes of granite, diabase, rhyolite, rhyolite porphyry, andesite, and lamprophyre (TKd, TKa) occur. None of these are gneissic, and all types intruded the thrust sheets; they are, therefore, considered at least as young as Late Cretaceous in age, and some may be as young as Tertiary.

TERTIARY OR QUATERNARY ROCKS

An extensive volcanic field south of the Agiapuk River contains deeply eroded scoriaceous basalt (QTb) that can be seen to overlie unconsolidated gravel in a single exposure near the western forks of the Agiapuk River. That the lava fields were once more extensive is suggested by eroded remnants of flows and by breccia necks eroded into relief, indicating extensive destruction of the original surface of the lava field. This erosion may have taken considerable time, and some of the volcanics may be as old as late Tertiary, although they most probably are Pleistocene. Fragments of scoria are found in the gravel overlying the York terrace of Yarmouth(?) age, and hence the basalt is at least as old as Yarmouth(?).

PLEISTOCENE ROCKS

Cemented conglomerate (Qpc) of Pleistocene age forms isolated patches over the York terrace of Yarmouth(?) age, which notches the south flank of the York Mountains (Teller B-4) quadrangle). The conglomerate, which represents old deltaic and alluvial gravel, has been described in detail (Sainsbury, 1965).

PLEISTOCENE AND HOLOCENE UNCONSOLIDATED DEPOSITS

Most of the low areas of the quadrangle are covered by perennially frozen surficial deposits which include (1) extensive silt and loess blankets over the marine platforms of Sangamon age, (2) glacial moraine and outwash gravel of Wisconsin age, and (3) upland silt of Holocene age. Rounded upland areas are mantled by frozen silt and a thick mat of tundra which effectively mask bedrock. The Pleistocene and Holocene deposits have been described in detail (Sainsbury, 1965, 1967).

STRUCTURE

The geologic structure of the Teller quadrangle is dominated by thrust faulting of two different ages. Beginning probably in the early mid-Cretaceous, Precambrian and Paleozoic rocks both were thrust eastward, north-trending folds were developed and overturned to the east, and an *ac*-plane lineation formed. The structural grain formed in this tectonic cycle is best shown east of the American River, where Precambrian and Paleozoic rocks are intimately intermixed. Later in the Cretaceous, the unmetamorphosed rocks of the York Mountains moved from the south into their present position; these rocks dip north, the thrust planes are but gently warped, and structural trends are mainly east-west. In the latest Cretaceous, isolated stocks of biotite granite intruded the thrust sheets, and several systems of normal faults developed, some of which cut the granites. In the York Mountains, the strongest system of normal faults strikes about N. 75°-85° E., and south blocks are downthrown. Faults of this system were very important in localizing ore deposits (Sainsbury, 1965, 1969c), especially where lamprophyre dikes in faults intersected porous zones along thrust faults.

In the east half of the quadrangle, high-angle faults of probable Tertiary age, striking N. 10°-20° E., are especially conspicuous. Some of these faults may be active yet, for the eastward-striking Kigluaik fault, which bounds the entire north front of the Kigluaik Mountains and which cuts glacial deposits, apparently is offset as much as several thousand feet by north-trending faults.

The structure of the Precambrian rocks in the Kigluaik Mountains appears simple on superficial examination, but structure as revealed in rocks along the great arch forming the axis of the range is extremely complex in detail. The distribution of lithologic units is most easily attributed to eastward thrusting and folding on north-south lines, followed by uplift and warping on east-west axes.

ORE DEPOSITS

Several distinct types of lode and placer deposits in the Teller quadrangle are of economic importance, the Lost River tin mine being the most important tin lode of the United States (Knopf, 1908; Sainsbury, 1964). Lode deposits include tin, tungsten, and beryllium lodes related to the Upper Cretaceous granites (Knopf, 1908; Sainsbury and others, 1968; Sainsbury, 1968), as well as minor lode deposits of copper localized along silicified zones above thrust faults in carbonate rocks. Graphite in economically important amounts occurs in altered graphitic schist near the Kigluaik fault. At least 2,500 tons of tin has been produced from placer deposits, mostly from Buck Creek, near Potato Mountain (Mulligan, 1965), and from Cape Creek (Mulligan, 1966), which is producing currently. Placer gold deposits are mined now at the headwaters of the Right Fork of the Bluestone River in the Teller A-3 quadrangle; other placer gold deposits in the same quadrangle were mined formerly (Collier and others, 1908). In the Teller C-2 quadrangle gold placers of importance were mined on Sunset Creek, north of Grantley Harbor, and on the tributaries of Budd Creek. Many small gold placers were mined elsewhere. Cinnabar accompanies some placer gold on the Bluestone River and its tributaries, and some platinum-group metals are known in auriferous gravels on the Bluestone River.

Many areas of altered bedrock were sampled during regional mapping, and stream-sediment surveys were made locally. Most of the important data accumulated before 1969 were released in an open-file report (Sainsbury and others, 1969), including economic data for parts of the Bendeleben quadrangle contiguous to the Teller quadrangle; however, one newly discovered area of tin-bearing skarn is outlined on the present map. This mineralized area is inferred from numerous boulders of frost-riven bedrock that lie along the long ridge between Igloo Creek and American River in the Teller B-2 quadrangle, and from scattered outcrops of tactite containing fluorite. Spectrographic analyses of this tactite show highly anomalous amounts of tin, beryllium, and bismuth (>1,000 ppm Sn, 1,000 ppm Be, and >1,000 ppm Bi). The widespread tactite is clear evidence of a nearby intrusive rock, and the abundant fluorite, tin, beryllium, and bismuth are similar to those in tin-bearing deposits elsewhere on the Seward Peninsula. The extent of the mineralized area, which lies on the public domain, has not been determined, but the area warrants more work. Too, the drainages that border the mineralized area should be evaluated for placer tin and gold.

