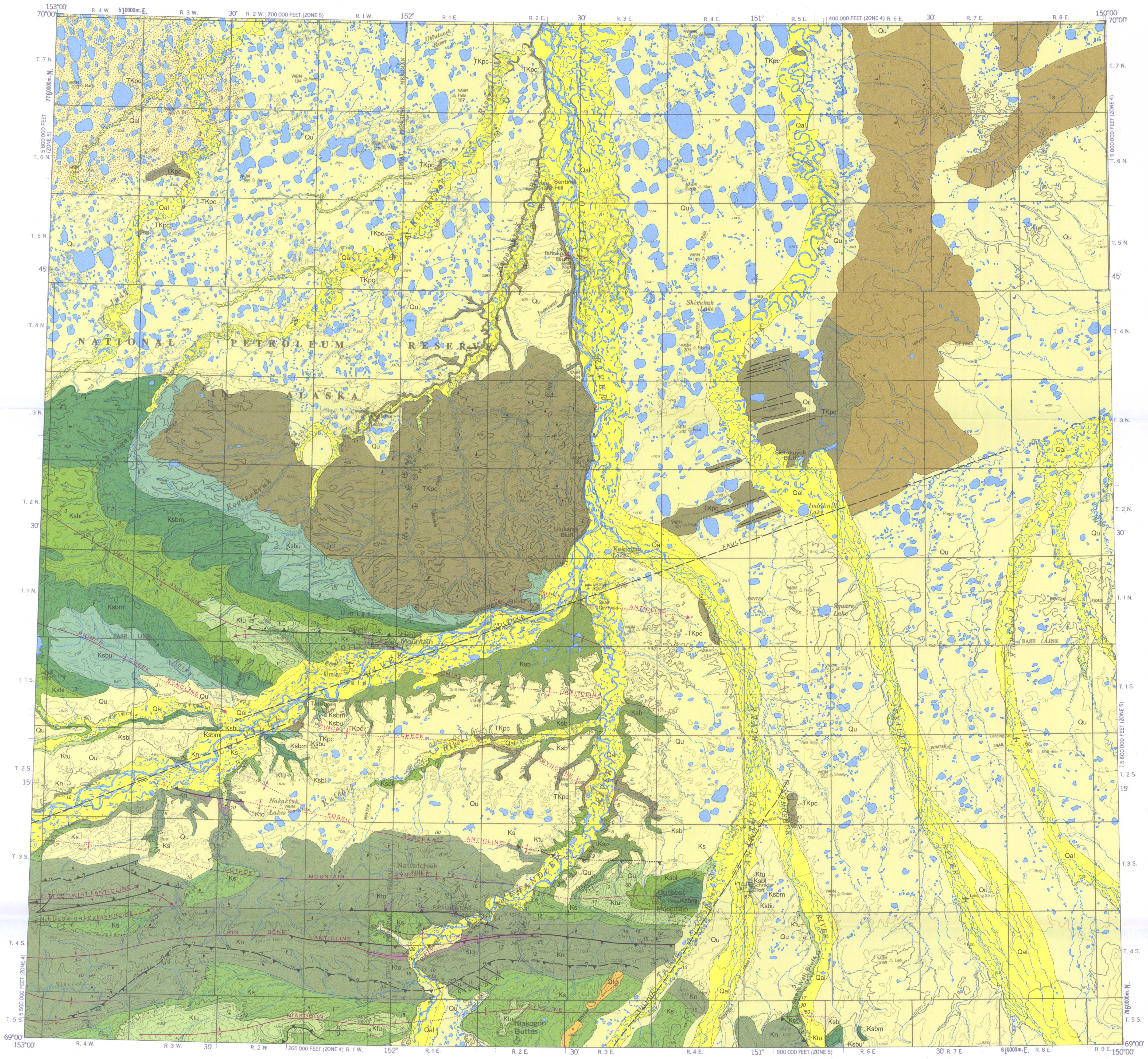
Prepared in cooperation with
ALASKA DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF OIL AND GAS

With regards
Gil



Base from U.S Geological Survey, 1956
Universal Transverse Mercator projection
1927 North American Datum
100,000-foot grid ticks based on Alaska coordinate system, zones 4 and 5

APPROXIMATE MEAN DECLINATION, 2004

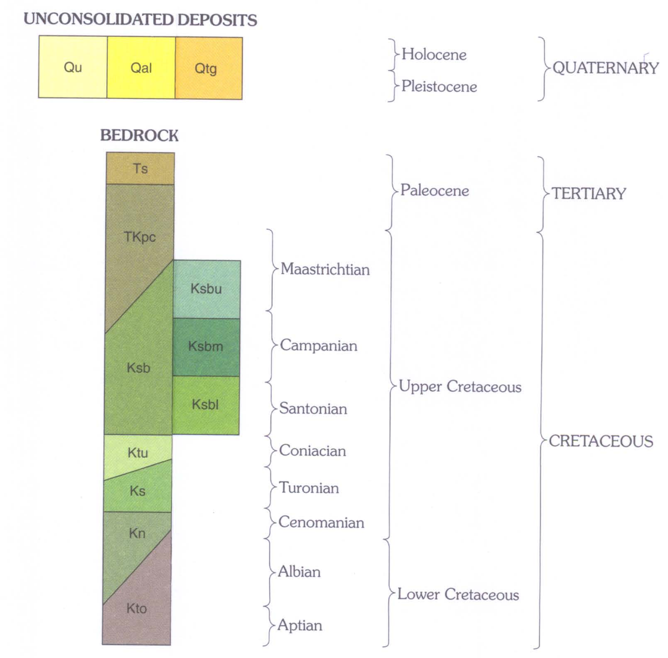
SCALE 1:250 000

CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

Geology mapped by W.P. Brosgé, C.L. Whittington, 1966; R.L. Detterman, R.S. Bickel, George Gryc, 1963; A.J. Martin and others, 1968; G.H. Pessel, C.G. Mull, 1964
Digital cartography and compilation by Christopher P. Garrity
Edited by Elizabeth D. Koozmin

CORRELATION OF MAP UNITS



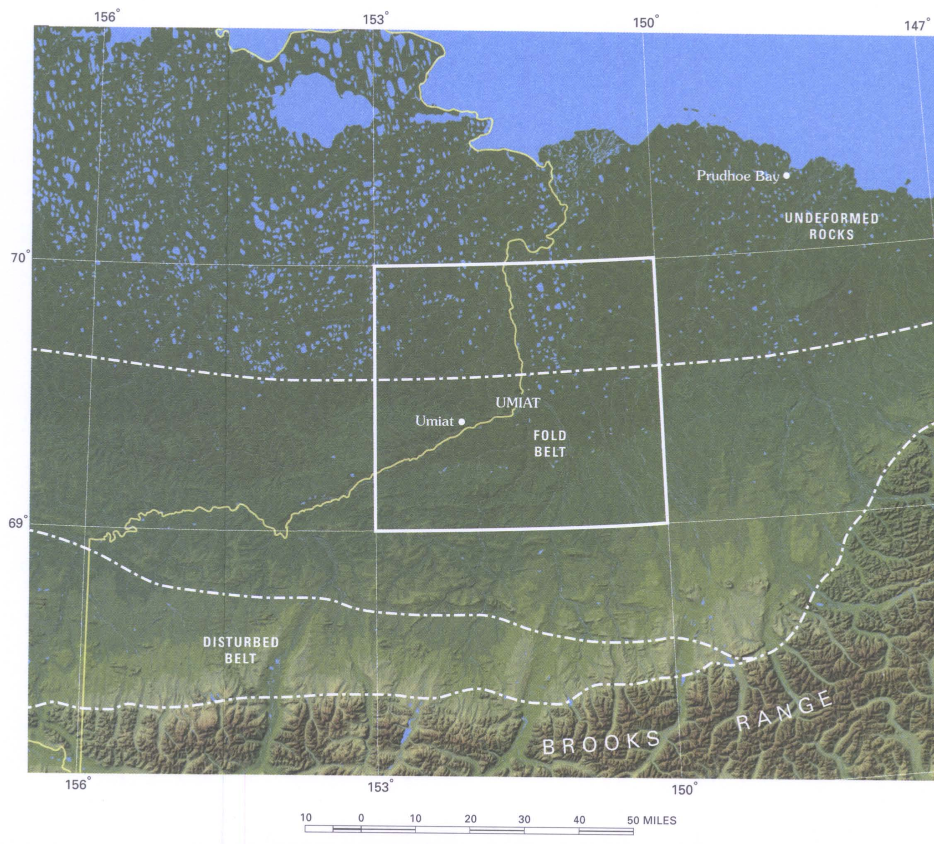


Figure 1.—East-central North Slope of Alaska showing location of Umiat quadrangle (outlined in white) and major geologic provinces. National Petroleum Reserve in Alaska (NPRA) outlined in yellow.