PETROLEUM POTENTIAL

With the intense interest in northern Alaskan oil, petroleum companies are becoming interested in the Seward Peninsula. The extreme structural complexity of the rocks is of primary importance in evaluating the petroleum potential of the area. Although unmetamorphosed limestones occur in the York Mountains, these limestones are part of relatively thin thrust sheets which overlie structurally complex rocks, principally of Precambrian age, which are mildly to intensely metmorphosed; thus the chances for oil pools in the mapped area are considered very small. Moreover, although sediments of Tertiary age occur offshore in the Bering and Chukchi Seas (Scholl and Hopkins, 1969), and may extend a short distance landward of present beaches, the complex structure in the pre-Tertiary rocks also extends seaward beneath the Tertiary rocks. Petroleum may occur in the Tertiary rocks, but is considered unlikely in the pre-Tertiary rocks as far as thrusting goes seaward.

REFERENCES CITED

Boucot, A. J., 1969, The Soviet Silurian—Recent impressions: Geol. Soc. America Bull., v. 80, no. 6, p. 1155-1162.

Brooks, A. H., assisted by G. B. Richardson and A. J. Collier, 1901, A reconnaissance of the Cape Nome and adjacent gold fields of Seward Peninsula, Alaska, in 1900, [Pt. 1] *of* Reconnaissances in the Cape Nome and Norton Bay regions, Alaska, in 1900: U.S. Geol. Spec. Pub., p. 1-185.

Cobb, E. H., and Sainsbury, C. L., compilers, 1968, Metallic mineral resources map of the Teller quadrangle, Alaska: U.S. Geol. Survey open-file report, 8 p., map, scale 1:250,000.

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

——1904, The tin deposits of the York region, Alaska: U.S. Geol. Survey Bull. 229, 61 p.

Collier, A. J., Hess, F. L., Smith, P. S., and Brooks, A. H., 1908, The gold placers of parts of the Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 328, 343 p.

Knopf, Adolph, 1908, Geology of the Seward Peninsula tin deposits, Alaska: U.S. Geol. Survey Bull. 358, 71 p.

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

Mulligan, J. J., 1965, Tin-lode investigations, Potato Mountain area, Seward Peninsula, Alaska: U.S. Bur. Mines Rept. Inv. 6587, 85 p.

——1966, Tin-lode investigations, Cape Mountain area, Seward Peninsula, Alaska: U.S. Bur. Mines Rept. Inv. 6737, 44 p.

Ross, R. J., Jr., 1965, Early Ordovician trilobites from the Seward Peninsula, Alaska: Jour. Paleontology, v. 39, no. 1, p. 17-20.

Sainsbury, C. L., 1964, Geology of the Lost River mine area, Alaska: U.S. Geol. Survey Bull. 1129, 80 p.

——1965, Quaternary geology of western Seward Peninsula, Alaska, *in* Hopkins, D. M., ed., The Bering land bridge: Stanford, Calif., Stanford Univ. Press, p. 121-143.

——1967, Upper Pleistocene features in the Bering Strait area, *in* Geological Survey research 1967: U.S. Geol. Survey Prof. Paper 575-D, p. D203-D213.

——1968, Tin and beryllium deposits of the Central York Mountains, western Seward Peninsula, Alaska, *in* Ridge, J. D., ed., Ore deposits in the United States, 1933-67: Am. Inst. Mining, Metall., and Petroleum Engineers, v. 2, p. 1555-1572.

——1969a, Geologic map of the Teller B-4 and southern part of the Teller C-4 quadrangles, western Seward Peninsula, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I-572.

—— 1969b, The A. J. Collier thrust belt of the Seward Peninsula, Alaska: Geol. Soc. America Bull., v. 80, no. 12, p. 2595-2596.

——1969c, Geology and ore deposits of the Central York Mountains, western Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 1287, 101 p.

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

Sainsbury, C. L., and Hamilton, J. C., 1967, Mineralized veins at Black Mountain, western Seward Peninsula, Alaska, *in* Geological Survey research 1967: U.S. Geol. Survey Prof. Paper 575-B, p. B21-B25.

Sainsbury, C. L., Hamilton, J. C., and Huffman, Claude, Jr., 1968, Geochemical cycle of selected trace elements in the tin-tungsten-beryllium district, western Seward Peninsula, Alaska—a reconnaissance study: U.S. Geol. Survey Bull. 1241-F, 41 p.

Sainsbury, C. L., Kachadoorian, Reuben, Hudson, Travis, Smith, T. E., Richards, T. R., and Todd, W. E., 1969, Reconnaissance geologic maps and sample data, Teller A-1, A-2, A-3, B-1, B-2, B-3, C-1, and Bendeleben A-6, B-6, C-6, D-5, D-6 quadrangles, Seward Peninsula, Alaska: U.S. Geol. Survey open-file report, 65 p.

Scholl, D. W., and Hopkins, D. M., 1969, Newly discovered Cenozoic basins, Bering Sea shelf, Alaska: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, p. 2067-2078.

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.