DESCRIPTION OF MAP UNITS

Qu **Surficial deposits, undifferentiated (Holocene and Pleistocene)**—Tundra-covered, fine-grained, organic-rich silt, loess, and local colluvium and fine-grained alluvial sand and silt in areas adjacent to upland slopes. Includes several levels of terrace deposits up to about 150 ft above stream level adjacent to Chandler River, Anaktuvuk River, and the Colville River upstream from Umiat; also includes unstratified marine sand, silt, and local gravel derived from the Gubik Formation, which underlies much of area of abundant shallow lakes in the northern part of the Umiat quadrangle and adjacent areas in Arctic coastal plain (Brosgé and Whittington, 1966), but is not differentiated on map. Includes vegetated eolian sand dunes in northwestern part of quadrangle

Qal **Alluvial deposits (Holocene and Pleistocene)**—Alluvial sand, gravel, and silt in active braided and meandering stream flood plains, and in adjacent low, lightly vegetated abandoned flood plains and low terraces

Qtg **Terrace gravels (Holocene and Pleistocene)**—Tundra-covered, high-level alluvial gravels from glacial outwash, mapped only on west side of Tuluga River about 250 ft above present stream level

Ts **Sagavanirktok Formation, lower part (Gryc and others, 1951; Detterman and others, 1975; revised by Mull and others, 2003) (upper Paleocene)**—Poorly consolidated, fine- to coarse-grained sandstone, pebble to cobble conglomerate, mudstone, shale, and lignite. Probably correlative with Sagwon Member of Sagavanirktok Formation to the east (Mull and others, 2003). Mostly covered by tundra and poorly exposed; underlies low rolling uplands in northeast part of quadrangle

TKpc **Prince Creek Formation (Gryc and others, 1951, Brosgé and Whittington, 1966; revised by Mull and others, 2003) (Upper Cretaceous, Campanian, to Paleocene)**—Lower part typically consists of medium- to coarse-grained, clean, well-sorted sandstone composed dominantly of quartz and chert; interbedded with bentonite, bentonitic shale, carbonaceous shale, and coal. Upper part is dominantly fine grained sandstone. Forms prominent bluffs along the north and northwest side of the Colville River downstream from Umiat, with scattered exposures along the Chandler and Anaktuvuk Rivers. Elsewhere, underlies broad, linear, tundra-covered ridges with almost no exposures in upland areas. Age is probably entirely Upper Cretaceous in map area; upper part becomes younger to the east

Ksb **Schrader Bluff Formation, undivided (Gryc and others, 1951; Whittington, 1956; Detterman and others, 1963; Brosgé and Whittington, 1966; revised by Mull and others, 2003) (Upper Cretaceous, Santonian, to Maastrichtian)**—Marine sandstone, bentonitic mudstone, and shale, with varying amounts of siltstone, fine-grained tuffaceous sandstone, tuff, and bentonite. In some areas, informally divided into upper, middle, and lower parts. Middle part more resistant than the upper and lower parts. Generally exposed only in intermittent streambanks or as scattered rubble traces on upland ridges. Type locality at Schrader Bluff on Anaktuvuk River. Includes rocks formerly included as Sentinel Hill, Barrow Trail, and Rogers Creek Members by Brosgé and Whittington (1966)

Ksbu Upper part—Dominantly bentonitic mudstone, shale, and thin-bedded bentonitic sandstone. Characterized by numerous bentonite slurry flows. Exposed in river bluffs along north side of Colville River, downstream from Umiat

Ksbm Middle part—Resistant tuffaceous sandstone with relatively abundant marine bivalves and tuff. Crops out locally and underlies tundra-covered upland ridges. Exposed intermittently along south bank of Colville River upstream from Umiat, along southeast bank of the Chandler River, and along upland ridge tops on Outpost Mountain

Ksbl Lower part—Dominantly bentonitic mudstone, shale, and thin-bedded bentonitic sandstone. Mostly covered but present along south bank of Colville River upstream from Umiat and along southeast bank of the Chandler River

Ktu **Tuluvak Formation (Gryc and others, 1951; Whittington, 1956; revised by Mull and others, 2003) (Upper Cretaceous, Turonian to Coniacian)**—Clean, well-sorted, fine- to medium-grained quartz sandstone and quartz- and chert-pebble conglomerate, commonly with good porosity and permeability. Contains two relatively resistant intervals that form either mesa-like uplands with locally resistant ledges, or rounded, rubble-covered benches on hillsides. Intervals separated by tundra-covered areas underlain by less resistant bentonitic shale and mudstone exposed only in scattered streambanks. Lower part includes sandstone, siltstone, and interbedded shale formerly mapped as upper part of the Ayiyak Member of the Seabee Formation by Detterman and others (1963). Forms main reservoir unit in Gubik gas field

Ks **Seabee Formation (Gryc and others, 1951; Whittington, 1956; revised by Mull and others, 2003) (Upper Cretaceous, Cenomanian, to Coniacian)**—Bentonitic mudstone, silty mudstone; and medium- to dark-gray to black, fissile, organic-rich shale, with interbedded bentonite and some thin, silicified tuff beds; some localities characterized by large, yellowish-brown-weathering ovoid concretions greater than 3 ft diameter. Generally poorly exposed, forms broad tundra-covered valleys marked by scattered, bare, white-weathering shale frost boils. Best exposed at Shale Wall Bluff on Nanushuk River and in scattered streambanks along the Chandler, Nanushuk, and Colville Rivers. Includes rocks formerly mapped as Shale Wall Member by Detterman and others (1963)

Kn **Nanushuk Formation, undivided (Gryc and others, 1951; Detterman, 1956; revised by Mull and others, 2003) (Lower Cretaceous, Albian, to Upper Cretaceous, Cenomanian)**—Fine- to medium-grained, locally conglomeratic sandstone consisting dominantly of quartz and black chert, with interbedded siltstone and silty and carbonaceous mudstone; uppermost part contains cleaner, more porous sandstones. Forms relatively resistant linear ridges with scattered rubble traces in upland areas on flanks of Big Bend anticline in southern part of quadrangle. Includes rocks formerly mapped as Ninuluk, Niakogon, Chandler, Grandstand, and Tuktu Formations of Nanushuk Group by Detterman (1956) and Detterman and others (1963). Forms reservoir interval in Umiat oil field

Kto **Torok Formation, upper part (Gryc and others, 1951; Patton, 1956) (Lower Cretaceous, Albian)**—Dark-gray mudstone and silty mudstone with lesser amounts of greenish-gray, thin-bedded siltstone. Poorly exposed in map area; present only in axial zone of Big Bend anticline near Chandler River

EXPLANATION OF MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed

Faults—Dashed where approximately located; dotted where concealed; queried where uncertain

Normal fault—U, upthrown side; D, downthrown side

Thrust fault—Teeth on upper plate

Wrench fault—Approximately located. Arrows indicate relative movement

Folds—Dashed where approximately located; dotted where concealed; queried where uncertain

Anticline—Showing direction of plunge

Syncline—Showing direction of plunge

Traceable beds

Lineaments

Strike and dip of beds

40 Inclined

Horizontal

Estimated

Vegetated dunes

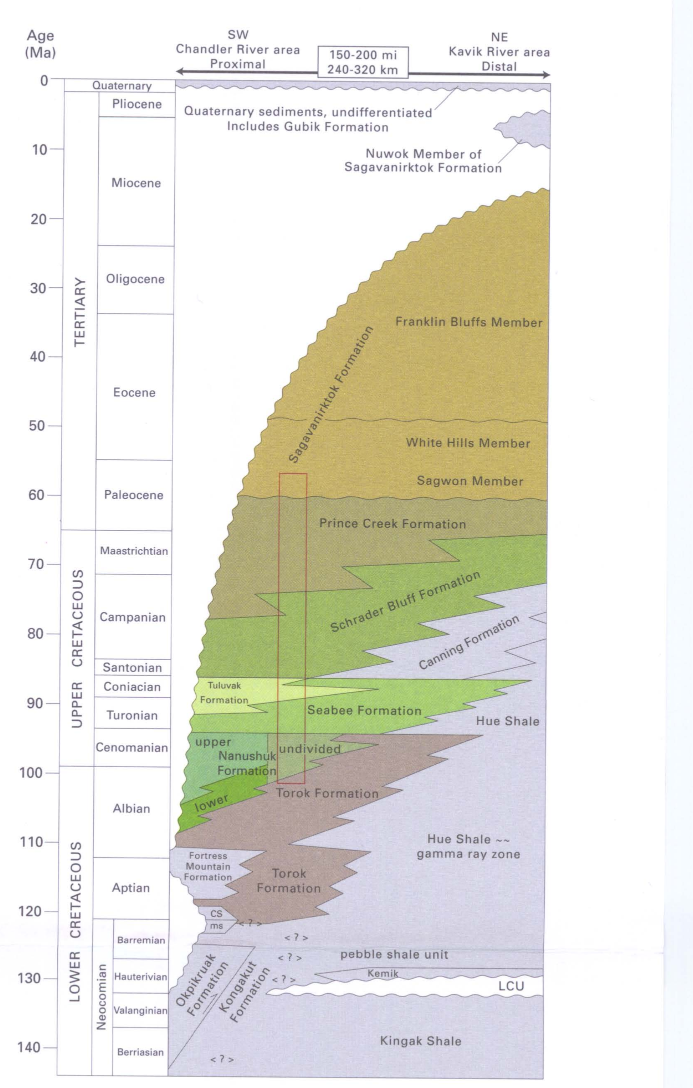


Figure 2.—Chronostratigraphic column for the Colville basin, northern Alaska. Red box shows stratigraphic section in the Umiat quadrangle. Abbreviations or symbols are as follows: <?>, uncertain relationship; CS, cobblestone sandstone of Fortress Mountain Formation (informal unit of Mull and others, in press); ms, manganiferous shale unit (informal term); Kemik, Kemik Sandstone (formation) as revised by Molenaar and others (1987); LCU, Lower Cretaceous unconformity. Geologic time scale from Gradstein and Ogg (1996).

GEOLOGIC MAPS OF NORTHERN ALASKA

Edited by

David W. Houseknecht

Arctic Alaska hosts a spectrum of geology and a wealth of natural resources matched by few areas on Earth. Prior to the 1940s, geologic investigations in the region mostly were limited to coastal surveys and inland reconnaissance studies. Nevertheless, the potential for petroleum accumulations beneath Alaska's North Slope and for mineral deposits in the Brooks Range was recognized through the observations of the early expeditions. World War II demonstrated an urgent need for domestic energy and mineral resources and stimulated the initial systematic geologic mapping in northern Alaska as a basis for energy and mineral exploration. The geologic maps generated by those initial efforts also served as the foundation for additional petroleum exploration in the wake of the oil embargo of the 1970s. A few years into the 21st century, the natural resources of northern Alaska again are a focus of national attention. The need for detailed geologic maps is greater than ever, not only as a basis for petroleum and mineral exploration, but also for land-use planning and mitigating the environmental impacts of developing those resources.

The U.S. Geological Survey (USGS) performed the initial systematic mapping of the geology of Alaska's North Slope, including the northern front and foothills of the Brooks Range, between 1944 and 1953. Maps resulting from that work were published between 1960 and 1966 as USGS Professional Paper 303. Since that time, numerous geologic maps of individual quadrangles, or parts of quadrangles, have been published by the USGS and by the Alaska Division of Geological and Geophysical Surveys (ADGGS). Until now, no attempt was made to produce an integrated set of geologic maps using a uniform scale and cartographic standards, and consistently applied stratigraphic nomenclature. SIM–2817 is a set of digital geologic maps comprising individual 1:250,000 quadrangles, each assigned a unique letter (for example, this map of the Umiat quadrangle is SIM–2817–A). The objective of these reports is to provide a new unified set of geologic maps of the northern flank and foothills of the Brooks Range using a uniform scale and cartographic style, as well as consistent stratigraphic nomenclature.

Although this collection of geologic maps incorporates significant contributions by many geologists who have mapped in northern Alaska during the past six decades, it would not be possible except for one geologist. This compilation is a testament to the career contributions of Charles G. (Gil) Mull, who has spent nearly forty years mapping the geology of the region for the petroleum industry, the USGS, the ADGGS, and the Alaska Division of Oil and Gas.

GEOLOGIC MAP OF THE UMIAT QUADRANGLE

By

Charles G. Mull, David W. Houseknecht, G.H. Pessel, and Christopher P. Garrity

INTRODUCTION

This geologic map of the Umiat quadrangle is a compilation of USGS geologic maps previously published by Detterman and others (1963) and Brosgé and Whittington (1966), and unpublished mapping by Pessel and Mull (1964) for the Richfield Oil Corporation. Geologic mapping from these three primary sources was augmented with additional unpublished map data from British Petroleum Company (Martin, 1968). This report incorporates recent revisions in stratigraphic nomenclature by Mull and others (2003). Stratigraphic and structural interpretations were revised with the aid of modern high-resolution color infrared aerial photographs. The revised geologic map was checked in the field during the summers of 2001 and 2002.

The geologic unit descriptions on this map are condensed from those in Mull and others (2003), who give detailed information on thicknesses, regional distributions, age determinations, and depositional environments. Details of many specific localities in the map area are provided by Detterman and others (1963) and Brosgé and Whittington (1966). Additional important aspects of the geology of the Umiat oil field are discussed by Molenaar (1982, 1985), Fox (1979), Huffman (1985), and May and Shane (1985).

HISTORY OF EXPLORATION

The Umiat area played an important role in the geological exploration of northern Alaska. The first geologic transect of the Arctic Slope was conducted during the summer of 1901 by USGS geologist F.C. Schrader and topographer W.J. Peters, who descended the Anaktuvuk River in canoes to its junction with the Colville River, not far downstream from the present settlement of Umiat in the west-central part of the quadrangle. From there they proceeded northward down the Colville River to the Beaufort Sea and then west along the coast to Barrow and, eventually, Cape Lisburne. While mapping the topography and making reconnaissance geological observations, they noted the presence of coal-bearing Cretaceous and Tertiary sediments along the rivers in what is now delineated as the Umiat quadrangle, and correctly surmised that a major sedimentary basin must underlie the area (Schrader, 1902, 1904). This information, combined with the reports of major oil seepages along the Arctic Coast by Leffingwell (1919), played a significant role in establishing the Naval Petroleum Reserve #4 (NPR-4, now known as the National Petroleum Reserve in Alaska, or NPRA) in 1923.

Oil seepages near Umiat Mountain, a prominent landmark, were first reported in the early 1940s by Simon Paneak, an Inupiat resident of Anaktuvuk Pass and Chandler Lake. Paneak guided U.S. Bureau of Mines scientists to these oil seeps during the summer of 1943, and the resulting report (Ebbley, 1943) led to aerial reconnaissance studies in the spring of 1944 by Lt. W.T. Foran of the U.S. Navy. Foran noted the presence of the prominent Umiat anticline in the vicinity of the oil seeps (Reed, 1958). Later that summer, the structure was mapped in detail on foot by Foran and others, and by boat by R.R. Coats and George Gryc of the USGS, who measured, described, and correlated many exposures of Cretaceous strata along the Colville River from Umiat Mountain to the mouth of the Anaktuvuk River (Reed, 1958). Using the structural mapping and regional correlations of Foran, Coats, and Gryc, a well location was selected and drilled by the Navy in 1945. This well, Umiat #1, was a dry hole, but subsequent wells drilled between 1946 and 1950 closer to the axis of the anticline resulted in the discovery and delineation of a small oil field with an estimated 70 million recoverable barrels in Lower Cretaceous rocks of the Nanushuk Formation (Molenaar, 1982). The Umiat #8 well, located near the crest of the anticline, also produced gas at a rate of about 6 million cubic feet per day; recoverable gas reserves were estimated at 4.7 billion cubic feet by Molanaar (1982).

In 1952, the Navy tested an anticline on the lower Chandler River, 16 mi east of Umiat, and discovered the Gubik gas field, estimated to contain 600 billion cubic feet of natural gas (Kornbrath and others, 1997) in Upper Cretaceous sandstones of the Tuluvak Formation and the upper part of the Nanushuk Formation (Robinson, 1958). Details of the extensive geologic field studies by the USGS in the Umiat area and the geophysical studies and drilling by the Navy are given by Reed (1958), Collins (1958), Brosgé and Whittington (1966), and Molenaar (1982).

The Navy established an all-weather airstrip and base camp at Umiat for its operations; the camp also served as a base for USGS geological field parties throughout the foothills of the Arctic Slope during the entire period of active drilling and seismic exploration of NPR-4 by the Navy, which extended from 1944 to 1953. From 1958 to 1964, Umiat served as the major base for operations by the oil industry in its surface mapping and geophysical exploration of the area until other all-weather airstrips were constructed along the Sagavanirktok River to the east. For the past four decades, the airstrip at Umiat and a commercial camp have continued to serve as a base of operations for intermittent geologic studies by both the USGS and the oil industry.

The oil and gas discoveries at Umiat and Gubik, although small by current Alaskan standards, served as the impetus for more widespread exploration by the oil industry. Exploration began in 1958 with surface geological investigations by a number of companies. These studies led to geophysical surveys and drilling of several additional exploration wells in the Umiat quadrangle by a partnership of British Petroleum and Sinclair Oil Company, and by other companies in the early 1960s. In 1968, studies by Atlantic Richfield Company and Humble Oil Company (now Exxon Co., USA) led to the discovery of the supergiant Prudhoe Bay oil field 100 mi northeast of Umiat. Following the success of industry exploration, the Navy and U.S. Department of Interior carried out renewed exploration of the renamed National Petroleum Reserve in Alaska (NPRA) from 1974 to 1982, including additional geophysical surveys and drilling of another deep exploratory well (Seabee #1) at Umiat. The results of this second phase of government exploration in NPRA were published in Gryc (1988).

REGIONAL SETTING

The geology of the Umiat 1:250,000-scale quadrangle in the east-central Alaska North Slope spans the transition from the deformed rocks of the foothills of the northern Brooks Range into the undeformed rocks of the Arctic coastal plain. Rocks exposed in the quadrangle are part of the gently south dipping northern flank of the Colville basin, which is a deep, asymmetrical foreland basin of Cretaceous and Tertiary age that lies north of the Brooks Range orogenic belt. The Colville basin is underlain by a Devonian and older, deformed and weakly metamorphosed basement complex (Dumoulin, 2001) assigned to the Franklinian sequence (Lerand, 1973; Hubbard and others, 1987a,b; Bird and Molenaar, 1992). A relatively thin section of Carboniferous to lowest Cretaceous (lower Neocomian) strata representing platform deposits of the Ellesmerian and Beaufortian sequences (Bird and Molenaar, 1992) overlies the basement.

The rocks of the Colville basin are assigned to the Brookian sequence, a thick section of lower to middle Cretaceous (Aptian to Cenomanian) foreland basin deposits. The Torok and Nanushuk Formations are the primary units that fill the Colville basin and form most of the surface exposures of the southern part of the Brooks Range foothills fold belt; they also underlie the northern foothills belt and coastal plain of northern Alaska (see regional map in Mull and others, 1987, or Moore and others, 1994). Brookian sediments were eroded and transported northward from orogenic belts in the Brooks Range and eastward from the Chukchi platform, an ancestral highland that now lies beneath the Chukchi Sea west of northern Alaska (Mull, 1979). The basin fill is a thick (>12,000 ft), eastward-prograding clastic wedge consisting of deep marine basin and slope deposits (Torok Formation) and overlying shallow-marine shelf, deltaic, and nonmarine deposits (Nanushuk Formation). Following the eastward progradation of the Torok-Nanushuk clastic wedge to an ultimate shelf margin east of the Colville River in the eastern Umiat quadrangle, the top of the Nanushuk was flooded by a regional marine transgression, which led to deposition of the Upper Cretaceous (Cenomanian to Coniacian) Seabee Formation. Renewed progradation of clastic depositional systems subsequently resulted in deposition of Upper Cretaceous to Miocene shallow-marine through nonmarine strata of the Tuluvak, Schrader Bluff, Prince Creek, and Sagavanirktok Formations. Deposition of these sediments completed the filling of the Colville basin in the area of the Umiat quadrangle.

Although mostly covered with tundra, the Umiat quadrangle and adjacent Chandler Lake quadrangle to the south contain the key exposures and the type sections of many of the formations of Aptian to Paleocene age on the Alaska North Slope (Mull and others, 2003). Excellent exposures are present at Umiat Mountain (uppermost Nanushuk, Seabee, and lower Tuluvak Formations) and Shivugak Bluff (Schrader Bluff and Prince Creek Formations) on the Colville River, Schrader Bluff (Tuluvak and Schrader Bluff Formations) on the Anaktuvuk River, Shale Wall Bluff (Seabee and lower Tuluvak Formations) on the Nanushuk River, and near Big Bend (Nanushuk Formation) on the Chandler River. Type sections for the Seabee Formation (Shale Wall Bluff) and Schrader Bluff Formation (Schrader Bluff), and typical exposures for the lower part of the Prince Creek Formation (Shivugak Bluff and unnamed bluffs along the Colville River downstream from the mouth of the Anaktuvuk River) are located in the Umiat quadrangle (Mull and others, 2003).

Seismic data east of the Colville River reveal north-south-trending, ultimate shelf margins of the Torok-Nanushuk clastic wedge in the eastern Umiat quadrangle and of the Seabee-Tuluvak clastic wedge along the boundary between the Umiat and Sagavanirktok quadrangles. These ultimate shelf margins represent the farthest basinward extent of shallow-marine through nonmarine deposits in these formations. Coeval rocks east of these ultimate shelf margins consist dominantly of a thinner succession of marine-slope, basin, and condensed sediments that have a separate stratigraphic nomenclature.

REGIONAL STRUCTURE

The succession of relatively resistant Albian to Eocene clastic rocks in the Umiat and adjacent quadrangles is regionally deformed into a series of long, linear, relatively broad, open synclines; and tightly folded and faulted anticlines. These structures are developed above a décollement in relatively incompetent shales and mudstones of the underlying Torok Formation (Aptian to Cenomanian) and Kingak Formation (Jurassic to Lower Cretaceous), which form the cores of the anticlines but are either poorly or not exposed in the Umiat quadrangle. Many of the anticlines mapped in the foothills of the Brooks Range are characterized by north-vergent thrust faults. However, south-vergent back thrusts also are evident in some areas, particularly in areas in which the anticlines are defined at the surface by resistant beds of the Nanushuk Formation. A thrust fault along the axis of Umiat anticline is here reinterpreted as a south-vergent back thrust. The area of Little Twist anticline, in the southwestern corner of the Umiat quadrangle, also is marked by two south-vergent back thrusts.

Regional structural and stratigraphic relationships and apatite fission-track data suggest that the deformation of this part of the foothills fold belt probably occurred during the early Tertiary in response to a late stage of uplift of the Brooks Range orogenic belt to the south (Mull and others, 1997; O'Sullivan and others, 1997; Mull and others, in press).

Two northeast-southwest-trending regional faults not mapped by earlier workers are inferred to underlie the linear northeast-trending reaches of the alluviated valleys of the Colville and Tuluga Rivers. These faults, the Colville and Tuluga faults, are inferred on the basis of (1) the anomalous linear character of the two river valleys, and (2) the presence of apparent structural anomalies flanking both valleys in the Umiat quadrangle and in the adjacent Chandler Lake, Ikpikpuk River, and Killik River quadrangles. Although detailed structural control is sparse adjacent to some parts of the Colville and Tuluga Rivers, anomalous bends in the axes of some anticlines are compatible with left-lateral strike-slip movement along wrench fault zones. The axis of the Umiat anticline is particularly anomalous; its regional northwest-southeast trend changes to an east-west trend adjacent to the inferred Colville fault zone, which trends N. 65° E. In addition, the axial zone of the anticline near the Colville River is markedly more complicated than elsewhere, and contains a south-vergent back thrust that is not evident along the anticline northwest of Umiat. In a similar fashion, on the south side of the Colville River, the Fossil Creek anticline is bifurcated and, near the river, has a significant thrust fault along the southern arm of the axis. This anticlinal trend seems to have no comparable expression on the north side of the river. In contrast to the Umiat and Fossil Creek anticlines, the axis of the relatively small Gubik anticline, northeast of Umiat, seems to extend uninterrupted across the trace of the inferred Colville fault. The trends of some of the other structural axes near the Colville River are poorly constrained. However, in general the Colville River seems to separate an area of northwest-southeast-trending fold axes north of the river from an area of generally east-west-trending fold axes south of the river. East of the Anaktuvuk River, unexplained northeast-trending linear features expressed in the tundra-covered coastal plain are parallel to the northeastern extension of the inferred Colville fault zone.

Similar structural anomalies are present across the Tuluga fault, which is inferred to trend N. 30° E. beneath the Tuluga River valley. Outpost Mountain, on the west side of the Tuluga River, displays a gently east-plunging open syncline in Upper Cretaceous rocks, whereas the coeval rocks at Schrader Bluff, on the east side of the Tuluga and Anaktuvuk Rivers, dip steeply southward. South of Outpost Mountain, the Big Bend anticline trends east-west on the west side of the Tuluga River, but has no expression on the east side of the river, where poor exposures of the Nanushuk Formation apparently strike about N. 45° W. South of the Umiat quadrangle, in the northern Chandler Lake quadrangle, additional structural anomalies compatible with left-lateral strike-slip movement are present along the trend of the inferred Tuluga fault.

The Colville and Tuluga faults are interpreted as deep-seated wrench faults above which the alternating relatively competent and incompetent Lower and Upper Cretaceous strata are deformed differentially above the underlying, more competent basal Mesozoic and Paleozoic rocks. The faulting is oblique to the fold trends and apparently postdates the early Tertiary deformation that formed the foothills fold belt. Slip along both faults probably does not exceed a few miles. The pattern of deflected axial traces in some areas, apparent termination of fold axes in other areas adjacent to the Colville River, and apparent en-echelon folding above the fault trace in still other areas are all compatible with deformation associated with small- to intermediate-displacement wrench faults (Harding and Lowell, 1979).

ACKNOWLEDGMENTS

Many of the authors whose work is cited in this report freely shared their data and insights with us. Over the years, field observations and discussions with a large number of colleagues have contributed immensely to our knowledge and understanding of the geology of the Alaskan Arctic Slope and northern Brooks Range. Special thanks go to field companions H.S. Sonneman, D.H. Roeder, and G.W. Newman of Exxon Company, USA; M.D. Mangus of Atlantic Richfield Company; J.E. Decker, J.T. Dillon, R.R. Reifenstuhl, E.E. Harris, and D.L. LePain of the Alaska Division of Geological and Geophysical Surveys; M.D. Myers of the Alaska Division of Oil and Gas; I.L. Tailleur, J.T. Dutro Jr., W.W. Patton, Jr., H.N. Reiser, C.M. Molenaar, I. Ellersicck, C.F. Mayfield, T.E. Moore, C.J. Schenk, and C.J. Potter of the U.S. Geological Survey; and D.A. Bodnar, J.P. Siok, K.E. Adams, R.A. Alexander, R.K. Glenn, A.V. Anderson, W.R. Camber, N.T. Harun, K.F. Watts, R.K. Crowder, W.W. Wallace, T.A. Imm, and M.K. Wartes of the University of Alaska Department of Geology and Geophysics. Office discussions and reviews by K.J. Bird, C.M. Molenaar, J.A. Dumoulin, S.M. Karl, K.D. Kelley, J.H. Dover, and A.G. Harris of the USGS added additional valuable data and understanding. In addition, we acknowledge the paleontological contributions of M.B. Mickey and H. Haga of Micropaleo Consultants, and of W.P. Elder and R.B. Blodgett, consultants. W.G. Dow and J.T. Allen of Baseline DGSI, Inc., provided valuable organic geochemical analyses. P.B. O'Sullivan and J.M. Murphy contributed their knowledge of fission-track dating.

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GEOLOGIC MAP OF THE UMIAT QUADRANGLE, ALASKA

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2004

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